# Carpe Diem Biophysics — The Energy Furnace — Question Bank

ANSWERS AFTER EACH SECTION · MLS 155 · BIOPHYSICS — MLS 155

720 questions · Lectures 1–9 · MLS/PHY · Devil 180 · Easy 180 · Hard 180 · Medium 180

## Contents


| Module | Title | Questions |
|---|---|---|
| 1 | Lecture 1 — Introduction & Energy Expenditure | 80 |
| 2 | Lecture 2 — Biomechanics | 80 |
| 3 | Lecture 3 — Biomechanics (Continued) | 80 |
| 4 | Lecture 4 — Physics of Eyes & Vision | 80 |
| 5 | Lecture 5 — Physics of Eyes & Vision (Cont.) | 80 |
| 6 | Lecture 6 — Physics of Hearing | 80 |
| 7 | Lecture 7 — Hemodynamics | 80 |
| 8 | Lecture 8 — Bioelectricity | 80 |
| 9 | Lecture 9 — Homeostasis | 80 |


Totals: 720 questions — Devil 180 · Easy 180 · Hard 180 · Medium 180.

**Module 1: Lecture 1 — Introduction & Energy Expenditure** — 80 questions

## 1. Set 1 · Q1–10

Fat reserve · Devil

**1. A 70 kg man has fat equal to 10% of body weight. If this fat were the only fuel (available energy 37.7 MJ/kg) and he used his BMR of 7100 kJ per day, for about how long would it last?**

**A** About 16 days
**B** About 37 days
**C** About 4 days
**D** About 370 days

Definition · Easy

**2. Which statement best defines biophysics?**

**A** It applies the theories and methods of physics to understand how biological systems work
**B** It studies the chemical composition of biomolecules without using any physical models
**C** It classifies living organisms by their anatomical features and natural habitats
**D** It tests how drugs are absorbed, distributed and excreted by the human body

BMR and age · Medium

**3. What does the lecture say about BMR as people age past 20?**

**A** It rises by about 1 to 2% per decade as fat mass accumulates
**B** It stays exactly constant throughout adult life
**C** It halves every decade because of reduced thyroid function
**D** It declines by about 1 to 2% per decade, mostly from loss of fat-free mass

Organ efficiency · Easy

**4. Which organ is stated to have an efficiency of less than 1%?**

**A** Skeletal muscle during exercise
**B** Heart during exercise
**C** Whole body during strenuous exercise
**D** Kidneys

BMR and age · Devil

**5. A man's BMR at 20 was 7100 kJ per day. Using the lecture's decline of 1 to 2% per decade (simple, not compounded), what range is expected at age 60?**

**A** About 6390 to 5680 kJ/day
**B** About 6960 to 7030 kJ/day
**C** About 7390 to 7680 kJ/day
**D** About 6530 to 6820 kJ/day

Environmental temperature · Hard

**6. Why does BMR increase when the environment is very cold and also when it is very hot?**

**A** Enzymes become faster at every temperature so reactions need less energy

**B** Heat or cold directly adds chemical energy to cells

**C** The body works harder to hold its temperature at about 37°C in both extremes

**D** BMR rises only in the cold and falls in heat, so the statement is incorrect

ATP · Easy

**7. What happens to ATP when its stored energy is released?**

**A** It returns to adenosine diphosphate (ADP)

**B** It is converted to adenosine monophosphate and glucose

**C** It is converted into glycogen

**D** It is oxidised into lactic acid Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 4

Heat of combustion · Medium

**8. Complete combustion of 1 kg of each fuel liberates different energies. How do fat and carbohydrate compare in available energy?**

**A** Carbohydrate gives about twice the available energy of fat

**B** Fat and carbohydrate give identical available energy of 16.7 MJ/kg

**C** Fat gives about twice the available energy of carbohydrate (37.7 versus 16.7 MJ/kg)

**D** Fat gives about ten times the available energy of carbohydrate

Field focus · Hard

**9. Which pairing of field and listed focus is correct?**

**A** Neuroscience: brain slicing, computer models and membrane permittivity

**B** Sports science: negentropy and stochastic processes

**C** Mathematics: Ångstrom-resolution structures of lipids

**D** Quantum biology: sequence alignment and phylogenetics

BMR power · Hard

**10. The BMR of an average young man is about 7100 kJ per day. What average power does this correspond to?**

**A** About 82 W

**B** About 1970 W

**C** About 8.2 W

**D** About 82 kW

## Answers — Set 1 · Q1–10

**1.** B — Correct: fat mass = 7 kg; 7 × 37.7 = 263.9 MJ; 263.9 ÷ 7.1 MJ/day ≈ 37 days.

**2.** A — Correct: the lecture defines biophysics as applying physics theories and methods to biological systems.

**3.** D — Correct: BMR typically falls 1 to 2% per decade after age 20, largely from reduced fat-free mass.

**4.** D — Correct: the kidneys have an efficiency below 1% because they perform little external mechanical work.

**5.** D — Correct: four decades give a 4 to 8% fall: 7100 × 0.92 = 6532 and 7100 × 0.96 = 6816 kJ/day.

**6.** C — Correct: thermoregulation against either extreme costs extra energy, raising BMR.

**7.** A — Correct: ATP returns to the lower-energy form ADP with a corresponding release of energy.

**8.** C — Correct: 37.7 ÷ 16.7 ≈ 2.3, so fat is roughly twice as energy-dense as carbohydrate.

**9.** A — Correct: neuroscience is listed with experimental brain slicing, theoretical computer models and membrane permittivity.

**10.** A — Correct: 7 100 000 J ÷ 86 400 s ≈ 82 W, inside the 60 to 100 W resting range in the power table.

## 2. Set 2 · Q11–20

Brain energy · Easy

**11. About what fraction of the energy used by the human body is consumed by the brain, according to the lecture?**

**A** Around 20%

**B** Around 2%

**C** Around 50%

**D** Around 90%

Calorie definition · Hard

**12. A sample of 250 g of water is warmed by 4°C. How much heat was supplied in kilojoules (1 cal = 4.184 J)?**

**A** 4.184 kJ

**B** 4184 kJ

**C** 1.0 kJ

**D** 0.239 kJ

Anaerobic respiration · Easy

**13. What is the product when glucose in muscle undergoes anaerobic respiration during heavy exercise?**

**A** Lactic acid and energy

**B** Carbon dioxide and water only

**C** Glycogen and oxygen

**D** Glycerol and fatty acids

Delta efficiency · Devil

**14. In a graded cycling test, work output rises from 50 W to 110 W while total energy expenditure rises from 300 W to 540 W. What is the delta efficiency for this increment?**

**A** 20%

**B** 11%

**C** 17%

**D** 25% Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 5

Fat stores · Devil

**15. The lecture gives fat as 10% of male and 25% of female body weight. Comparing a 60 kg woman with an 80 kg man, how many times more fat energy store does the woman hold?**

**A** About 0.5 times

**B** About 2.5 times

**C** About 1.9 times

**D** About 1.0 times

Aerobic respiration · Medium

**16. What is required, and what is produced, in aerobic combustion of fuel in the body?**

**A** Fuel and nitrogen giving ammonia, water and energy

**B** Fuel, oxygen and light giving glucose and energy

**C** Fuel without oxygen giving lactic acid, carbon dioxide and energy

**D** Fuel, oxygen and enzyme catalysts giving water, carbon dioxide and energy

Forms of energy · Easy

**17. Which form of energy in biological systems is associated with membrane potentials and nerve impulses?**

**A** Electrical energy

**B** Chemical energy

**C** Mechanical energy

**D** Thermal energy

Daily balance · Devil

**18. A person eats 2800 kcal. TEF is 10% of intake, BMR is 1700 kcal and activity costs 600 kcal. What is the surplus stored?**

**A** 220 kcal

**B** 500 kcal

**C** 780 kcal

**D** 270 kcal

Departments · Medium

**19. Why do many universities lack a dedicated biophysics department?**

**A** Biophysics has been abandoned as a research field by most modern institutions

**B** National law forbids standalone biophysics departments at undergraduate level

**C** Biophysics groups sit within related departments such as biochemistry, physics and physiology

**D** Biophysics can only be taught within medical schools and teaching hospitals

Instrumentation · Hard

**20. Which technique does the lecture name for observing protein dynamics?**

**A** Atomic force microscopy

**B** Neutron spin echo spectroscopy

**C** X-ray crystallography

**D** Small-angle X-ray scattering

### Answers — Set 2 · Q11–20

**11.** A — Correct: the brain uses about 20% of the body's energy, and mental activity raises this moderately.

**12.** A — Correct: 250 g × 4°C × 1 cal = 1000 cal = 1 kcal = 4.184 kJ.

**13.** A — Correct: glucose is converted to lactic acid with release of a limited amount of energy.

**14.** D — Correct: delta efficiency = extra work ÷ extra energy cost = (110 − 50) ÷ (540 − 300) = 60 ÷ 240 = 25%.

**15.** C — Correct: woman = 0.25 × 60 = 15 kg; man = 0.10 × 80 = 8 kg; 15 ÷ 8 ≈ 1.9.

**16.** D — Correct: at body temperature enzymes catalyse fuel + oxygen → water + carbon dioxide + energy. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 16

**17.** A — Correct: the lecture links electrical energy to membrane potentials and nerve impulses.

**18.** A — Correct: TEF = 280 kcal; 2800 − (280 + 1700 + 600) = 220 kcal is left to be stored.

**19.** C — Correct: each institution makes its own rules, so groups are spread across related departments with much overlap.

**20.** B — Correct: protein dynamics can be observed by neutron spin echo spectroscopy.

## 3. Set 3 · Q21–30

Basal metabolism · Easy

**21. Basal metabolism is the utilisation of energy by the body when it is in which state?**

**A** Digesting a large meal

**B** Completely at rest

**C** Exercising at moderate intensity

**D** Exposed to extreme cold

Thermic effect of food · Easy

**22. Approximately what percentage of the calories in a meal is used to digest, metabolise and store that meal (the thermic effect of food)?**

**A** About 1%

**B** About 10%

**C** About 40%

**D** About 75% Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 6

Molecular biophysics · Hard

**23. Which frameworks do molecular biophysicists use to understand complex biological events as systems of interacting entities?**

**A** Optics, acoustics and fluid statics

**B** Genetics, taxonomy and ecology

**C** Electromagnetism, geometry and relativity

**D** Statistical mechanics, thermodynamics and chemical kinetics

Thermic effect of food · Medium

**24. Which statement correctly describes what determines the size of the thermic effect of food?**

**A** It is fixed at one value and does not depend on what or how much is eaten

**B** It rises with meal size and depends on the protein, fat and carbohydrate composition

**C** It depends only on the person's height and is unaffected by the meal

**D** It is the energy lost in faeces from undigested material

Harris-Benedict · Hard

**25. Using the Harris-Benedict equation in the lecture, what is the BMR of a 20-year-old man weighing 70 kg and 175 cm tall?**

**A** About 1866 kcal/day

**B** About 1752 kcal/day

**C** About 1980 kcal/day

**D** About 1550 kcal/day

Bridging science · Easy

**26. The lecture calls biophysics a bridge between which two sciences?**

**A** Chemistry and geology

**B** Biology and physics

**C** Anatomy and psychology

**D** Medicine and economics

BMR factors · Medium

**27. Which situation is expected to lower BMR or resting metabolic rate?**

**A** Fighting an infection

**B** Pregnancy

**C** Crash dieting or prolonged fasting

**D** Caffeine intake

Activity intensity · Medium

**28. Using the lecture's classification, which expenditure counts as vigorous physical activity?**

**A** Between 3 and 7 Cal/min

**B** More than 7 Cal/min

**C** Less than 3 Cal/min

**D** Exactly 1200 Cal/min

Calorie · Easy

**29. How is one small calorie (cal) defined in the lecture?**

**A** Heat needed to raise 1 kg of water by 1°C at 1 atmosphere

**B** Heat needed to raise 1 g of water by 1 K at zero pressure

**C** Heat needed to raise 1 g of water by 1°C at 1 atmosphere

**D** Heat released by burning 1 g of glucose completely in oxygen

Careers · Devil

**30. Which statement about biophysics is FALSE?**

**A** The structure of DNA was solved in 1953 using biophysics

**B** Biophysicists work only in universities and cannot be employed by hospitals or start-ups

**C** Biophysical models are used extensively to study electrical conduction in single neurons

**D** Biophysics contributes to the creation of vaccines against infectious diseases Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 7

### Answers — Set 3 · Q21–30

**21.** B — Correct: basal metabolism is the energy used when the body is completely at rest, the lowest energy level.

**22.** B — Correct: roughly 10% of meal calories is spent on processing the food just eaten.

**23.** D — Correct: the lecture names statistical mechanics, thermodynamics and chemical kinetics. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 17

**24.** B — Correct: the lecture says TEF is directly related to meal size and food composition.

**25.** B — Correct: 88.362 + 13.397×70 + 4.799×175 − 5.677×20 = 1752.4 kcal/day.

**26.** B — Correct: biology describes life's variety and complexity while physics supplies mathematical laws, and biophysics links them.

**27.** C — Correct: eating too few calories makes the body conserve energy and may cause loss of lean muscle, both reducing BMR.

**28.** B — Correct: vigorous activity expends over 7 Cal/min.

**29.** C — Correct: a small calorie warms one gram of water by one degree Celsius at 101.325 kPa.

**30.** B — Correct (it is the false statement): biophysicists work in universities, hospitals, tech start-ups, engineering companies, law, writing and government.

## 4. Set 4 · Q31–40

Thermic effect of food · Hard

**31. A student takes in 2400 kcal in a day. Using the lecture's estimate of the thermic effect of food, about how much of this energy is spent processing the food?**

**A** About 24 kcal

**B** About 960 kcal

**C** About 2160 kcal

**D** About 240 kcal

Units · Easy

**32. Which unit is described as the SI unit of food energy in nutrition?**

**A** Kilocalorie (kcal)

**B** Watt (W)

**C** Newton (N)

**D** Kilojoule (kJ)

Activity threshold · Devil

**33. A 50 kg adolescent walks briskly for 30 minutes at 5 Cal/min. What fraction of the lecture's 'active enough' threshold of 8 kcal per kg per day does this provide?**

**A** 18.75%

**B** 37.5%

**C** 267%

**D** 75%

ATP and glycogen · Devil

**34. Which statement about energy storage and release is FALSE?**

**A** ATP is the body's main long-term reserve and is stored mainly in adipose tissue

**B** ATP later returns to ADP with a corresponding release of energy

**C** Glycogen is readily broken down by enzyme to glucose units for aerobic or anaerobic respiration

**D** Fats and carbohydrates are the two major reserves, held in different tissues

Power and energy · Devil

**35. A porter carries loads at 300 W of power consumption for 2 hours. About how much energy is expended, in kilocalories?**

**A** About 2160 kcal

**B** About 9037 kcal

**C** About 8.6 kcal

**D** About 516 kcal

Economy of energy · Medium

**36. How does the energy cost of walking on snow or sand compare with walking on a hard surface?**

**A** About twice as great

**B** About half as great

**C** About the same

**D** About ten times as great

BMR comparison · Devil

**37. The lecture gives BMR as about 7100 kJ per day for a young man and 5900 kJ per day for a woman. By about what percentage is the man's BMR higher than the woman's?**

**A** About 17%

**B** About 120%

**C** About 20%

**D** About 1.2% Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 8

Clinical anaerobic · Devil

**38. A severely anaemic patient climbs stairs and quickly develops muscle pain, fatigue and rapid breathing. Which explanation fits the lecture?**

**A** Fat is converted to glycogen in muscle, and rapid breathing removes the stored fat

**B** Oxygen supply is insufficient, so muscle glucose is converted to lactic acid with limited energy, and panting helps oxidise the acid

**C** ATP is converted to glucose, producing lactic acid as a by-product of storage

**D** Protein becomes the main fuel and its oxidation in muscle causes the pain

Economy: swimming · Hard

**39. A runner expends 600 kcal over a given distance. Using the lecture's comparison, roughly what would swimming the same distance cost?**

**A** About 2400 kcal

**B** About 150 kcal

**C** About 1200 kcal

**D** About 600 kcal

Energy expenditure of activity · Medium

**40. Why is exercise described as the most important variable in daily energy expenditure?**

**A** It is the largest component of expenditure for every sedentary person

**B** It is the only component that cannot be influenced by lifestyle

**C** It is the most changeable component over 24 hours and is under voluntary control

**D** It remains constant between individuals of the same sex and age

## Answers — Set 4 · Q31–40

**31.** D — Correct: 10% of 2400 kcal = 240 kcal is used to digest, absorb, transport and metabolise the food.

**32.** D — Correct: the kilojoule is the SI unit of food energy.

**33.** B — Correct: 5 × 30 = 150 Cal; threshold = 8 × 50 = 400 kcal; 150 ÷ 400 = 37.5%. The pace also lies in the moderate range of 3 to 7 Cal/min.

**34.** A — Correct (it is the false statement): ATP is a short-term high-energy molecule held in muscle; fat in adipose tissue is the major long-term store.

**35.** D — Correct: 300 J/s × 7200 s = 2 160 000 J = 2160 kJ; 2160 ÷ 4.184 ≈ 516 kcal.

**36.** A — Correct: walking on snow and sand needs roughly twice the energy expenditure of walking on hard surfaces.

**37.** C — Correct: (7100 − 5900) ÷ 5900 = 1200 ÷ 5900 ≈ 20%, and the woman's value is about 68 W.

**38.** B — Correct: low oxygen delivery forces anaerobic respiration, giving lactic acid, little energy, fatigue and pain; panting improves oxygen supply and blood flow.

**39.** A — Correct: swimming costs about four times as much as running the same distance, so 4 × 600 = 2400 kcal.

**40.** C — Correct: exercise is the most changeable component over 24 hours and the one most people control voluntarily.

## 5. Set 5 · Q41–50

Swimming drag · Devil

**41. Which of the following is NOT one of the drag forces the lecture lists for a swimmer?**

**A** Wave drag

**B** Skin friction drag

**C** Viscous pressure drag

**D** Induced lift drag

Fat storage · Easy

**42. In which tissue is fat stored as the body's major energy store?**

**A** Cardiac muscle

**B** Hepatic portal blood

**C** Adipose tissue

**D** Bone marrow cartilage

Applications · Devil

**43. Which of the following is NOT an application attributed to biophysics in the lecture?**

**A** Designing nanomaterials for drug delivery and better prosthetic limbs

**B** Modifying microorganisms to make biofuel and bioelectricity

**C** Discovering new antibiotics purely through chemical synthesis without physical methods

**D** Modelling why a new flu strain eludes the immune system

Heart rate and oxygen · Devil

**44. A subject's oxygen uptake is 0.30 L/min at 70 beats per minute and 0.90 L/min at 130 beats per minute. Assuming the linear relationship in the lecture, what is the oxygen uptake at 100 beats per minute?**

**A** 0.69 L/min

**B** 0.50 L/min

**C** 0.60 L/min

**D** 0.45 L/min

Protein as fuel · Hard

**45. Under which circumstance is protein used as a significant fuel, according to the lecture?**

**A** During a normal balanced meal

**B** During extreme starvation

**C** During light walking after a carbohydrate meal

**D** During short sprints when glycogen is full Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 9

Biology vs physics · Easy

**46. According to the lecture, which science looks for mathematical laws of nature and makes detailed predictions about forces driving idealized systems?**

**A** Biology

**B** Pharmacology

**C** Physics

**D** Sociology

Fuel table · Devil

**47. Which statement about the heat of combustion and available energy table is FALSE?**

**A** Fat provides about twice the available energy per kilogram as carbohydrate

**B** Carbohydrate loses only about 0.5 MJ/kg between heat of combustion and available energy

**C** Protein loses less energy between combustion and availability than carbohydrate does

**D** Protein and carbohydrate have the same available energy of 16.7 MJ/kg

Nomogram estimate · Hard

**48. A patient's body surface area from the nomogram is 1.8 m². The resting expenditure is 40 kcal per m² per hour. What is the estimated resting daily energy expenditure?**

**A** 72 kcal

**B** 1152 kcal

**C** 533 kcal

**D** 1728 kcal

Fuel supply speed · Easy

**49. Which ordering of energy supply speed from the three macronutrients does the lecture give?**

**A** Fats are quickest and carbohydrates are slowest

**B** Carbohydrates are quickest and fats are slowest

**C** Proteins are quickest and carbohydrates are slowest

**D** All three supply energy at the same speed

Activity threshold · Hard

**50. How much energy must a 55 kg child expend per day to be classed as active enough, using the lecture's threshold of 8 kcal per kg body mass per day?**

**A** At least 4400 kcal

**B** At least 6.9 kcal

**C** At least 440 kcal

**D** At least 1200 kcal

## Answers — Set 5 · Q41–50

**41.** D — Correct (not listed): induced lift drag is an aerodynamic wing concept and is not given for swimmers.

**42.** C — Correct: fats are stored in cells of specialised connective tissue called adipose tissue, mainly under the skin, around the kidneys and in the abdominal cavity.

**43.** C — Correct (it is not attributed): antibiotic discovery by synthesis alone is chemistry and is never credited to biophysics in the slides.

**44.** C — Correct: slope = 0.60 ÷ 60 = 0.01 L/min per beat; 0.30 + 30 × 0.01 = 0.60 L/min.

**45.** B — Correct: protein is rarely burnt, except in extreme starvation or with excess food intake.

**46.** C — Correct: physics searches for mathematical laws and predicts the forces acting on idealized systems.

**47.** C — Correct (it is the false statement): protein falls from 23.4 to 16.7 MJ/kg, a loss of 6.7 MJ/kg, far more than the 0.5 MJ/kg lost by carbohydrate.

**48.** D — Correct: 1.8 $m^2$ × 40 kcal/$m^2$/h × 24 h = 1728 kcal.

**49.** B — Correct: the slide states carbohydrates supply energy quickest and fats slowest.

**50.** C — Correct: 8 kcal/kg/day × 55 kg = 440 kcal per day.

## 6. Set 6 · Q51–60

Anaerobic recovery · Hard

**51. After a sprint a student pants for several minutes. What is the physiological benefit of panting described in the lecture?**

**A** It converts lactic acid directly into glycogen without oxygen

**B** It increases oxygen supply and blood flow and promotes oxidation of the lactic acid

**C** It stops respiration in muscle so that fatigue disappears

**D** It raises body temperature to speed up anaerobic respiration

Unit conversion · Hard

**52. A diet is set at 2000 kcal per day. Using 1 kcal = 4.184 kJ, what is this in kilojoules?**

**A** About 478 kJ

**B** About 2000 kJ

**C** About 836 kJ

**D** About 8368 kJ

Calorie content of food · Medium

**53. How is the total calorie content of a food worked out in the lecture?**

**A** Sum of energy from protein, carbohydrate, fat and fibre, since fibre is fully digested

**B** Sum of energy from protein, carbohydrate and fat, minus the fibre content

**C** Energy from carbohydrate only, since fat and protein are not fuels

**D** Energy from fat only, because fat yields the most energy per gram Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 10

Available energy · Hard

**54. Protein has a heat of combustion of 23.4 MJ/kg but an available energy of only 16.7 MJ/kg, whereas carbohydrate loses just 0.5 MJ/kg. What best explains the larger loss for protein?**

**A** Protein is poorly digested and is absorbed only as long-chain fatty acids

**B** Protein contains fibre which is subtracted from its energy value

**C** Protein is not completely oxidised in the body and energy is lost via excretion of its end-products

**D** Protein oxidation requires no oxygen so less heat is released

Digestion · Medium

**55. Which pairing of macronutrient and digestion end-product is correct?**

**A** Fat gives glycerol and long-chain fatty acids

**B** Fat gives amino acids

**C** Protein gives glucose and glycerol

**D** Carbohydrate gives fatty acids

Computer modelling · Hard

**56. A researcher builds an in-silico model to see and manipulate the shape of a mutated protein that drives tumour growth. Which biophysics activity is this?**

**A** Tracking molecules in motion with fluorescent tags

**B** Design of prosthetic limbs in bioengineering

**C** Computer modelling of protein structures

**D** Modelling ocean vents in environmental biophysics

Energy balance · Devil

**57. Which statement about the human machine energy diagram is FALSE?**

**A** Food energy input may be stored in the body

**B** Work done can be internal or external

**C** Heat is released as part of body energy output

**D** Body output consists only of external work, with no heat produced

Heart rate · Medium

**58. Why is the intensity of work often assessed using heart rate?**

**A** Heart rate has a linear relationship with oxygen uptake

**B** Heart rate is independent of oxygen uptake and so is a stable index

**C** Heart rate falls linearly as work intensity rises

**D** Heart rate measures body temperature directly

Efficiency calculation · Hard

**59. A worker produces 60 W of useful mechanical power while the body uses 240 W of power input. What is the efficiency?**

**A** 25%

**B** 400%

**C** 75%

**D** 2.5%

DNA structure · Easy

**60. In which year was the structure of DNA solved using biophysics?**

**A** 1935

**B** 1973

**C** 1993

**D** 1953

### Answers — Set 6 · Q51–60

**51.** B — Correct: panting boosts oxygen supply and blood flow so lactic acid built up anaerobically can be oxidised.

**52.** D — Correct: 2000 × 4.184 = 8368 kJ, the SI food-energy value. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 21

**53.** B — Correct: fibre is subtracted because humans cannot fully digest it.

**54.** C — Correct: incomplete oxidation, absorption and utilisation cause excretory losses, so available energy is lower than heat of combustion.

**55.** A — Correct: fat is reduced to glycerol and long-chain fatty acids.

**56.** C — Correct: computer modelling is used to see and manipulate protein shapes, to find drug targets and understand mutations causing tumours.

**57.** D — Correct (it is the false statement): the diagram shows heat as an output alongside work, and internal work too ends up as heat.

**58.** A — Correct: because heart rate rises linearly with oxygen uptake, it serves as an index of work intensity.

**59.** A — Correct: 60 ÷ 240 × 100% = 25%, typical of working muscle.

**60.** D — Correct: the DNA structure was solved in 1953, showing DNA acts as a blueprint for life.

## 7. Set 7 · Q61–70

Clinical BMR · Devil

**61. Which adult is expected to have the highest resting energy expenditure, other factors being equal?**

**A** An elderly woman on a crash diet in a comfortable room

**B** A muscular young man fighting an infection in a very cold room

**C** A sedentary middle-aged woman resting in a thermoneutral room

**D** A man on a three-day fast in a comfortable room Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 11

Body mass and activity · Medium

**62. How does body mass influence energy expended in weight-bearing versus non-weight-bearing activities?**

**A** Both activity types cost the same, whatever the body mass

**B** Non-weight-bearing cost rises with mass, while weight-bearing cost stays flat

**C** Both activity types cost less for heavier people than for lighter ones

**D** Weight-bearing cost scales with body mass; non-weight-bearing barely does

Imaging · Easy

**63. Which diagnostic imaging techniques does the lecture say biophysicists have developed?**

**A** Western blot, ELISA and PCR

**B** MRI, CT scans and PET scans

**C** Gram stain, Ziehl-Neelsen and India ink

**D** Full blood count, ESR and PCV

Efficiency · Easy

**64. How is the efficiency of a machine defined in the lecture?**

**A** Power input divided by useful power output, × 100%

**B** Heat produced divided by work done, × 100%

**C** Useful power output divided by power input, × 100%

**D** Total energy stored divided by body mass, × 100%

Field focus · Medium

**65. Which field focus in the lecture lists sequence alignment, structural alignment and protein structure prediction?**

**A** Bioinformatics

**B** Structural biology

**C** Neuroscience

**D** Quantum biology

Net efficiency · Hard

**66. During cycling a subject's total energy expenditure is 500 W, resting expenditure is 80 W and work output is 105 W. What is the net efficiency?**

**A** 21%

**B** 25%

**C** 131%

**D** 16%

Mixed fuel · Hard

**67. A diet supplies 300 g carbohydrate, 100 g fat and 50 g protein. Using the available energy values (16.7, 37.7 and 16.7 MJ/kg), what is the total available energy?**

**A** About 10.3 MJ

**B** About 8.8 MJ

**C** About 96 MJ

**D** About 9.6 MJ

Environmental biophysics · Medium

**68. Which activity does the lecture attribute to environmental biophysicists?**

**A** Designing pacemakers and defibrillators for cardiac patients

**B** Performing serum electrolyte assays in hospital laboratories

**C** Mapping the genes responsible for inherited metabolic disease

**D** Tracking pollutants across the atmosphere and turning algae into biofuels

Medical physics · Easy

**69. How does the lecture define medical physics?**

**A** Any application of physics to medicine or healthcare, from radiology to nanomedicine

**B** The use of chemical assays alone to measure analytes in blood and urine specimens

**C** The study of physical injuries and their surgical treatment in hospital wards

**D** The application of biology to the engineering of buildings and bridges Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 12

Glycogen · Easy

**70. Where is carbohydrate stored in the body, and in what form?**

**A** As glucose crystals in the kidneys

**B** As starch granules in adipose tissue

**C** As lactic acid in the bone marrow

**D** As glycogen in liver and muscle cells

### Answers — Set 7 · Q61–70

**61.** B — Correct: male sex, high muscle mass, infection and cold exposure all raise BMR/RMR and act together.

**62.** D — Correct: carrying the body against gravity scales cost with mass, whereas e.g. cycling on a support shows little relation.

**63.** B — Correct: MRIs, CT scans and PET scans are named as imaging developed by biophysicists.

**64.** C — Correct: efficiency = useful power output ÷ power input × 100%.

**65.** A — Correct: these are the bioinformatics topics given in the list of field foci.

**66.** B — Correct: net efficiency = 105 ÷ (500 − 80) = 105 ÷ 420 = 25%.

**67.** D — Correct: 0.300×16.7 + 0.100×37.7 + 0.050×16.7 = 5.01 + 3.77 + 0.835 ≈ 9.6 MJ.

**68.** D — Correct: environmental biophysics models the environment from stratosphere to ocean vents, tracks pollutants and develops algal biofuels.

**69.** A — Correct: medical physics is a branch of biophysics covering any application of physics to medicine or healthcare.

**70.** D — Correct: carbohydrate is stored as glycogen in liver and muscle cells and broken down to glucose when energy is needed.

## 8. Set 8 · Q71–80

Efficiency · Devil

**71. Which statement about efficiency in the lecture is FALSE?**

**A** Kidneys are the most efficient organ at 25 to 30% because they perform the most external work

**B** Muscles and the heart reach about 25 to 30% efficiency during exercise

**C** Gross efficiency of the body is highest in strenuous exercise and lowest during basal metabolism

**D** Net efficiency subtracts resting energy from the total, whereas gross efficiency uses total oxygen uptake

Medical applications · Medium

**72. Which set contains only treatments or devices the lecture credits to biophysics?**

**A** Kidney dialysis, penicillin therapy and artificial heart valves

**B** Radiation therapy, insulin injection and cardiac pacemakers

**C** Pacemakers, oral rehydration salts and cardiac defibrillators

**D** Kidney dialysis, radiation therapy and artificial heart valves

Efficiency types · Medium

**73. Which statement correctly distinguishes gross and net efficiency?**

**A** Gross subtracts resting energy, while net uses total energy expended

**B** Gross and net both use only the energy above rest

**C** Gross uses total energy expended, while net subtracts resting energy from the total

**D** Gross measures work input and net measures heat output

Training of biophysicists · Medium

**74. Why are biophysicists well placed to make sense of the huge datasets of 21st-century biology?**

**A** They are trained in the quantitative sciences of physics, mathematics and chemistry

**B** They are trained only in clinical medicine and bedside patient examination

**C** They avoid mathematics and rely purely on verbal description of organisms

**D** They work only with idealized systems and ignore experimental data

Net vs gross · Devil

**75. In one test the work output is 120 W, total expenditure 600 W and resting expenditure 100 W. Which statement is correct?**

**A** Gross efficiency is 20% and net efficiency is 24%, because net removes resting energy from the denominator

**B** Gross efficiency is 24% and net efficiency is 20%, because net adds resting energy to the denominator

**C** Gross and net efficiency are both 20% because resting energy does not affect efficiency

**D** Gross efficiency is 17% and net efficiency is 20%, because work is also divided by resting energy

Field focus · Medium

**76. Molecular dynamics simulation, molecular docking and quantum chemistry belong to which listed field?**

**A** Bioinformatics

**B** Computational chemistry

**C** Computer science

**D** Structural biology

Molecules in motion · Easy

**77. What did fluorescent tags allow biophysicists to do?**

**A** Sterilise culture media before the incubation of bacterial plates

**B** Measure blood glucose through intact skin without any sample taken

**C** Make cells glow under a microscope to learn about the cell's internal transit system

**D** Grow bacteria on selective agar in the absence of oxygen Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 13

Harris-Benedict · Hard

**78. Using the lecture's women's equation, a woman aged 20 weighs 60 kg and is 165 cm tall. What is her BMR?**

**A** About 1570 kcal/day

**B** About 1514 kcal/day

**C** About 1427 kcal/day

**D** About 1600 kcal/day

Field focus · Devil

**79. Which statement about the listed biophysics field foci is FALSE?**

**A** Quantum biology applies quantum mechanics to biological objects, with implications for quantum computing

**B** Medical biophysics is closely related to physiology and covers blood flow fluid dynamics and respiratory gas physics

**C** Computer science contributes neural networks and biomolecular and drug databases

**D** Structural biology aims at micrometre-resolution images of cells and tissues

BMR factors · Medium

**80. Why do men generally have a higher BMR than women on average?**

**A** They have more adipose tissue, which is metabolically more active than muscle

**B** They tend to be larger and to have more muscle tissue

**C** They have a lower body temperature

**D** They sleep fewer hours per night

## Answers — Set 8 · Q71–80

**71.** A — Correct (it is the false statement): kidneys are below 1% efficient because they do very little external mechanical work; 25 to 30% belongs to exercising muscle and heart.

**72.** D — Correct: dialysis, radiation therapy, defibrillators, pacemakers and artificial heart valves are all listed.

**73.** C — Correct: gross efficiency = work output ÷ energy expended, and net efficiency = work output ÷ energy expended above rest.

**74.** A — Correct: the lecture says biophysicists are uniquely trained in the quantitative sciences, which equips them to analyse big data.

**75.** A — Correct: gross = 120 ÷ 600 = 20%; net = 120 ÷ (600 − 100) = 24%; net is larger whenever resting energy is positive.

**76.** B — Correct: the lecture lists these three topics under computational chemistry.

**77.** C — Correct: tagged cells glow like a firefly and reveal how molecules such as hormones move inside cells.

**78.** C — Correct: $447.593 + 9.247 \times 60 + 3.098 \times 165 - 4.330 \times 20 = 1427.0$ kcal/day.

**79.** D — Correct (it is false): structural biology deals with Ångstrom-resolution structures of proteins, nucleic acids, lipids and carbohydrates; one Ångstrom is $10^{-10}$ m, thousands of times finer than a micrometre.

**80.** B — Correct: larger bodies with more muscle have more metabolically active tissue.

**Module 2: Lecture 2 — Biomechanics** — 80 questions

## 1. Set 1 · Q1–10

Stability calculation · Devil

**81. Using the same person (700 N, centre of gravity 1.0 m), they widen the feet to 0.6 m apart and bend the knees so the centre of gravity falls to 0.8 m. What is the new critical push?**

**A** 210 N
**B** 262.5 N
**C** 105 N
**D** 525 N

Definition · Easy

**82. In the term biomechanics, what does the prefix bio mean?**

**A** Life
**B** Bone
**C** Body
**D** Motion

Equilibrium · Hard

**83. A tall laboratory stool is pushed so that a vertical line from its centre of gravity falls just beyond one leg. What does principle 3 of body mechanics predict?**

**A** It stays stable, since the centre of gravity is still above the floor
**B** It stays stable, since the stool legs have strong friction
**C** It slides sideways, since the base becomes wider when tilted
**D** It tips, since the line of gravity no longer passes through the base

Lymphatic system · Medium

**84. Which role belongs to the lymphatic system?**

**A** Pumping blood through the vessels of the body
**B** Delivering oxygen and removing carbon dioxide at the alveoli
**C** Producing sperm and male sex hormones in the testes
**D** Returning fluid leaked from blood vessels back to the blood

Life functions · Devil

**85. A patient has intestinal obstruction with failed peristalsis, and the kidneys are normal. Which pair of necessary life functions is most directly disturbed?**

**A** Excretion by the kidneys and reproduction at the cellular level
**B** Responsiveness of the skin and growth of body parts
**C** Maintaining boundaries by the plasma membrane and metabolism
**D** Movement of gut contents and digestion

Lever speed · Devil

**86. In a third-class forearm lever the biceps inserts 4 cm from the elbow and the hand is 32 cm from it. If the muscle shortens 3 cm in 0.1 s, what is the speed of the hand?**

**A** 0.3 m/s

**B** 0.0375 m/s

**C** 2.4 m/s

**D** 24 m/s

Biometrics · Medium

**87. Which pairing correctly classifies biometric identifiers according to the lecture?**

**A** Fingerprint is physiological and voice is behavioural

**B** Fingerprint is behavioural and voice is physiological

**C** Both fingerprint and voice are physiological

**D** Both fingerprint and voice are behavioural Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 26

Life functions · Medium

**88. Peristalsis is best described in the lecture as an example of which necessary life function?**

**A** Digestion, the chemical breakdown of ingested food

**B** Responsiveness, sensing changes in the environment

**C** Movement, the periodic propulsion along the alimentary canal

**D** Excretion, the removal of wastes from the body

Levers · Easy

**89. Which class of lever is the most common in the human body, with the barbell curl as an example?**

**A** Third class

**B** First class

**C** Second class

**D** Fourth class

Kinetics · Hard

**90. A gait lab reports knee flexion angle against time and also the line of action and point of application of the ground reaction force. Which classification is correct?**

**A** Angle against time is kinematic; line of action and point of application are kinetic

**B** Angle against time is kinetic; line of action is kinematic

**C** All three measures are kinematic since the body is moving

**D** All three measures are anthropometric since they describe the body

## Answers — Set 1 · Q1–10

**81.** B — F = 700 × 0.30 ÷ 0.8 = 262.5 N, 2.5 times the original, showing base width and height both help.

**82.** A — Bio means life, and the term joins it with mechanics, the study of the actions of forces.

**83.** D — Equilibrium holds only while the line of gravity passes through the base of support; outside it a turning moment topples the stool.

**84.** D — The lymphatic system picks up leaked fluid, disposes of debris and houses white blood cells.

**85.** D — Peristalsis is the periodic movement of the alimentary canal, and without it ingested food cannot be broken down and advanced properly.

**86.** C — Muscle speed is 0.3 m/s, and the hand is eight times farther from the fulcrum, so its speed is 0.3 × 8 = 2.4 m/s.

**87.** A — The slide gives fingerprint as a physiological and voice as a behavioural identifier.

**88.** C — Movement includes locomotion, propulsion and peristalsis, the periodic movement of the alimentary canal.

**89.** A — In a third-class lever the force is applied between the resistance and the fulcrum, and it is the most common in the body.

**90.** A — The slide lists durations and sequencing as kinematics, and magnitude, direction, line of action and point of application as kinetics.

## 2. Set 2 · Q11–20

Levers · Medium

**91. In a first-class lever, where is the fulcrum located and what is a body example?**

**A** Between the applied force and the resistance, as in neck extension

**B** Between the resistance and the end of the lever, as in a barbell curl

**C** At one end with the resistance in the middle, as in the calf raise

**D** At the point of applied force, as in all joint movements

Spinal load · Devil

**92. A technician holds a 15 kg box 0.5 m in front of the lumbar spine. The erector spinae acts 5 cm behind the spine. Ignoring trunk weight, what muscle force is needed? (g = 9.8 m/s²)**

**A** 1470 N

**B** 735 N

**C** 147 N

**D** 2940 N

Directional terms · Medium

**93. The sternum lies in the midline while the shoulder lies away from it. Which statement is correct?**

**A** The shoulder is lateral to the sternum

**B** The shoulder is medial to the sternum

**C** The shoulder is proximal to the sternum

**D** The shoulder is deep to the sternum

Friction and leverage · Devil

**94. An 80 kg patient must be moved up the bed. Lifting needs a force equal to body weight; sliding on a draw sheet of coefficient 0.3 needs μ × weight. What force is needed to slide? (g = 9.8 m/s²)**

**A** 784 N

**B** 2613 N

**C** 24 N

**D** 235.2 N

Fluid biomechanics · Devil

**95. In a patient with bronchoconstriction the airway radius halves. For laminar airflow under the same pressure difference (flow ∝ r⁴), what fraction of the original flow remains?**

**A** 1/4 (25%)

**B** 1/2 (50%)

**C** 1/16 (6.25%)

**D** 1/8 (12.5%) Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 27

Endocrine system · Medium

**96. Which description fits the endocrine system?**

**A** A network of nerves giving a fast response to stimuli

**B** A network of vessels returning leaked fluid to blood

**C** A network of ducts that carry sperm to the female tract

**D** A network of glands using hormones to control metabolism, growth and stress response

Centre of gravity · Medium

**97. A nurse carries a heavy specimen crate close to her body. Why does this reduce injury risk?**

**A** It brings the load's centre of gravity close to her own centre of gravity

**B** It increases the friction between the crate and her hands

**C** It lowers the mass of the crate that she must support

**D** It widens her base of support through the carried crate

Muscle terminology · Devil

**98. During a chin-up the hands are fixed on the bar and the trunk moves toward the bar. What does a strict reading of the lecture say about the biceps ends?**

**A** The definition is by mobility: the movable end is the insertion

**B** The origin stays on the shoulder because of its nearness to the heart

**C** Origin and insertion are fixed anatomical labels that never change

**D** Both ends are origins because neither moves relative to the bone

Directional terms · Easy

**99. The elbow is described relative to the wrist as being closer to the point of attachment of the limb. Which term fits?**

**A** Distal

**B** Superficial

**C** Proximal

**D** Intermediate

Organization · Easy

**100. Which is the first and simplest level of structural organization listed in the lecture?**

**A** Cellular level, where molecules interact to make up cells

**B** Chemical level, where atoms combine to form molecules

**C** Tissue level, where cells are grouped together

**D** Organ level, where tissues compose a body organ

### Answers — Set 2 · Q11–20

**91.** A — A first-class lever is a seesaw: fulcrum in the middle, as in extension of the neck.

**92.** A — Torque of the box = 15 × 9.8 × 0.5 = 73.5 N·m; muscle force = 73.5 ÷ 0.05 = 1470 N, about ten times the box weight.

**93.** A — Lateral means away from the midline, and medial means toward it.

**94.** D — Weight is 784 N; sliding force is 0.3 × 784 = 235.2 N, about 30% of the lifting force, as principles 7 and 8 predict. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 38

**95.** C — Flow scales with $r^4$, so halving r gives $(1/2)^4 = 1/16$ of the original flow.

**96.** D — The lecture describes the endocrine system as glands and organs using hormones to coordinate the body.

**97.** A — The slide advises keeping objects close so the combined centres of gravity nearly coincide, reducing the turning effect on the spine.

**98.** A — The lecture defines origin as the stationary end and insertion as the movable end, so mobility decides.

**99.** C — Proximal means closer to the origin of the body part or point of attachment of the limb.

**100.** B — The hierarchy begins at the chemical level, then cellular, tissue, organ, organ system and organism.

## 3. Set 3 · Q21–30

Anthropometrics · Medium

**101. Which measurement belongs to the field of anthropometrics?**

**A** Speed of forearm rotation during a throw

**B** Length and mass of the forearm segment

**C** Torque generated at the elbow joint

**D** Fingerprint ridge pattern of the thumb

Lifting technique · Medium

**102. A technician must pick up a light item from a low bench and cannot avoid bending. Which technique protects the spine?**

**A** Bend at the waist with both knees locked straight

**B** Golfer's lift: straighten one leg and raise it backwards while bending forward

**C** Twist the trunk sideways while keeping both feet planted

**D** Hold the breath and jerk the item upward quickly

Organ systems · Easy

**103. Which organ system is the site of blood cell formation and mineral storage according to the lecture?**

**A** Muscular system

**B** Respiratory system

**C** Digestive system

**D** Skeletal system Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 28

Metabolism · Medium

**104. Digestion of a protein into amino acids and building new muscle protein from amino acids are respectively:**

**A** Anabolism then catabolism

**B** Catabolism then anabolism

**C** Catabolism then catabolism

**D** Anabolism then anabolism

Biometrics · Hard

**105. A hospital in Kumasi adds voice and fingerprint checks for staff access. Which classification, and which weakness, fits the lecture's definitions?**

**A** Voice is physiological and fingerprint behavioural, so prints change daily

**B** Fingerprint is physiological and voice behavioural, so voice may change with illness

**C** Both are behavioural, so neither identifies an individual

**D** Both are anthropometric, so they measure segment weights

Definition · Easy

**106. Which forces does biomechanics study, according to the lecture?**

**A** Only internal forces generated by muscles of the body

**B** Internal forces produced by muscles and external forces acting on the body

**C** Only external forces such as gravity and friction

**D** Only electromagnetic forces within nerve and muscle cells

Lever calculation · Hard

**107. In plantar flexion, treat the ball of the foot as the fulcrum, body weight of 700 N acting 12 cm from it and the Achilles tendon pulling 18 cm from it. What calf force is needed to hold the heel off the ground?**

**A** 1050 N

**B** 700 N

**C** 467 N

**D** 311 N

Lifting mechanics · Hard

**108. Which combination best explains why squatting with a straight back protects the lumbar spine compared with stooping?**

**A** The trunk stays rigid and the base of support narrows

**B** The load stays near the body and large leg muscles do the work

**C** The centre of gravity rises and the arms bear most load

**D** The spine rotates slightly to share the load between discs

Muscle groups · Medium

**109. Why is it better to lift a box from the floor by squatting and using the legs rather than bending over?**

**A** Squatting raises the centre of gravity of the box and body

**B** Bending over increases the base of support too much

**C** Large leg muscle groups can do more work safely than the arms and back

**D** Arm muscles cannot generate any force against gravity

Muscles · Easy

**110. In muscle terminology, the origin is defined as which end?**

**A** The movable end

**B** The stationary end

**C** The end nearest the heart

**D** The end attached to the cartilage Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 29

## Answers — Set 3 · Q21–30

**101.** B — Anthropometrics concerns dimensions and weights of body segments and size and shape descriptors.

**102.** B — The golfer's lift keeps the spine from bending by counterbalancing with the rear leg.

**103.** D — The skeletal system provides the framework for muscles, forms blood cells and stores minerals such as calcium.

**104.** B — Breaking down substances is catabolism; synthesizing complex substances is anabolism.

**105.** B — Behavioural identifiers depend on how a person acts or speaks, and a cold can alter the voice.

**106.** B — The slide states both internal muscle-generated forces and external forces on the body are studied.

**107.** C — Second-class lever: F × 18 = 700 × 12, so F = 8400 ÷ 18 ≈ 467 N, below body weight because the effort arm is longer.

**108.** B — Keeping the load close shortens its moment arm on the spine, and the legs are the larger muscle group suited to heavy work.

**109.** C — Principle 4 and the muscle-group component state that stronger, larger groups can safely do more work.

**110.** B — Origin is the stationary end and insertion is the movable end.

## 4. Set 4 · Q31–40

Statics vs dynamics · Hard

**111. A ward trolley is pushed along a corridor at a steady 1.2 m/s with no change in speed or direction. How is it classified in the lecture's branches?**

**A** Dynamics, because it is moving along the floor

**B** Kinetics, because a pushing force is applied by the hand

**C** Anthropometrics, because the corridor distance is measured

**D** Statics, because it moves at constant velocity with no acceleration

Friction · Medium

**112. A ward assistant slides a patient across the bed using a smooth draw sheet instead of dragging. Which principle is applied?**

**A** A wider base of support gives greater stability

**B** Facing the direction of movement prevents spinal twisting

**C** Alternating rest and activity reduces fatigue

**D** Reducing friction between object and surface reduces the force needed

Anatomical position · Devil

**113. In the anatomical position with palms facing forward, which statement about the hand is correct?**

**A** The thumb is medial to the little finger and the palm is posterior

**B** The thumb is lateral to the little finger and the palm is anterior

**C** The thumb is proximal to the little finger and the palm is dorsal

**D** The thumb is superior to the little finger and the palm is deep

Classification · Devil

**114. A sprinter is studied in two ways: (1) knee angle and stride timing from video, and (2) torque produced at the knee joint. Which classification is correct?**

**A** (1) is kinematics and (2) is kinetics

**B** (1) is kinetics and (2) is kinematics

**C** Both are kinematics because the sprinter is moving

**D** Both are statics since the sprinter completes a fixed race

False statement · Devil

**115. Which statement about levers is FALSE?**

**A** A lever is a rigid structure that moves on a fixed point called the fulcrum

**B** Levers can change the direction and strength of an applied force

**C** Levers can change the distance and speed of a movement

**D** Third-class levers are rare in the body and the barbell curl is second class

Spinal torque · Hard

**116. A technician holds a 10 kg tray first 0.4 m and then 0.1 m horizontally from the spine. Comparing the torque of the load about the spine, the first position is how many times larger?**

**A** 4 times

**B** 2 times

**C** 16 times

**D** 1 time

Metabolism · Devil

**117. Which scenario correctly illustrates both anabolism and catabolism occurring in the same patient?**

**A** Starch digestion and fat breakdown both describe anabolism

**B** Glycogen synthesis and protein synthesis both describe catabolism

**C** Muscle protein builds after a meal while stored fat is broken down for energy

**D** Nitrogenous waste excretion is the anabolic part of metabolism Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 30

Sprinting dynamics · Devil

**118. Which statement correctly classifies a sprinter during the first second off the blocks and at the steady 10th second of a race?**

**A** Both phases are dynamics since the athlete is always moving

**B** Acceleration phase is dynamics; steady constant-velocity phase is statics

**C** Both phases are statics since the athlete's mass is constant

**D** Acceleration phase is statics; steady phase is dynamics

Principle of leverage · Hard

**119. Why does rolling or pivoting a heavy patient need less work than lifting, according to principle 7 and the mechanics of lifting?**

**A** The patient's weight is supported by the surface or fulcrum, not fully by muscle

**B** The patient's mass is reduced while turning on the bed

**C** Gravity stops acting on the patient during turning

**D** The base of support becomes narrower during rotation

Posture · Medium

**120. A patient with back pain sleeps on one side. What does the lecture advise?**

**A** Straighten the legs and place a pillow under the chest

**B** Lie flat with both arms stretched above the head

**C** Bend the knees and place a pillow between the legs

**D** Curl the neck forward and tuck the chin to the chest

### Answers — Set 4 · Q31–40

**111.** D — Statics covers bodies at rest or moving at constant velocity, so zero net force applies even though it moves.

**112.** D — Principle 8 states less force is required when friction is reduced.

**113.** B — With palms forward and thumbs pointing away from the body, the thumb lies lateral and the palm faces anterior.

**114.** A — Kinematics describes how far, how fast and the timing, while kinetics studies forces and torques.

**115.** D — Third-class levers are the most common in the body, and the barbell curl is the lecture's third-class example.

**116.** A — Torque = weight × lever arm: 98 N × 0.4 m = 39.2 N·m versus 98 N × 0.1 m = 9.8 N·m, a ratio of 4.

**117.** C — Building muscle from amino acids is anabolic and breaking fat into simpler components is catabolic.

**118.** B — Dynamics covers bodies under acceleration and statics covers bodies at rest or moving at constant velocity.

**119.** A — Rolling and pivoting use leverage so that the force needed is only a fraction of the weight.

**120.** C — This keeps the spine straight in side sleeping.

## 5. Set 5 · Q41–50

Solid biomechanics · Devil

**121. Which scenario correctly pairs the branch of biomechanics with the lecture's subject matter?**

**A** Fracture of a femur is fluid, and blood flow in capillaries is solid

**B** Tendon stretching is fluid, and lung airflow is solid

**C** Ligament rupture is statics, and blood flow is anthropometrics

**D** Fracture of a femur under load is solid biomechanics, and blood flow in capillaries is fluid

Kinematics vs kinetics · Medium

**122. A physiotherapist records stride length and walking speed of a stroke patient using video. Which branch is being applied?**

**A** Kinetics, since it studies how far and how fast the patient moves

**B** Auxology, since the walking pattern shows physical growth

**C** Kinematics, since the motion is described without considering forces

**D** Biometrics, since walking is an identifying behaviour

Kinematics · Easy

**123. Kinematics is best described as the study of what?**

**A** The forces and torques that cause motion

**B** The dimensions and weights of body segments

**C** The description of motion without regard to forces

**D** The measurement of human identifying characteristics

False statement · Devil

**124. Which statement about mechanics terminology is FALSE?**

**A** Kinetics deals with forces, torques and the moment of a force

**B** Dynamics deals with systems under acceleration or acting forces

**C** Kinematics studies the forces and torques that cause motion

**D** Kinematics is known as the geometry of motion

Spinal load · Devil

**125. Using the same box and muscle arm, the technician pulls the box close so it is 0.1 m from the spine. By what percentage does the required erector spinae force fall?**

**A** 50%

**B** 80%

**C** 20%

**D** 90% Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 31

Scope · Easy

**126. Which field of biomechanics contributes prosthetics, implants and rehabilitation devices?**

**A** Physics

**B** Biology

**C** Engineering

**D** Sports science

False statement · Devil

**127. Which statement about the principles of body mechanics is FALSE?**

**A** Facing the direction of movement prevents abnormal spinal twisting

**B** Dividing activity between arms and legs reduces back injury risk

**C** Equilibrium is kept even when the line of gravity falls outside the base

**D** Alternating rest and activity helps reduce muscular fatigue

Directional terms · Hard

**128. For a standing patient in anatomical position, which statement about the knee is correct?**

**A** The knee is proximal to the hip and distal to the ankle

**B** The knee is superior to the hip and inferior to the ankle

**C** The knee is deep to the hip and superficial to the ankle

**D** The knee is distal to the hip and proximal to the ankle

Levers · Medium

**129. During plantar flexion (ankle extension) the calf muscles act on which lever class and why?**

**A** First class, because the fulcrum lies between force and resistance

**B** Second class, because the resistance lies between the force and fulcrum

**C** Third class, because the force is applied between R and the fulcrum

**D** No class, because muscles do not form lever systems

Endocrine vs nervous · Hard

**130. A patient shows slow, long-lasting growth abnormalities such as gigantism. Which system and speed of control are most consistent with the lecture?**

**A** Nervous, which is fast-acting and controls growth directly

**B** Lymphatic, which disposes of debris in the lymphatic stream

**C** Endocrine, using hormones for slower coordination of growth

**D** Integumentary, which synthesizes vitamin D in the skin

### Answers — Set 5 · Q41–50

**121.** D — Bones, tendons and ligaments belong to solid biomechanics, while blood flow and airflow belong to fluid biomechanics.

**122.** C — Distance, speed and timing describe motion pattern, which is kinematics.

**123.** C — Kinematics describes how far, how fast and how consistent a motion is, along with timing and sequencing.

**124.** C — This defines kinetics; kinematics describes motion without regard to its causes.

**125.** B — Force becomes 15 × 9.8 × 0.1 ÷ 0.05 = 294 N versus 1470 N, a fall of 1176 N, or 80%.

**126.** C — The slide links engineering with prosthetics, implants and rehabilitation devices.

**127.** C — Principle 3 says equilibrium holds only as long as the line of gravity passes through the base of support.

**128.** D — Proximal and distal refer to distance from the limb attachment, so the knee lies between hip and ankle.

**129.** B — The lecture lists the calf during ankle extension as a second-class lever with R between AF and Ful.

**130.** C — The endocrine system uses hormones to control growth and development, and auxology links gigantism to endocrine abnormalities.

## 6. Set 6 · Q51–60

Levels of organization · Hard

**131. Which sequence orders the structural levels from simplest to most complex, as in the lecture diagram?**

**A** Atom, organelle, molecule, cell, tissue, organ, organ system, organism

**B** Atom, molecule, organelle, cell, tissue, organ, organ system, organism

**C** Molecule, atom, organelle, cell, organ, tissue, organ system, organism

**D** Atom, molecule, cell, organelle, tissue, organ system, organ, organism

Kinesiology · Hard

**132. A physiotherapist designs a therapeutic exercise programme and relies on adaptation through exercise. How does the lecture relate this field to biomechanics?**

**A** Kinesiology is a subdiscipline of biomechanics focused on forces only

**B** Kinesiology is the study of human growth and its disorders

**C** Kinesiology deals only with bodies at rest or in constant motion

**D** Biomechanics of movement is a subdiscipline of kinesiology, the study of human movement

Respiratory and urinary · Medium

**133. Which statement about wastes is consistent with the organ-system interrelationships slide?**

**A** Metabolic wastes are eliminated mainly by the muscular system

**B** Metabolic wastes are eliminated by the urinary and respiratory systems

**C** Nutrients are distributed by the urinary system

**D** Oxygen is taken in by the integumentary system Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 32

Organ interrelationships · Hard

**134. A patient has kidney failure. Which consequence follows directly from the organ-system interrelationships slide?**

**A** Oxygen delivery stops because the urinary system distributes oxygen

**B** Digestion halts because kidneys break down ingested food

**C** Nitrogenous and metabolic wastes accumulate because urinary elimination is impaired

**D** Blood cell formation stops because kidneys store calcium

Lever calculation · Hard

**135. In a barbell-curl style third-class lever, the biceps inserts 4 cm from the elbow and a 2 kg load sits 32 cm from the elbow. Ignoring forearm weight, what muscle force holds the load in equilibrium? (g = 9.8 m/s²)**

**A** 156.8 N

**B** 19.6 N

**C** 2.45 N

**D** 1568 N

Organ systems · Easy

**136. Which organ system synthesizes vitamin D and protects deep tissues from injury?**

**A** Skeletal system

**B** Endocrine system

**C** Integumentary system

**D** Urinary system

False statement · Devil

**137. Which statement about organ systems is FALSE?**

**A** The skeletal system stores minerals and is a site of blood formation

**B** The urinary system regulates water, electrolyte and pH balance

**C** The respiratory system supplies blood with oxygen, removing carbon dioxide

**D** The lymphatic system synthesizes vitamin D and forms hormones

Anatomical structures · Medium

**138. Which pairing of anatomical structure and role is correct?**

**A** Tendons transmit force; ligaments stabilize joints

**B** Tendons stabilize joints; ligaments transmit force

**C** Tendons generate force; muscles stabilize joints

**D** Ligaments allow motion; joints transmit force

Regional terms · Hard

**139. Which pairing of bones and skeleton division follows the lecture?**

**A** Sternum is axial and the pelvic girdle is appendicular

**B** Sternum is appendicular and the pelvic girdle is axial

**C** Ribs are appendicular and the pectoral girdle is axial

**D** Skull is appendicular and the hyoid is axial

Body mechanics · Easy

**140. According to the lecture, poor body mechanics are often the cause of which problem?**

**A** Skin infections

**B** Anaemia

**C** Hearing loss

**D** Back problems

## Answers — Set 6 · Q51–60

**131.** B — The diagram builds from atoms upward to the whole organism.

**132.** D — The lecture states biomechanics of human movement is one of the subdisciplines of kinesiology.

**133.** B — The slide states that urinary and respiratory systems eliminate metabolic wastes.

**134.** C — The urinary system eliminates nitrogenous wastes and balances water, electrolytes and pH.

**135.** A — Torque balance: F × 0.04 m = (2 × 9.8) N × 0.32 m, so F = 6.272 ÷ 0.04 = 156.8 N, eight times the load.

**136.** C — The integumentary system (skin, glands, hair, nails) covers the body, protects deep tissues and synthesizes vitamin D.

**137.** D — The integumentary system synthesizes vitamin D; the lymphatic system returns fluid and houses immune cells.

**138.** A — Tendons connect muscle to bone to transmit force, while ligaments stabilize joints.

**139.** A — The axial skeleton includes the skull, hyoid, vertebrae, ribs and sternum; the limb girdles belong to the appendicular part.

**140.** D — The slide says poor body mechanics are often the cause of back problems through abnormal spinal stress.

## 7. Set 7 · Q61–70

False statement · Devil

**141. Which statement about biometrics and anthropometrics is FALSE?**

**A** Biometrics measures human characteristics to identify individuals in groups

**B** Anthropometrics identifies individuals using behavioural patterns such as voice

**C** Fingerprint is a physiological identifier in biometrics

**D** Anthropometrics gives dimensional descriptors of body size and shape Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 33

Branches · Medium

**142. Which pair correctly matches the branch of biomechanics with its subject matter?**

**A** Fluid biomechanics: bones and tendons; solid biomechanics: blood flow

**B** Fluid biomechanics: muscle force; solid biomechanics: airflow

**C** Fluid biomechanics: joint motion; solid biomechanics: body growth

**D** Fluid biomechanics: blood flow and airflow; solid biomechanics: bones and tendons

Principles · Easy

**143. According to the principles of body mechanics, what happens when the centre of gravity is lowered?**

**A** Stability of the body or patient decreases

**B** Stability of the body or patient increases

**C** Muscle strength of the whole body increases

**D** Friction between object and floor is eliminated

Muscular system · Medium

**144. Shivering in a cold room mainly demonstrates which function of the muscular system?**

**A** Maintaining organ volume through smooth muscle tone

**B** Facial expression through skeletal muscle contraction

**C** Thermogenesis, the production of heat

**D** Locomotion through coordinated limb movement

Anatomical position · Easy

**145. In the anatomical position the palms face which direction?**

**A** Forward

**B** Backward

**C** Toward the thighs

**D** Upward

Origin and insertion · Hard

**146. In a biceps curl, which description of the muscle ends matches the lecture's definitions?**

**A** The end on the forearm is the origin because it is lifted

**B** The stationary end on the shoulder girdle is the origin and the end on the forearm is the insertion

**C** The end on the shoulder girdle is the insertion because it is closer to the body

**D** Both ends are insertions because both attach to bone

Levers · Hard

**147. A rigid crowbar pivots on a fixed point and a force near one end lifts a load near the other end with the fulcrum in the middle. Which description is accurate?**

**A** It is second class, since the load is lifted against gravity

**B** It is third class, since a person applies the force

**C** It is not a lever, since the fulcrum is not at one end

**D** It is first class, and changes both direction and strength of force

Regional terms · Easy

**148. Which body parts make up the axial region?**

**A** Arms and legs only

**B** Hands and feet only

**C** Skin and underlying muscles

**D** Head, neck and trunk

Principles · Easy

**149. Which principle of body mechanics relates base of support to stability?**

**A** The wider the base of support, the greater the stability

**B** The wider the base of support, the lower the stability

**C** The narrower the base of support, the greater the stability

**D** Base of support has no effect on stability of the body Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 34

Statics · Medium

**150. Which situation is a statics problem as defined in the Branches of Biomechanics slide?**

**A** A sprinter accelerating off the starting block

**B** A weightlifter jerking a barbell upward quickly

**C** A footballer speeding up while kicking a ball

**D** A patient standing still in an upright posture

## Answers — Set 7 · Q61–70

**141.** B — Identification by voice is biometrics; anthropometrics describes dimensions and weights of body segments.

**142.** D — The lecture assigns blood and airflow to fluid and bones, tendons and ligaments to solid biomechanics. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 44

**143.** B — Principle 2 states that the lower the centre of gravity, the greater the stability.

**144.** C — The lecture lists thermogenesis as a function of muscle; shivering generates heat.

**145.** A — Anatomical position is body erect, feet slightly apart, palms forward, thumbs pointing away from the body.

**146.** B — Origin is the stationary end and insertion the movable end, so the forearm attachment moves toward the shoulder.

**147.** D — The fulcrum lies between force and resistance, and the lecture says levers change direction and strength of applied force.

**148.** D — The axial region consists of head, neck and trunk.

**149.** A — This is principle 1 on the slide.

**150.** D — Statics deals with bodies at rest or moving at constant velocity. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 45

## 8. Set 8 · Q71–80

Stability calculation · Devil

**151. A 700 N person with feet 0.3 m apart (half-width 0.15 m) has the centre of gravity 1.0 m high. A horizontal push at the centre of gravity topples them when F × h exceeds W × half-width. What is the critical push?**

**A** 105 N

**B** 210 N

**C** 700 N

**D** 46.7 N

Posture · Easy

**152. Good standing posture lines up which body parts?**

**A** Ears, elbows, knees and wrists in a line

**B** Eyes, chin, navel and toes in a line

**C** Head, wrists, thighs and heels in a line

**D** Ears, shoulders, hips and ankles

Friction · Hard

**153. A patient of 80 kg is dragged across a sheet with friction coefficient 0.5, then across a draw sheet with coefficient 0.2. Taking g = 9.8 m/s², how much force does the lower friction save?**

**A** 392 N

**B** 156.8 N

**C** 235.2 N

**D** 627.2 N

Anatomy and physiology · Easy

**154. Anatomy is defined in the lecture as the study of what?**

**A** The structure of the body and relationships of its parts

**B** The functions of the body parts and organ systems

**C** The chemical reactions occurring in body cells

**D** The forces acting on the body during movement

False statement · Devil

**155. Which statement about directional terms is FALSE?**

**A** Medial means away from the midline and lateral means toward it

**B** Anterior is a synonym of ventral and posterior of dorsal

**C** Superficial means toward the body surface and deep away from it

**D** Proximal means closer to the point of attachment of a limb

Directional terms · Easy

**156. Which term is the synonym of superior in anatomy?**

**A** Caudal

**B** Cranial

**C** Ventral

**D** Dorsal

Components · Easy

**157. Which set lists the four components of body mechanics given in the lecture?**

**A** Posture, hydration, diet, sleep duration and exercise habit

**B** Posture, balance, reflexes, vision and hearing sensitivity

**C** Posture, base of support and centre of gravity, muscle groups, lifting technique

**D** Lifting technique, pulse rate, blood pressure and body weight Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 35

Metabolism · Hard

**158. Which process is anabolic rather than catabolic?**

**A** Digestion of dietary starch to glucose in the intestine

**B** Breakdown of muscle glycogen to supply energy to cells

**C** Synthesis of glycogen from glucose in the liver

**D** Oxidation of glucose to carbon dioxide and water

Nervous system · Easy

**159. Which statement describes the nervous system according to the lecture?**

**A** It uses hormones to slowly regulate growth and metabolism

**B** It picks up leaked fluid and returns it to blood

**C** It eliminates nitrogenous wastes from the body

**D** It is the fast-acting control system that activates muscles and glands

Lever classes · Hard

**160. Which statement correctly explains why third-class levers are common in the limbs despite needing large muscle forces?**

**A** They give a mechanical advantage greater than one for the load

**B** They trade force for range and speed of the distal limb segment

**C** They place the fulcrum between the muscle and the load

**D** They keep the load between the muscle insertion and fulcrum

## Answers — Set 8 · Q71–80

**151.** A — F = 700 × 0.15 ÷ 1.0 = 105 N, the push at which the line of gravity leaves the base of support.

**152.** D — The slide says to stand straight with ears, shoulders, hips and ankles aligned.

**153.** C — Force = μ × m × g: 0.5 × 784 = 392 N versus 0.2 × 784 = 156.8 N, a saving of 235.2 N.

**154.** A — Anatomy is about structure; physiology is about function.

**155.** A — The terms are swapped: medial means toward the midline and lateral away from it.

**156.** B — Superior (cranial) means toward the head or upper part of a structure.

**157.** C — This matches the slide exactly.

**158.** C — Anabolism builds complex substances from simpler ones, and glycogen is built from glucose units.

**159.** D — The nervous system (brain, spinal column, nerves) responds to stimuli by activating muscles and glands. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 46

**160.** B — With the effort arm shorter than the resistance arm, a small muscle shortening gives a large, fast movement at the hand.

**Module 3: Lecture 3 — Biomechanics (Continued)** — 80 questions

## 1. Set 1 · Q1–10

Impulse · Devil

**161. A person lands with average force 2000 N over 0.25 s. Landing stiff-legged brings the same body to rest in 0.05 s. With the same impulse, the average force becomes:**

**A** 2000 N, because impulse is unchanged

**B** 10 000 N, five times larger

**C** 2500 N, a small rise

**D** 100 000 N, fifty times larger

Definition · Easy

**162. The term biomechanics combines 'bio' with mechanics. Which description matches the lecture definition?**

**A** Life, combined with the study of the actions of forces

**B** Life, combined with the study of heat and energy transfer

**C** Body, combined with the study of chemical reactions

**D** Movement, combined with the study of light and sound

Density · Hard

**163. A dried bone specimen has a mass of 90 g and a volume of 50 $cm^3$. Its density in $kg/m^3$ is:**

**A** 1.8 $kg/m^3$

**B** 555 $kg/m^3$

**C** 18 000 $kg/m^3$

**D** 1800 $kg/m^3$

Mechanical loads · Medium

**164. When an eccentric (non-axial) force acts on a structure such as a bone, the structure:**

**A** Is compressed uniformly on all sides

**B** Slides one portion over another in a plane

**C** Twists about its longitudinal axis

**D** Bends, with compression on one side and tension on the other

Loading and failure · Devil

**165. Which statement about effects of loading is FALSE?**

**A** Yield point is where deformation becomes permanent

**B** Failure is loss of mechanical continuity, such as a fracture

**C** Repeated subacute loads over time can cause a stress injury

**D** Failure marks the point where deformation first becomes permanent

Free body diagram · Devil

**166. Which statement about free body diagrams is FALSE?**

**A** An FBD can isolate a joint system such as the knee or elbow

**B** Weight is drawn as W = mg acting at the center of mass

**C** An FBD can only be drawn for the whole body, never a single segment

**D** Ground reaction forces are shown with vertical and horizontal components

Acceleration · Medium

**167. Why should a sprinter's acceleration be close to zero in the middle of a 100 m race?**

**A** Velocity is then constant and near maximum

**B** The runner has stopped and velocity is zero

**C** Speed is decreasing at a steady rate

**D** Forces on the body have all vanished

Kinematics · Medium

**168. The qualitative kinematics of a soccer kick would list which major joint actions?**

**A** Hip abduction, knee eversion and ankle pronation

**B** Trunk circumduction and wrist supination only

**C** Hip flexion, knee extension and possibly ankle plantar flexion

**D** Ankle inversion and hip adduction only Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 48

Impulse · Easy

**169. Impulse (J) is given by:**

**A** J = F t, the product of force and time

**B** J = F / t, force divided by time

**C** J = F d, force times distance

**D** J = m a g, mass times acceleration due to gravity

Acceleration · Hard

**170. A runner slows from 10 m/s to 6 m/s over 2 s. The average linear acceleration is:**

**A** −2 m/s², meaning velocity is decreasing

**B** +2 m/s², meaning velocity is decreasing

**C** −8 m/s², meaning velocity is decreasing

**D** −2 m/s², meaning velocity is constant

## Answers — Set 1 · Q1–10

**161.** B — Impulse J = 2000 × 0.25 = 500 N·s. With J fixed, F = 500 ÷ 0.05 = 10 000 N, so shorter stopping time means greater force and injury risk.

**162.** A — Bio means life and mechanics is the study of the actions of forces, so biomechanics is the mechanics of living organisms producing movement.

**163.** D — ρ = 90 g ÷ 50 cm³ = 1.8 g/cm³ = 1800 kg/m³, because 1 g/cm³ equals 1000 kg/m³ (denser than water).

**164.** D — Bending produces compressive stress on one side and tensile stress on the opposite side.

**165.** D — This is false: the point where deformation becomes permanent is the yield point, whereas failure is the later loss of mechanical continuity.

**166.** C — This is false: the lecture states that an FBD can show the whole body, a segment (foot, leg, forearm, trunk, head), a joint system or an interacting object.

**167.** A — Zero acceleration means constant velocity, which fits a runner holding near-maximum speed mid-race.

**168.** C — The lecture lists hip flexion, knee extension and possibly plantar flexion at the ankle.

**169.** A — Impulse is force multiplied by the time of its application.

**170.** A — $a = (6 - 10) \div 2 = -2$ m/s²; negative acceleration here means the runner is decelerating.

## 2. Set 2 · Q11–20

Impulse · Medium

**171. A force of 50 N is applied to a body for 0.4 s. The impulse is:**

**A** 20 N·s

**B** 125 N·s

**C** 2 N·s

**D** 200 N·s

Torque balance · Devil

**172. A 4 kg ball (g = 9.8 m/s²) is held 0.30 m from the elbow axis. The forearm weighs 15 N, acting 0.15 m from the axis. The biceps inserts 0.04 m from the axis. The biceps force needed for equilibrium is about:**

**A** 350 N

**B** 294 N

**C** 140 N

**D** 3500 N

Mechanical loads · Medium

**173. A force acting parallel or tangent to a surface, tending to make one portion slide relative to another, is:**

**A** Shear

**B** Compression

**C** Tension

**D** Bending

Vector composition · Devil

**174. Two perpendicular muscle forces of 60 N and 80 N act on one point. The resultant magnitude and its angle from the 60 N force are:**

**A** 140 N at about 53°

**B** 100 N at about 37°

**C** 70 N at about 45°

**D** 100 N at about 53°

Newton's second law · Devil

**175. A 70 kg sprinter drives forward with 400 N while air resistance opposes with 100 N. The horizontal acceleration is about:**

**A** 5.7 m/s²

**B** 7.1 m/s²

**C** 4.3 m/s²

**D** 1.4 m/s²

Center of gravity · Medium

**176. The center of gravity of a body is best described as:**

**A** The point where its mass is greatest in every position

**B** The point fixed at the geometric centre of the trunk

**C** The point about which its volume is equally divided

**D** The point about which its weight is equally balanced in any position Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 49

Torque · Medium

**177. A force of 200 N acts with a perpendicular distance of 0.3 m from the axis of rotation. The torque is:**

**A** 60 N·m

**B** 600 N·m

**C** 667 N·m

**D** 0.15 N·m

Mass and weight · Devil

**178. A 70 kg patient is moved from Earth (g = 9.8 m/s²) to the Moon (g = 1.6 m/s²). Which statement is correct?**

**A** Mass and inertia stay 70 kg; weight drops to 112 N

**B** Mass drops to 11.4 kg; weight drops to 112 N

**C** Inertia drops sixfold; weight drops to 112 N

**D** Mass stays 70 kg; weight stays 686 N

Joint movements · Easy

**179. Outward and inward rotation of the forearm are respectively called:**

**A** Pronation and supination

**B** Eversion and inversion

**C** Supination and pronation

**D** Radial and ulnar deviation

Inertia and mass · Easy

**180. The amount of inertia a body possesses is directly proportional to its:**

**A** The local gravitational acceleration

**B** Mass

**C** Velocity

**D** Volume

### Answers — Set 2 · Q11–20

**171.** A — Impulse J = F × t = 50 N × 0.4 s = 20 N·s.

**172.** A — Torques about the elbow: ball 39.2 × 0.30 = 11.76 N·m plus forearm 15 × 0.15 = 2.25 N·m gives 14.01 N·m, and 14.01 ÷ 0.04 ≈ 350 N.

**173.** A — Shear force acts parallel to a surface and tends to displace one portion of the object relative to another.

**174.** D — R = √(60² + 80²) = 100 N, and the angle from the 60 N force is arctan(80/60) ≈ 53°, tilted toward the larger force.

**175.** C — Net force = 400 − 100 = 300 N, so a = 300 ÷ 70 ≈ 4.3 m/s².

**176.** D — The lecture defines the center of gravity (center of mass) as the point around which the body's weight is equally balanced however it is positioned.

**177.** A — Torque = F × d = 200 N × 0.3 m = 60 N·m.

**178.** A — Mass and inertia are unchanged, while weight = m g = 70 × 1.6 = 112 N.

**179.** C — In the transverse plane, outward forearm rotation is supination and inward rotation is pronation.

**180.** B — Inertia is the tendency to maintain the current state of motion, and it is directly proportional to mass.

## 3. Set 3 · Q21–30

Projectile · Medium

**181. Which of these is a projectile according to the lecture?**

**A** A rocket during powered flight

**B** A discus moving through the air after release

**C** An aeroplane flying under engine thrust

**D** A sprinter pushing off the starting block

Weight · Medium

**182. Using g = 9.8 m/s², the weight of a 70 kg patient is:**

**A** 70 N

**B** 686 N

**C** 7.1 N

**D** 6860 N

Torque · Easy

**183. Algebraically, torque is the product of force and:**

**A** The time over which the force is applied to the segment

**B** The area over which the force is spread out evenly

**C** The mass of the segment that is rotating about the axis

**D** The perpendicular distance from the force line to the axis

Mechanical loads · Medium

**184. A person plants a foot while the body turns above it, so the tibia twists about its long axis with one end fixed. This loading is:**

**A** Compression

**B** Torsion

**C** Pure shear

**D** Tension Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 50

Newton's second law · Hard

**185. A 60 kg sprinter leaves the blocks with an average acceleration of 3 m/s². Using F = ma, the net horizontal force on the sprinter is:**

**A** 20 N

**B** 180 N

**C** 588 N

**D** 1764 N

Definition · Easy

**186. Which forces are studied in biomechanics according to the lecture?**

**A** Only internal forces produced by muscle contraction

**B** Internal forces from muscles and external forces acting on the body

**C** Only external forces such as gravity and friction

**D** Only the electrical forces between ions in tissues

Impulse · Hard

**187. Four forces act on a ball: 400 N for 0.05 s, 150 N for 0.15 s, 100 N for 0.30 s, and 60 N for 0.40 s. Which delivers the greatest impulse?**

**A** 400 N for 0.05 s (20 N·s)

**B** 150 N for 0.15 s (22.5 N·s)

**C** 100 N for 0.30 s (30 N·s)

**D** 60 N for 0.40 s (24 N·s)

Vector composition · Hard

**188. Two perpendicular muscle forces of 30 N and 40 N act on the same point of a bone. Using tip-to-tail composition, the resultant magnitude is:**

**A** 70 N

**B** 50 N

**C** 10 N

**D** 35 N

Pressure · Medium

**189. A force of 600 N is spread evenly over an area of 0.03 m². The pressure is:**

**A** 18 Pa

**B** 2 kPa

**C** 20 kPa

**D** 200 kPa

Mechanical loads · Easy

**190. Which load is described as a squeezing force?**

**A** Tension

**B** Compression

**C** Shear

**D** Torsion

### Answers — Set 3 · Q21–30

**181.** B — A projectile is a body in free fall subject only to gravity and air resistance, as a released discus is.

**182.** B — wt = m × g = 70 kg × 9.8 m/s² = 686 N.

**183.** D — Torque T = F × d, where d is the perpendicular distance from the force's line of action to the axis. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 61

**184.** B — Torsion is twisting about the longitudinal axis, typically with one end fixed.

**185.** B — F = m a = 60 kg × 3 m/s² = 180 N; this is the net force, not the weight.

**186.** B — The lecture states that both internal muscle forces and external forces acting on the body are studied.

**187.** C — Impulse J = F t: 20, 22.5, 30 and 24 N·s respectively, so 100 N for 0.30 s is largest despite the smallest-looking force.

**188.** B — For perpendicular vectors the resultant is √(30² + 40²) = √2500 = 50 N.

**189.** C — P = F/A = 600 N ÷ 0.03 m² = 20 000 Pa = 20 kPa.

**190.** B — Compressive force squeezes an object.

## 4. Set 4 · Q31–40

Gait · Hard

**191. A person walks at 1.4 m/s with a stride length of 1.75 m. Using speed = stride length × stride frequency, the stride frequency is:**

**A** 1.25 strides per second

**B** 2.45 strides per second

**C** 0.57 strides per second

**D** 0.8 strides per second

Density · Medium

**192. A tissue sample has a mass of 2.4 kg and occupies 0.002 m³. Its density is:**

**A** 4.8 kg/m³

**B** 120 kg/m³

**C** 12 000 kg/m³

**D** 1200 kg/m³ Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 51

Stability and CG · Devil

**193. A person weighing 800 N stands with feet 0.40 m apart. The left foot carries 600 N and the right foot 200 N. The CG lies on the line between the feet, at what distance from the left foot?**

**A** 0.30 m

**B** 0.10 m

**C** 0.20 m

**D** 0.15 m

Mechanical loads · Devil

**194. Which statement about mechanical loads is FALSE?**

**A** Shear force acts perpendicular to a surface, squeezing it

**B** Tension pulls and is the opposite of compression

**C** Torsion twists a structure about its longitudinal axis

**D** Bending creates compression on one side and tension on the other

Projectile · Devil

**195. Which statement about projectiles is FALSE?**

**A** A discus in flight is a projectile

**B** Rockets and aeroplanes do not qualify as projectiles

**C** Angle, speed and relative height of projection set the path

**D** Trajectory depends only on the mass and the shape of the body

Vector resolution · Hard

**196. A therapist pulls a limb with a 200 N force directed 40° above the horizontal. The vertical component is about:**

**A** 129 N

**B** 153 N

**C** 200 N

**D** 76 N

Density and weight · Devil

**197. A blood donation of 450 mL ($4.5 \times 10^{-4}$ m³) has density 1060 kg/m³. Its mass and weight (g = 9.8 m/s²) are about:**

**A** 4.77 kg and 47 N

**B** 0.477 kg and 0.48 N

**C** 0.477 kg and 4.7 N

**D** 477 kg and 4675 N

Kinetics vs kinematics · Devil

**198. Which pair of measured quantities is entirely kinetic?**

**A** Stride length and knee angle

**B** Ground reaction force and net joint torque

**C** Joint torque and stride timing

**D** Ground reaction force and walking speed

Projectile · Hard

**199. Two shot putters release the shot at the same speed and angle, but one releases it from a higher point. Neglecting air resistance, the higher release gives:**

**A** A longer flight time and a greater horizontal range

**B** A shorter flight time and a smaller horizontal range

**C** The same range, since speed and angle are equal

**D** A smaller range because the weight acts for longer

Yield point · Medium

**200. The yield point (elastic limit) on a load-deformation curve is the point:**

**A** At which the tissue first begins to be loaded

**B** At which the tissue ruptures completely

**C** Beyond which deformation becomes permanent

**D** Where deformation is greatest and always reversible Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 52

### Answers — Set 4 · Q31–40

**191.** D — Frequency = speed ÷ length = 1.4 ÷ 1.75 = 0.8 strides/s. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 62

**192.** D — Density = mass ÷ volume = 2.4 kg ÷ 0.002 $m^3$ = 1200 $kg/m^3$.

**193.** B — Moments about the right foot: 600 × 0.40 = 800 × (0.40 − x), so 0.40 − x = 0.30 and x = 0.10 m; the CG sits nearer the more heavily loaded foot.

**194.** A — This is false: shear acts parallel or tangent to a surface and makes one portion slide relative to another.

**195.** D — This is false: the lecture lists angle of projection, projection speed and relative height of projection as the three trajectory factors.

**196.** A — Vertical component = 200 sin40° ≈ 129 N; horizontal = 200 cos40° ≈ 153 N, and the two recombine to 200 N.

**197.** C — Mass = 1060 × 4.5 × $10^{-4}$ = 0.477 kg, and weight = 0.477 × 9.8 ≈ 4.7 N.

**198.** B — Forces and torques are kinetic quantities, so both belong to kinetics.

**199.** A — A greater relative height of projection lets the shot fall for longer before landing, increasing horizontal displacement.

**200.** C — Past the yield point the tissue does not fully recover; deformation is permanent.

## 5. Set 5 · Q41–50

Vector resolution · Devil

**201. A ground reaction force of 1200 N acts 20° from the vertical. Its vertical and horizontal components are about:**

**A** 410 N and 1128 N

**B** 1128 N and 764 N

**C** 1200 N and 410 N

**D** 1128 N and 410 N

Gait · Medium

**202. A walker has a stride length of 1.5 m and a stride frequency of 1.2 strides per second. The walking speed is:**

**A** 1.25 m/s

**B** 0.8 m/s

**C** 1.8 m/s

**D** 2.7 m/s

Vectors · Easy

**203. Which of the following is a scalar quantity?**

**A** Velocity

**B** Displacement

**C** Speed

**D** Acceleration

Pressure · Devil

**204. A lancet tip presses on a finger with a 2 N force over an area of 0.01 mm². The pressure at the tip is:**

**A** 200 kPa

**B** 2 GPa

**C** 200 MPa

**D** 20 MPa

Pressure · Devil

**205. A 70 kg person (weight 686 N) balances on one stiletto heel of area 1 cm² and then on a flat sole of area 140 cm². The heel pressure and its ratio to flat-sole pressure are:**

**A** 686 kPa, 14 times greater

**B** 6.86 MPa, 140 times greater

**C** 68.6 MPa, 1400 times greater

**D** 6.86 kPa, 1.4 times greater

Definition · Easy

**206. Biomechanics of human movement is a subdiscipline of which field?**

**A** Histology, the study of microscopic tissue structure

**B** Haematology, the study of blood and its disorders

**C** Kinesiology, the study of human movement

**D** Pharmacology, the study of drug action on the body

Gait · Devil

**207. A patient has a stride length of 1.2 m and a cadence of 90 steps per minute (one stride equals two steps). Using speed = stride length × stride frequency, the walking speed is:**

**A** 1.8 m/s

**B** 0.45 m/s

**C** 0.9 m/s

**D** 0.6 m/s Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 53

Torque · Hard

**208. Force X of 300 N acts with a perpendicular distance of 0.2 m from a joint axis, and force Y of 120 N acts with a perpendicular distance of 0.6 m. Which statement is correct?**

**A** X produces the greater torque because its force is larger

**B** Both produce equal torques since the distances sum to 0.8 m

**C** X produces 1500 N·m and Y produces 200 N·m

**D** Y produces the greater torque, 72 N·m against 60 N·m

Speed vs velocity · Medium

**209. A skater travels 400 m round a circular track in 50 s and finishes at the start point. Her average speed and average velocity are:**

**A** Speed 0 m/s; velocity 8 m/s

**B** Speed 8 m/s; velocity 0 m/s

**C** Speed 8 m/s; velocity 8 m/s

**D** Speed 0 m/s; velocity 0 m/s

Gait · Hard

**210. A walker increases from stride length 1.2 m at 1.5 strides/s to stride length 1.5 m at 1.6 strides/s. The speed rises by about:**

**A** 25%, from 1.8 m/s to 2.25 m/s

**B** 8%, from 1.8 m/s to 1.95 m/s

**C** 33%, from 1.8 m/s to 2.4 m/s

**D** 67%, from 1.8 m/s to 3.0 m/s

## Answers — Set 5 · Q41–50

**201.** D — From the vertical, vertical = 1200 cos20° ≈ 1128 N and horizontal = 1200 sin20° ≈ 410 N.

**202.** C — Gait speed = stride length × stride frequency = 1.5 × 1.2 = 1.8 m/s.

**203.** C — Speed has magnitude only (distance divided by time), so it is scalar.

**204.** C — 0.01 mm² = $10^{-8}$ m², so P = 2 ÷ $10^{-8}$ = 2 × $10^{8}$ Pa = 200 MPa, which is why a sharp tip pierces skin easily.

**205.** B — Heel: 686 ÷ 1 × $10^{-4}$ m² = 6.86 MPa. Sole: 686 ÷ 0.014 m² = 49 kPa. Same force, so the ratio equals the area ratio of 140.

**206.** C — The slide places the biomechanics of human movement under kinesiology, the study of human movement.

**207.** C — 90 steps/min = 45 strides/min = 0.75 strides/s, so speed = 1.2 × 0.75 = 0.9 m/s.

**208.** D — T = F × d gives 60 N·m for X and 72 N·m for Y, so the longer lever arm outweighs the smaller force.

**209.** B — Speed uses distance (400 m ÷ 50 s = 8 m/s) while velocity uses displacement, which is zero for a closed lap.

**210.** C — Speed = length × frequency: 1.2 × 1.5 = 1.8 m/s and 1.5 × 1.6 = 2.4 m/s, a rise of 0.6/1.8 ≈ 33%.

## 6. Set 6 · Q51–60

Density and weight · Hard

**211. Blood has a density of about 1060 kg/m³. For a 5 litre (0.005 m³) volume, the mass and weight (g = 9.8 m/s²) are:**

**A** 5.3 kg and about 5.3 N

**B** 5.3 kg and about 52 N

**C** 212 kg and about 2078 N

**D** 0.53 kg and about 5.2 N

Free body diagram · Hard

**212. A leg is in equilibrium. The floor pushes up on the foot with F1 = 700 N, gravity pulls the leg down with F3 = 100 N, and the rest of the body acts at the hip with force F2 along the same vertical line. The force F2 must be:**

**A** 800 N directed downward

**B** 600 N directed upward

**C** 700 N directed downward

**D** 600 N directed downward

Vector resolution · Medium

**213. A 100 N force acts at 30° above the horizontal. Its horizontal and vertical components are about:**

**A** 50 N and 86.6 N

**B** 86.6 N and 50 N

**C** 70.7 N and 70.7 N

**D** 100 N and 30 N

Bending · Hard

**214. A long bone is loaded eccentrically and bows so that its lateral surface becomes convex. The stresses on its lateral and medial surfaces are respectively:**

**A** Compressive on the lateral and tensile on the medial

**B** Compressive on both lateral and medial surfaces

**C** Tensile on the lateral and compressive on the medial

**D** Tensile on both lateral and medial surfaces Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 54

Torque balance · Hard

**215. A 5 kg mass (weight 49 N, g = 9.8 m/s²) is held in the hand 0.35 m from the elbow axis. The biceps inserts 0.05 m from the axis. Ignoring the forearm's own weight, the biceps force needed is:**

**A** 343 N

**B** 49 N

**C** 245 N

**D** 3430 N

Pressure · Easy

**216. Pressure is defined as:**

**A** Force multiplied by the time of application

**B** Force multiplied by perpendicular distance

**C** Force distributed over a given area

**D** Mass per unit volume

Acceleration · Devil

**217. A runner moving at +4 m/s reverses and is moving at −2 m/s three seconds later. The average acceleration is:**

**A** +0.67 m/s², directed along the initial motion

**B** −0.67 m/s², directed opposite to the initial motion

**C** −6 m/s², directed opposite to the initial motion

**D** −2 m/s², directed opposite to the initial motion

Vector composition · Medium

**218. Two muscles pull on one bone in exactly opposite directions with forces of 30 N and 45 N. The resultant is:**

**A** 15 N in the direction of the larger force

**B** 75 N in the direction of the larger force

**C** 15 N in the direction of the smaller force

**D** 37.5 N in the direction of the larger force

Pressure · Hard

**219. An 80 kg man stands with weight shared equally between two feet, each with contact area 200 cm² (0.02 m²). Using g = 9.8 m/s², the pressure under each foot is:**

**A** 19.6 kPa

**B** 39.2 kPa

**C** 1.96 kPa

**D** 392 kPa

Kinematics vs kinetics · Easy

**220. In mechanics, kinetics is best described as:**

**A** The description of how far and how fast a body moves

**B** The study of the sequencing and duration of movements

**C** The study of motion with no reference to mass

**D** The study of forces that cause motion

## Answers — Set 6 · Q51–60

**211.** B — Mass = ρ × V = 1060 × 0.005 = 5.3 kg, and weight = m g = 5.3 × 9.8 ≈ 52 N.

**212.** D — For equilibrium the vector sum is zero: 700 N up balanced by 100 N down plus F2, so F2 = 600 N down.

**213.** B — Horizontal = 100 cos30° ≈ 86.6 N and vertical = 100 sin30° = 50 N; they recombine to the original vector.

**214.** C — In bending, the convex (stretched) side carries tensile stress and the concave side carries compressive stress.

**215.** A — Torque balance gives F × 0.05 = 49 × 0.35, so F = 17.15 ÷ 0.05 = 343 N; the short moment arm forces a large muscle force.

**216.** C — Pressure P = F/A, the force spread over an area.

**217.** D — a = (−2 − 4) ÷ 3 = −2 m/s²; velocity is a vector, so the reversal counts as a change of 6 m/s.

**218.** A — Opposite vectors are composed by subtracting magnitudes: 45 − 30 = 15 N toward the larger force.

**219.** A — Weight = 784 N, so each foot carries 392 N and P = 392 ÷ 0.02 = 19 600 Pa = 19.6 kPa.

**220.** D — Kinetics studies the forces causing motion, characterised by magnitude, direction, line of action and point of application.

## 7. Set 7 · Q61–70

Torque · Devil

**221. A 100 N force acts on a 0.4 m lever at 30° to the lever's length. The torque about the pivot is:**

**A** 34.6 N·m

**B** 20 N·m

**C** 40 N·m

**D** 2 N·m

Loading types · Medium

**222. A runner develops a stress fracture after weeks of repeated low-magnitude impacts. This injury arose from:**

**A** Acute loading by a single large force

**B** A purely tensile load on the skin

**C** A vector composition error in gait

**D** Repetitive (chronic) loading of subacute magnitude Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 55

Linear motion · Easy

**223. Linear motion along a straight line is called:**

**A** Curvilinear motion

**B** Rectilinear motion

**C** Angular motion

**D** General motion

Projectile · Medium

**224. Which set lists the three factors that influence a projectile's trajectory?**

**A** Angle of projection, mass and air temperature

**B** Speed, body volume and surface friction

**C** Angle, speed and relative height of projection

**D** Relative height, density and time of day

Joint movements · Easy

**225. Flexion, extension and hyperextension occur mainly in which plane?**

**A** Sagittal plane

**B** Frontal plane

**C** Transverse plane

**D** Coronal-transverse plane

Vector composition · Hard

**226. Two muscles pull on a bone in the same direction with forces of 40 N and 25 N, while an opposing load of 10 N acts in the opposite direction along the same line. The resultant is:**

**A** 75 N in the direction of the muscle pull

**B** 55 N in the direction of the muscle pull

**C** 15 N in the direction of the muscle pull

**D** 55 N in the direction of the load

Yield point · Hard

**227. A ligament is loaded just past its yield point and the load is then removed. Its state is best described as:**

**A** Restored fully to its original length and shape

**B** Ruptured, because passing yield equals failure

**C** Unchanged, because deformation only starts at failure

**D** Permanently lengthened but with mechanical continuity retained

Joint movements · Easy

**228. Bringing the top of the foot toward the lower leg is termed:**

**A** Plantar flexion

**B** Eversion

**C** Inversion

**D** Dorsiflexion

Linear motion · Easy

**229. Linear motion is also referred to as:**

**A** Translatory motion, or translation

**B** Rotatory motion, or rotation

**C** General motion, or combined motion

**D** Circumduction, or circular motion

Acceleration · Medium

**230. A sprinter's velocity increases from 2 m/s to 8 m/s in 3 s. The average acceleration is:**

**A** 6 $m/s^2$

**B** 3.3 $m/s^2$

**C** 0.5 $m/s^2$

**D** 2 $m/s^2$ Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 56

### Answers — Set 7 · Q61–70

**221.** B — Only the perpendicular component counts: T = 100 × sin30° × 0.4 = 20 N·m, equal to F multiplied by the perpendicular distance 0.2 m.

**222.** D — Repeated subacute loads over a period can produce a chronic or stress injury. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 66

**223.** B — If the line of translation is straight, the motion is rectilinear.

**224.** C — The lecture names angle of projection, projection speed and relative height of projection.

**225.** A — The three primary sagittal plane movements from anatomical position are flexion, extension and hyperextension.

**226.** B — Same-direction vectors add (40 + 25 = 65 N) and the opposing 10 N is subtracted, leaving 55 N along the muscle pull.

**227.** D — Past the yield point deformation is permanent, but failure (loss of continuity) needs further loading.

**228.** D — Dorsiflexion moves the top of the foot toward the lower leg, in the sagittal plane.

**229.** A — In linear motion all parts of the system move in the same direction at the same speed, which is called translation.

**230.** D — a = change in velocity ÷ change in time = (8 − 2) ÷ 3 = 2 m/s². Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 67

## 8. Set 8 · Q71–80

Free body diagram · Devil

**231. A leg is in equilibrium. The floor pushes up with 700 N and pushes forward with a 150 N friction force. The leg's weight is 100 N. The hip force F2 has magnitude and direction:**

**A** About 618 N, down and against the friction force

**B** 600 N, pointing straight down

**C** About 750 N, down and along the friction force

**D** About 716 N, down and against the friction force

General motion · Easy

**232. When translation and rotation are combined, the resulting movement is called:**

**A** Rectilinear motion

**B** Pure angular motion

**C** Projectile motion

**D** General motion

Speed vs velocity · Hard

**233. A jogger runs 3 km east in 15 min, then 1 km west in 5 min. For the whole 20 min, average speed and average velocity are:**

**A** Speed 6 km/h; velocity 12 km/h east

**B** Speed 12 km/h; velocity 12 km/h east

**C** Speed 12 km/h; velocity 6 km/h east

**D** Speed 8 km/h; velocity 4 km/h east

Joint movements · Easy

**234. Rotation of a body segment beyond anatomical position, in the direction opposite flexion, is called:**

**A** Hyperextension

**B** Extension

**C** Abduction

**D** Circumduction

Fracture mechanism · Devil

**235. A skier's boot stays fixed in the binding while the body rotates, producing a spiral tibial fracture. A pedestrian struck on the side of the leg gets a transverse fracture. The loads are respectively:**

**A** Torsion, then bending

**B** Bending, then torsion

**C** Pure shear, then torsion

**D** Compression, then tension

Joint movements · Easy

**236. Abduction is the movement of a body segment:**

**A** Toward the midline of the body

**B** Away from the midline of the body

**C** Backward beyond anatomical position

**D** Outward about the longitudinal axis

Angular motion · Easy

**237. The axis of rotation in angular motion is oriented:**

**A** Parallel to the plane in which the rotation occurs

**B** Along the midline of the body in every case

**C** Perpendicular to the plane in which the rotation occurs

**D** Within the plane, passing through the centre of gravity

Weight and force · Hard

**238. A 150 kg weight bar is lifted vertically with an upward acceleration of 0.5 m/s² (g = 9.8 m/s²). The upward force the lifter must apply is:**

**A** 1470 N

**B** 75 N

**C** 1545 N

**D** 1395 N Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 57

Free body diagram · Easy

**239. A free body diagram is best defined as:**

**A** A graph of displacement plotted against time

**B** A photograph of the body taken during movement

**C** A diagram of internal muscle fibre arrangement only

**D** A simplified drawing of an isolated body showing all external forces and moments

Pressure · Hard

**240. A 60 kg woman (weight 588 N) momentarily balances on one stiletto heel of area 4 cm² (4 × 10⁻⁴ m²). The pressure under the heel is:**

**A** 147 kPa

**B** 1.47 MPa

**C** 14.7 MPa

**D** 2.35 kPa

## Answers — Set 8 · Q71–80

**231.** A — Vertical: 700 − 100 = 600 N down. Horizontal: 150 N opposing the friction force. Magnitude √(600² + 150²) ≈ 618 N.

**232.** D — Combined translation and rotation is general motion, which is how most human movement occurs.

**233.** C — Speed = total distance 4 km ÷ (1/3 h) = 12 km/h; velocity = net displacement 2 km east ÷ (1/3 h) = 6 km/h east.

**234.** A — Hyperextension is rotation past anatomical position opposite to the direction of flexion.

**235.** A — A fixed foot with a rotating body twists the tibia about its long axis (torsion), while a lateral blow is an eccentric force that bends it.

**236.** B — Abduct means 'to take away', so abduction moves a segment away from the midline.

**237.** C — The lecture defines the axis as an imaginary line perpendicular to the plane of rotation.

**238.** C — The net force is m a = 75 N upward over and above the weight of 1470 N, so the lifter supplies 1470 + 75 = 1545 N.

**239.** D — An FBD isolates a body or segment from its surroundings and shows the external forces and moments acting on it.

**240.** B — P = F/A = 588 N ÷ 4 × 10⁻⁴ m² = 1.47 × 10⁶ Pa = 1.47 MPa; converting cm² to m² is the key step.

**Module 4: Lecture 4 — Physics of Eyes & Vision** — 80 questions

## 1. Set 1 · Q1–10

Image size · Devil

**241. Using image = (0.02 m ÷ object distance) × object height, what is the retinal image of a 1.7 m tall person standing 5.0 m away?**

**A** 0.68 mm
**B** 6.8 mm
**C** 68 mm
**D** 13.6 mm

Radiation · Easy

**242. According to the lecture, radiation is best described as:**

**A** energy moving from one place to another as waves or particles
**B** a substance that is stored permanently inside living tissue
**C** a chemical reaction that releases heat inside the cell
**D** the flow of electric charge through a conducting wire

Optical power · Hard

**243. In a relaxed normal eye the lens focal length is 2.5 cm. Treating the eye as one thin lens, its optical power is:**

**A** 4 D
**B** 0.4 D
**C** 2.5 D
**D** 40 D

Rods and cones · Medium

**244. Cones have higher acuity than rods mainly because:**

**A** three cones share a single bipolar cell, pooling signals
**B** cones are located across the whole retina, including the edge
**C** cones contain rhodopsin, which is the most stable pigment
**D** each cone connects to its own bipolar cell, preserving fine detail

Visual perception · Devil

**245. A researcher uses a contact-lens device that holds a test image perfectly fixed on the retina despite eye movements. According to the lecture, the viewer will find the image:**

**A** sharper and brighter, as the receptors keep a steady signal
**B** unchanged, as the visual cortex fills in the missing signal
**C** flipped in colour, since cones adapt to opposite hues
**D** fading away, as stationary retinal images are essentially invisible

Accommodation · Devil

**246. Extra power over the relaxed eye is 1/(near point in metres). A child has a near point of 10 cm and the same person at 60 years has 50 cm. How much accommodation is lost?**

**A** 0.8 D, falling from 1.0 D to 0.2 D

**B** 12 D, falling from 12 D to 0 D

**C** 8 D, falling from 10 D to 2 D

**D** 40 cm, falling from 50 cm to 10 cm

Refractive focusing · Medium

**247. Which eye medium has the highest average refractive index according to the lecture?**

**A** the crystalline lens, at about 1.43

**B** the cornea, at about 1.37

**C** the aqueous humour, at about 1.337

**D** the vitreous humour, at about 1.337 Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 70

Colour effects · Medium

**248. A slide designer wants to reduce chromatic aberration on a large projected area in a lecture room. The best choice is:**

**A** saturated red text on a saturated blue background

**B** saturated green text on a magenta background

**C** pastel or darker shades, avoiding extreme pairs like red with blue

**D** pure yellow text on a pure white background

Refractive index · Easy

**249. The refractive index n of a material is defined as:**

**A** n = c/v, speed of light in vacuum over speed in the medium

**B** n = v/c, speed in the medium over speed in vacuum

**C** n = c × v, the product of the two speeds

**D** n = 1/f, the reciprocal of focal length

Eye defects · Hard

**250. A short-sighted student has a far point of 50 cm. A thin lens that makes distant objects appear at 50 cm must have a power of:**

**A** −2.0 D, a diverging lens of f = −50 cm

**B** +2.0 D, a converging lens of f = +50 cm

**C** −0.5 D, a diverging lens of f = −2.0 m

**D** −20 D, a diverging lens of f = −5 cm

## Answers — Set 1 · Q1–10

**241.** B — I = (0.02 / 5.0) × 1.7 m = 0.0068 m = 6.8 mm.

**242.** A — This is the lecture definition: radiation is energy that travels from one place to another in a form describable as waves or particles.

**243.** D — P = 1/f = 1/0.025 m = 40 $m^{-1}$ = 40 dioptres.

**244.** D — One cone to one bipolar cell keeps spatial detail separate, whereas three rods converge on one bipolar cell and blur detail.

**245.** D — Eye movements keep shifting the image on the retina; a stabilised image is stationary there and fades from perception.

**246.** C — Child: 1/0.10 = 10 D; at 50 cm: 1/0.50 = 2 D; the loss is 8 D, consistent with weaker ciliary muscles and a stiffer lens.

**247.** A — The lecture gives 1.43 for the lens versus about 1.337 for aqueous and vitreous humour and 1.37 for the cornea.

**248.** C — The lecture advises avoiding extreme colour pairs and de-saturating (adding white), preferring pastel or darker shades for large areas.

**249.** A — n = c/v, where c is the speed of light in vacuum and v is the phase velocity in the medium.

**250.** A — The lens must form a virtual image of infinity at 50 cm, so f = −0.50 m and P = 1/f = −2.0 D.

## 2. Set 2 · Q11–20

Accommodation · Medium

**251. When the ciliary muscles are relaxed, a normal eye has a lens focal length of about 2.5 cm. This means:**

**A** objects at infinity are in sharp focus on the retina

**B** objects at 25 cm are in sharp focus on the retina

**C** objects at all distances are in focus without any effort

**D** the cornea has taken over all of the focusing duty

Eye defects · Devil

**252. A myopic patient has a far point of 2.0 m. Treating the spectacle as a thin lens, the power needed to see distant objects clearly is:**

**A** −0.5 D, a diverging lens with f = −2.0 m

**B** +0.5 D, a converging lens with f = +2.0 m

**C** −2.0 D, a diverging lens with f = −0.5 m

**D** −5.0 D, a diverging lens with f = −0.2 m

Colour vision · Medium

**253. In an exam hall of 250 male students and 500 female students, how many colour-defective individuals are expected using the lecture's figures (8% males, 0.4% females)?**

**A** 20 males and 2 females

**B** 2 males and 20 females

**C** 20 males and 20 females

**D** 200 males and 2 females

Refractive index · Devil

**254. Take c = 3.0 × $10^8$ m/s. How long does light take to cross a crystalline lens 4.0 mm thick (n = 1.43)?**

**A** about 13 ps

**B** about 190 ps

**C** about 27 ps

**D** about 19 ps Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 71

Bipolar cells · Devil

**255. A retinal patch holds 900 rods and 900 cones. Using the lecture's wiring, how many bipolar cells carry its signals?**

**A** 1800

**B** 600

**C** 1200

**D** 3600

Bleaching · Medium

**256. After staring at a red picture and then looking at white paper, you briefly see a pale blue-green patch because:**

**A** the rods have been permanently destroyed by the red light

**B** the cornea has become more curved after prolonged staring

**C** the optic nerve has reversed the direction of its signals

**D** the red iodopsin has been bleached and is temporarily out of order

Cornea · Medium

**257. According to the lecture, the amount of bending of light by the cornea depends on:**

**A** the curvature of its surfaces and the speed of light in it versus the surroundings

**B** the thickness of the sclera and the size of the pupil opening

**C** the tension in the ciliary muscles holding the corneal edge

**D** the colour of the iris and the amount of pigment in the choroid

Colour vision · Devil

**258. A first-year group has 600 males and 600 females. Using 8% and 0.4% colour defect rates, what share of the colour-defective students would be male?**

**A** about 95%

**B** about 50%

**C** about 20%

**D** about 8%

Eye structure · Easy

**259. The anterior chamber of the eye contains:**

**A** gelatinous vitreous humour

**B** blood-rich pigmented tissue

**C** clear, watery aqueous humour

**D** a mucous film of tear secretion

Brain organization · Easy

**260. The right and left cerebral hemispheres are joined only by the:**

**A** cerebellum

**B** corpus callosum

**C** optic chiasm

**D** fovea centralis

### Answers — Set 2 · Q11–20

**251.** A — With relaxed muscles the lens is at its weakest; its roughly 2.5 cm focal length puts distant objects in focus on the retina.

**252.** A — The lens must place infinity at the far point as a virtual image 2.0 m away, so f = −2.0 m and P = 1/f = −0.5 D.

**253.** A — 8% of 250 = 20 males and 0.4% of 500 = 2 females.

**254.** D — $t = d/v = n\,d/c = 1.43 \times 4.0 \times 10^{-3} / 3.0 \times 10^{8} \approx 1.9 \times 10^{-11}$ s = 19 ps.

**255.** C — Rods: 900 ÷ 3 = 300 bipolar cells; cones: 900 × 1 = 900; the total is 1200.

**256.** D — The lecture explains bleaching: prolonged red stimulation exhausts the red iodopsin, which then cannot respond properly to white light for a while.

**257.** A — Refraction at the cornea is set by surface curvature and by the speed of light in the corneal material compared with the surrounding medium.

**258.** A — Males: 48; females: 2.4; total 50.4, so males make 48/50.4 ≈ 95%.

**259.** C — The anterior chamber holds aqueous humour, which is clear and watery and leaks out when the eye is injured.

**260.** B — The lecture states the hemispheres are split into right and left and joined only by the corpus callosum.

## 3. Set 3 · Q21–30

Refractive focusing · Medium

**261. Why is the cornea the main focusing element of the eye?**

**A** the cornea has a higher index than the lens, at 1.43

**B** light meets its largest index step there, from air (1) to cornea (1.37)

**C** the cornea can change its shape by ciliary muscle action

**D** the cornea absorbs most light and re-emits it inward

Eye defects · Medium

**262. A student's cornea is curved more than normal. What defect does the lecture say results?**

**A** far sightedness, because light is focused behind the retina

**B** near sightedness, because light is focused in front of the retina

**C** astigmatism, because the retina is unevenly illuminated

**D** colour blindness, because cones receive too much light Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 72

Accommodation · Easy

**263. For a normal eye, the far point lies at:**

**A** 25 cm

**B** 2.5 cm

**C** 1 m

**D** infinity

Colour vision · Medium

**264. The eye is most sensitive to which colours and least sensitive to which?**

**A** most to blue, least to green/yellow

**B** most to green/yellow, least to blue

**C** most to red, least to green/yellow

**D** most to blue/violet, least to red

Eye defects · Hard

**265. A far-sighted person has a near point at 100 cm and wants to read at 25 cm. The required thin-lens power is:**

**A** −3.0 D, a diverging lens

**B** +3.0 D, a converging lens

**C** +5.0 D, a converging lens

**D** +1.0 D, a converging lens

Radiation · Easy

**266. The two main sources of radiation named in the lecture are:**

**A** solar sources and nuclear sources

**B** natural sources and artificial sources

**C** medical sources and industrial sources

**D** visible sources and invisible sources

Image size · Hard

**267. The fly of 3 mm moves from 3.0 m to 1.5 m from the eye. How does its retinal image change (lens-to-retina distance fixed)?**

**A** it halves, from 20 μm to 10 μm

**B** it quadruples, from 20 μm to 80 μm

**C** it doubles, from 20 μm to 40 μm

**D** it stays at 20 μm because the lens adjusts

Refractive index · Hard

**268. Taking $c = 3.0 \times 10^8$ m/s, the speed of light in the crystalline lens ($n = 1.43$) is closest to:**

**A** $4.3 \times 10^8$ m/s

**B** $2.1 \times 10^8$ m/s

**C** $2.1 \times 10^7$ m/s

**D** $3.0 \times 10^8$ m/s

Eye defects · Medium

**269. A cornea with not enough curvature will cause:**

**A** near sightedness, with focus falling ahead of the retina

**B** astigmatism, with focus split across different planes

**C** far sightedness, with focus falling behind the retina

**D** presbyopia, with a lens that cannot change shape

Optical power · Easy

**270. Optical power of a lens is given by P = 1/f. Its SI unit is:**

**A** the metre, called the focal unit

**B** the inverse metre, called the dioptre

**C** the candela, a unit of light intensity

**D** the watt, a unit of energy rate Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 73

### Answers — Set 3 · Q21–30

**261.** B — Bending depends on the index change at an interface, and the air-cornea boundary has the largest step (1 to 1.37) in the whole eye.

**262.** B — Excess corneal curvature gives too much bending, so the focus falls in front of the retina: near sightedness (myopia).

**263.** D — The far point is the most distant point seen clearly; for a normal eye it is at infinity. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 83

**264.** B — The lecture states the eye is most sensitive to green/yellow and least sensitive to blue.

**265.** B — The lens must place an object at 25 cm as a virtual image at 100 cm: $1/f = 1/0.25 - 1/1.0 = 4 - 1 = +3.0$ D.

**266.** B — The lecture splits radiation sources into natural (e.g. cosmic, terrestrial) and artificial (man-made, e.g. X-ray machines).

**267.** C — Image size is inversely proportional to object distance, so halving the distance doubles the image: $0.02/1.5 \times 0.003$ m = 40 µm.

**268.** B — $v = c/n = 3.0 \times 10^8 / 1.43 \approx 2.1 \times 10^8$ m/s.

**269.** C — Insufficient curvature under-bends light, so the focal point lies behind the retina; the lecture calls this far sightedness.

**270.** B — Optical power is the reciprocal of focal length ($m^{-1}$), commonly called the dioptre.

## 4. Set 4 · Q31–40

Refractive focusing · Hard

**271. A single refracting surface has power $(n_2 - n_1)/R$. For the cornea, $n_1 = 1$ (air), $n_2 = 1.37$ and R = 7.8 mm. The power is about:**

**A** 4.7 D

**B** 210 D

**C** 0.37 D

**D** 47 D

Eye defects · Medium

**272. Uneven curvature of the cornea produces:**

**A** near sightedness, where distant objects look blurred

**B** far sightedness, where near objects look blurred

**C** bleaching, where the cones go temporarily blind

**D** astigmatism, where one plane focuses differently from another

Visual acuity · Devil

**273. A patient tests at 20/80 on a Snellen chart. Compared with the 20/20 line, the smallest line they can just read at 20 ft is:**

**A** four times smaller, matching the line read at 5 ft

**B** four times larger, matching the line normal vision reads at 80 ft

**C** two times larger, matching the line normal vision reads at 40 ft

**D** the same size, but they must stand 80 ft away

Accommodation · Devil

**274. Model the eye with the retina 2.5 cm behind a thin lens. To focus on an object at 25 cm, the lens focal length must shorten from 2.5 cm to about:**

**A** 2.27 cm, as 1/f = 4 + 40 = 44 D

**B** 2.50 cm, as the lens stays unchanged

**C** 2.78 cm, as the power falls to 36 D

**D** 22.7 cm, as f scales with the object distance

Refractive index · Devil

**275. Which statement about refractive index is FALSE?**

**A** it is dimensionless, as it is a ratio of two speeds

**B** water has n = 1.333, so light is 1.333 times slower in it

**C** corneal index is nearly constant between people, while curvature varies

**D** a higher index means light moves faster in the material

Accommodation · Hard

**276. Treat the eye as a thin lens with the retina fixed 2.5 cm behind it. How much extra power must it add to see an object at the 25 cm near point instead of infinity?**

**A** 4 D, since 1/0.25 m adds to the relaxed 40 D

**B** 40 D, since the full lens power must be added again

**C** 0.4 D, since 25 cm is ten times the focal length

**D** 11 D, since 25 ÷ 2.5 is added to 1

Radiation · Devil

**277. In a laboratory safety briefing, which pairing of radiation type with its class is correct?**

**A** X-rays are non-ionizing, whereas radio waves are ionizing

**B** visible light and X-rays are both non-ionizing

**C** X-rays are ionizing, whereas radio waves are non-ionizing

**D** gamma rays and radio waves are both ionizing

Eye structure · Devil

**278. Which statement about the coats of the eye is FALSE?**

**A** the choroid is the middle coat, rich in vessels and pigment

**B** the sclera is the middle coat, rich in blood vessels and pigment

**C** the retina is the innermost coat and carries rods and cones

**D** the conjunctiva lines the eyelid and covers the eyeball surface Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 74

Colour vision · Hard

**279. A patient cannot tell red from green on a plate test. Which receptors are most likely defective?**

**A** the cones mainly sensitive to red or to green

**B** the rods, which handle black-and-white vision

**C** the cones mainly sensitive to blue only

**D** the bipolar cells connected to the rods

Colour vision · Medium

**280. The fovea centralis gives very detailed colour vision over about:**

**A** 10 degrees of the visual field

**B** 25 degrees of the visual field

**C** 1 degree of the visual field

**D** 180 degrees of the visual field

### Answers — Set 4 · Q31–40

**271.** D — P = (1.37 − 1)/0.0078 m = 0.37/0.0078 ≈ 47 D, which shows why the cornea supplies most of the eye's power. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 84

**272.** D — The lecture states uneven curvature produces astigmatism, so rays in different planes focus at different points.

**273.** B — 20/80 means they can just read at 20 ft what normal eyes read at 80 ft, so detail four times larger than the 20/20 line.

**274.** A — 1/f = 1/0.25 + 1/0.025 = 44 D, so f = 1/44 m ≈ 2.27 cm.

**275.** D — This is false: since n = c/v, a higher index means a lower speed of light in the medium.

**276.** A — 1/f = 1/u + 1/v = 4 + 40 = 44 D, so the extra accommodation over the relaxed 40 D is 4 D.

**277.** C — X-rays can ionize matter and are treated as harmful; radio waves lack the energy to ionize and are classed as non-ionizing.

**278.** B — This is false: the sclera is the tough white outer coat; the choroid is the middle, vascular and pigmented coat.

**279.** A — Red/green blindness, the most common defect, involves the cone types mainly sensitive to red or green; the blue cones are usually spared.

**280.** C — The lecture states the fovea covers about 1 degree of the visual field.

## 5. Set 5 · Q41–50

Colour and depth · Devil

**281. Which statement about colour and depth impression is FALSE?**

**A** red focuses behind the retina and gives an impression of closeness

**B** yellow focuses most directly on the retina with no adjustment

**C** blue in a painting gives an impression of distance

**D** blue focuses behind the retina, so the lens becomes more convex

Accommodation · Medium

**282. The range of vision of an eye is the:**

**A** distance between the cornea and the retina

**B** angle subtended at the eye by the fovea

**C** distance between the near point and the far point

**D** greatest distance at which an object can be seen

Retina · Easy

**283. The area of the retina with the highest concentration of cones and clearest colour vision is the:**

**A** optic disc

**B** ciliary body

**C** fovea

**D** pupil

Optical power · Devil

**284. A relaxed eye modelled as a 40 D thin lens is fitted with a +2.5 D thin lens held in contact. The combined power and focal length are:**

**A** 37.5 D, with f ≈ 2.67 cm

**B** 42.5 D, with f ≈ 23.5 cm

**C** 42.5 D, with f ≈ 2.35 cm

**D** 2.5 D, with f = 40 cm

Eye defects · Devil

**285. An older patient has a near point of 60 cm and wants to read comfortably at 25 cm. The thin-lens power required is closest to:**

**A** +4.0 D, a converging lens

**B** +2.3 D, a converging lens

**C** +5.7 D, a converging lens

**D** +1.7 D, a converging lens

Radiation · Easy

**286. The two main types of radiation described in the lecture are:**

**A** natural and artificial radiation

**B** alpha and beta radiation

**C** non-ionizing and ionizing radiation

**D** thermal and chemical radiation Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 75

Rods and cones · Devil

**287. Which statement about rods and cones is FALSE?**

**A** rods have monochromatic vision, while cones are trichromatic

**B** three rods share one bipolar cell, while each cone has its own

**C** cones are more sensitive than rods and work well in the dark

**D** iodopsin is the cone pigment and rhodopsin the rod pigment

Optical power · Hard

**288. A thin +12 D lens is placed closely against a thin −4 D lens. The combination is:**

**A** diverging, with f = −12.5 cm

**B** converging, with f = 8 cm

**C** converging, with f = 25 cm

**D** converging, with f = 12.5 cm

Accommodation · Medium

**289. The near point of the eye moves farther away with age mainly because:**

**A** the cornea becomes steadily more curved over the years

**B** the ciliary muscles lose effectiveness and the lens loses flexibility

**C** the retina moves further back inside the eyeball

**D** the vitreous humour becomes steadily more watery

Photopigments · Hard

**290. Walking from a dim clinic into bright Accra sunlight, which statement about photopigments is correct per the lecture?**

**A** rhodopsin in rods stays more stable than iodopsin in cones

**B** both pigments are equally stable in all light levels

**C** iodopsin in cones stays more stable than rhodopsin in rods

**D** iodopsin is found in rods, and rhodopsin is found in cones

## Answers — Set 5 · Q41–50

**281.** D — This is false: blue focuses in front of the retina and the lens is made flatter, as in distance viewing; red is the colour that focuses behind.

**282.** C — The lecture defines range of vision as the distance between the near point and the far point of the eye.

**283.** C — The fovea has the highest concentration of cone cells and few rods, giving clearest colour vision.

**284.** C — P = 40 + 2.5 = 42.5 D, so f = 1/42.5 m ≈ 0.0235 m = 2.35 cm.

**285.** B — The lens must make an object at 25 cm appear at 60 cm: 1/f = 1/0.25 − 1/0.60 = 4.00 − 1.67 ≈ +2.3 D.

**286.** C — Radiation is classified by whether it can ionize matter; the lecture labels non-ionizing as not harmful and ionizing as harmful.

**287.** C — This is false: rods are more sensitive and work in dim light, while cones need bright light and cannot function in the dark.

**288.** D — P = 12 + (−4) = +8 D, so the system converges, and f = 1/8 m = 0.125 m = 12.5 cm.

**289.** B — The lecture ties the increasing near-point distance to weaker ciliary muscles and a stiffer lens that cannot bulge enough.

**290.** C — The lecture states iodopsin, the cone pigment, is more stable in bright light than rhodopsin of the rods, so cone vision works in bright light.

## 6. Set 6 · Q51–60

Eye structure · Hard

**291. Which of the following is NOT one of the three structures formed by the modified anterior choroid?**

**A** the ciliary body

**B** the conjunctiva

**C** the suspensory ligament

**D** the iris

Background colour · Hard

**292. A designer shows the same yellow disc once on a white slide and once on a black slide. According to the lecture, how will it look?**

**A** brighter and larger on white, darker and smaller on black

**B** identical on both, because the cones adapt completely

**C** brighter on white, but smaller on black

**D** darker and smaller on white, brighter and larger on black

Visual perception · Medium

**293. Why does the lecture say continual movement of the image on the retina is essential?**

**A** moving images are brighter, so the pupil dilates more

**B** stationary images on the retina are essentially invisible

**C** movement keeps the lens flat so the far point stays at infinity

**D** movement lowers the refractive index of the aqueous humour

Colour and depth · Hard

**294. Looking at a saturated red object, what does the lecture predict the eye does, and what impression results?**

**A** the lens becomes less convex, so red seems distant

**B** the lens does not adjust, because red focuses on the retina

**C** the lens becomes more convex, so red seems close

**D** the pupil closes completely, so red seems dark and flat Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 76

Image size · Hard

**295. Using the lecture's method (image = lens-to-retina distance ÷ object distance × object size, with 0.02 m as the lens-to-retina distance), what is the retinal image of a 3 mm fly on a wall 3.0 m away?**

**A** 20 µm

**B** 2 µm

**C** 200 µm

**D** 6.7 mm

Accommodation · Easy

**296. For a normal eye, the least distance of distinct vision (near point) is about:**

**A** 2.5 cm

**B** 250 cm

**C** 25 cm

**D** infinity

Bleaching · Devil

**297. After staring at a saturated blue picture and then looking at white paper, the viewer sees a faint afterimage patch. Following the lecture's bleaching idea, the patch looks:**

**A** bluish, because the blue receptors respond more strongly

**B** pure white, because bleaching affects the rods only

**C** completely black, because no receptor responds

**D** yellowish, because red and green receptors still respond best

Optical power · Medium

**298. Two thin lenses of 10 D and 30 D are placed close together. The combined power and focal length are:**

**A** 40 D, so f = 2.5 cm

**B** 20 D, so f = 5.0 cm

**C** 40 D, so f = 25 cm

**D** 7.5 D, so f = 13 cm

Visual acuity · Hard

**299. A person with 20/40 vision looks at a chart. At what distance can they just read the line that a person with 20/20 vision reads at 20 ft?**

**A** 10 ft

**B** 20 ft

**C** 40 ft

**D** 80 ft

Components of vision · Easy

**300. In the three-part sense of vision, which part is where the information from the nerves is 'all put together'?**

**A** the retina at the back of the eye

**B** the cornea at the front of the eye

**C** the sclera around the eyeball

**D** the visual cortex of the brain

## Answers — Set 6 · Q51–60

**291.** B — The anterior choroid is modified into the ciliary body, the suspensory ligament and the iris; the conjunctiva is a mucous membrane over the eyeball and eyelid.

**292.** D — The lecture states colours look darker and smaller against white and brighter and larger against black.

**293.** B — The lecture states that eye movement prevents stationary images on the retina, which are essentially invisible.

**294.** C — Red focuses behind the retina, so the eye compensates by making the lens convex, as in near focusing; this gives the impression of closeness.

**295.** A — $I = (0.02 / 3.0) \times 0.003\ m = 2 \times 10^{-5}\ m = 20\ \mu m$.

**296.** C — The slides give d = 25 cm as the normal near point.

**297.** D — The blue pigment is temporarily exhausted, so white light is signalled mainly by the red and green cones, which gives a yellowish patch.

**298.** A — $P = P1 + P2 = 40$ D and $f = 1/40\ m = 0.025\ m = 2.5$ cm.

**299.** A — 20/40 vision resolves at 20 ft what normal vision resolves at 40 ft, so half the normal acuity. They must stand at half the distance: 10 ft.

**300.** D — The lecture states the visual cortex is the part of the brain where the visual information is assembled into perception.

## 7. Set 7 · Q61–70

Refractive focusing · Devil

**301. A swimmer opens their eyes underwater (n = 1.333) and sees a blur. Using the index step at the cornea (n = 1.37), the cornea's refracting power compared with air is roughly:**

**A** unchanged, since the cornea's curvature is the same

**B** ten times smaller, since the step falls from 0.37 to 0.037

**C** twice as large, since water is denser than air

**D** about half as large, since n drops from 1.37 to 1.333 Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 77

Optical power · Medium

**302. A lens has high optical power. What does that tell you?**

**A** it has a long focal length and converges light weakly

**B** it has a negative power and spreads light outwards

**C** it has a refractive index below that of air

**D** it has a short focal length and converges light strongly

Eye structure · Easy

**303. The optic nerve is described in the lecture as:**

**A** the first cranial nerve, carrying smell from nose to brain

**B** the second cranial nerve, carrying signals from eye to brain

**C** a motor nerve that moves the eyeball in its orbit

**D** a blood vessel that supplies the retina with oxygen

Rods and cones · Medium

**304. Which statement correctly compares rods and cones?**

**A** cones are more sensitive, and rods have higher acuity

**B** rods are more sensitive and also have higher acuity

**C** rods are more sensitive, but cones have higher acuity

**D** cones are both more sensitive and have higher acuity

Eye structure · Easy

**305. The coloured part of the eye, made of circular and smooth muscle fibres that control light entry, is the:**

**A** iris

**B** cornea

**C** conjunctiva

**D** choroid

Bipolar cells · Hard

**306. In dim light, why can rods signal when only one of three connected rods is activated, and what is the cost?**

**A** each rod has its own bipolar cell, so acuity is the highest

**B** pooling on one bipolar cell raises sensitivity but lowers acuity

**C** pooling on one bipolar cell raises acuity but lowers sensitivity

**D** rods contain iodopsin, which is more stable in bright light

Colour and depth · Hard

**307. Which pairing of colour, focus position and depth impression matches the lecture?**

**A** blue, behind the retina, impression of closeness

**B** yellow, behind the retina, impression of closeness

**C** red, in front of the retina, impression of distance

**D** blue, in front of the retina, impression of distance

Eye structure · Easy

**308. Which substance in the posterior chamber is gelatinous and helps the eye keep its shape?**

**A** aqueous humour

**B** lacrimal fluid

**C** cerebrospinal fluid

**D** vitreous humour

Components of vision · Easy

**309. According to the lecture, blindness results when:**

**A** any one of the three parts of the vision system fails

**B** only the eyes themselves are damaged

**C** only the visual cortex is damaged

**D** all three parts fail at the same time Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 78

Refractive index · Medium

**310. The refractive index of water is 1.333. What does the lecture say this means?**

**A** light travels 1.333 times faster in water than in a vacuum

**B** light loses 1.333 % of its energy passing through water

**C** light bends by 1.333 degrees at every water surface

**D** light travels 1.333 times slower in water than in a vacuum

### Answers — Set 7 · Q61–70

**301.** B — Refracting power scales with the index difference: air gives 1.37 − 1 = 0.37, water gives 1.37 − 1.333 = 0.037, about one tenth.

**302.** D — P = 1/f, so high power means a short focal length and strong convergence.

**303.** B — The optic nerve is cranial nerve II and transmits the eye's nerve impulses to the brain.

**304.** C — The lecture states rods are more sensitive than cones, while cones have the higher acuity.

**305.** A — The iris is the coloured part of the eye; its muscle fibres vary pupil size to control light reaching the retina.

**306.** B — Three rods feed a single bipolar cell, so one activated rod is enough to send an impulse; that sensitivity comes at the price of fine detail.

**307.** D — Blue wavelengths focus in front of the retina, the lens flattens as for distance focusing, and blue conveys distance.

**308.** D — The posterior chamber contains gelatinous vitreous humour, which maintains the eyeball's shape.

**309.** A — Vision needs the eyes, the nerve pathway and the visual cortex working together; failure of any one causes blindness.

**310.** D — Since n = c/v, n = 1.333 means v = c/1.333, so light is 1.333 times slower in water.

## 8. Set 8 · Q71–80

Colour vision · Devil

**311. The fovea covers about 1° of the visual field. About how wide a strip of a wall 3.0 m away falls on the fovea?**

**A** about 5.2 cm

**B** about 10 cm

**C** about 52 cm

**D** about 0.52 cm

Focusing elements · Easy

**312. Which structure is variable in shape and focuses objects at various distances?**

**A** the cornea

**B** the sclera

**C** the optic nerve

**D** the crystalline lens

Refractive index · Hard

**313. Using c = 3.0 × 10⁸ m/s, which ordering of speeds of light in the eye media is correct?**

**A** cornea (1.37) is faster than the vitreous (1.337)

**B** lens (1.43) is faster than the cornea (1.37)

**C** cornea (1.37) is slower than vitreous (1.337) but faster than lens (1.43)

**D** all three media transmit light at the same speed

General structure · Easy

**314. The eyeballs sit in bony sockets of the skull called the:**

**A** orbits

**B** sinuses

**C** fossae

**D** foramina

Accommodation · Devil

**315. Which statement about accommodation is FALSE?**

**A** the near point moves closer to the eye as a person ages

**B** tension in the ciliary muscles changes the lens curvature

**C** with relaxed muscles the lens focal length is about 2.5 cm

**D** range of vision is the span between the near and far points

Eye structure · Easy

**316. Which layer of the eye holds the rods and cones?**

**A** the sclera, the outermost coat

**B** the retina, the innermost coat

**C** the choroid, the middle coat

**D** the conjunctiva, the surface membrane

Focusing elements · Easy

**317. Which part of the eye is the fixed-focus element?**

**A** the crystalline lens

**B** the iris

**C** the cornea

**D** the vitreous humour Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 79

Brain organization · Hard

**318. The lecture gives about $10^{11}$ neurones and $10^{14}$ connections. The average number of connections per neurone is:**

**A** about 100

**B** about 10 000

**C** about 1000

**D** about 3

Visual acuity · Easy

**319. A person whose eyes test as 20/20 on a Snellen chart can:**

**A** read from 20 ft the detail others read from 40 ft

**B** read from 40 ft the detail others read from 20 ft

**C** read letters only if they are 20 inches tall

**D** read from 20 ft the detail a good-vision person reads from 20 ft

Image size · Hard

**320. A moth 12 mm long sits on a wall 6.0 m away. With the lens-to-retina distance 0.02 m, its retinal image is:**

**A** 4 μm

**B** 40 μm

**C** 400 μm

**D** 80 μm

## Answers — Set 8 · Q71–80

**311.** A — Width = 3.0 m × tan 1° ≈ 3.0 × 0.01746 ≈ 0.052 m = 5.2 cm.

**312.** D — The lens changes shape (via the ciliary muscles) so objects at different distances can be focused on the retina.

**313.** C — Speed = c/n: lens $2.10 \times 10^8$, cornea $2.19 \times 10^8$, vitreous $2.24 \times 10^8$ m/s, so the cornea sits between them.

**314.** A — The lecture says the eyeballs are surrounded by the orbits, which are covered with fatty and fibrous tissue for protection.

**315.** A — This is false: the near point moves farther away with age because the ciliary muscles weaken and the lens stiffens.

**316.** B — The retina is the innermost coat and contains the colour and light receptors, cones and rods.

**317.** C — The lecture lists the cornea as the fixed-focus element, doing most of the bending of light.

**318.** C — $10^{14} \div 10^{11} = 10^3 = 1000$ connections per neurone.

**319.** D — 20/20 means normal acuity: the detail readable at 20 ft equals that readable by a person with good vision at 20 ft.

**320.** B — I = (0.02 / 6.0) × 0.012 m = $4.0 \times 10^{-5}$ m = 40 μm.

**Module 5: Lecture 5 — Physics of Eyes & Vision (Cont.)** — 80 questions

## 1. Set 1 · Q1–10

FALSE statement: reflecting telescope · Devil

**321. Which statement about reflecting telescopes is FALSE?**

**A** There is no chromatic aberration

**B** The mirror needs grinding and polishing on both sides

**C** A paraboloid mirror reduces spherical aberration

**D** The image is brighter than in a refractor

Eye defects list · Easy

**322. Which of the following is listed in the lecture as a common optical defect of the eye?**

**A** Presbyopia

**B** Glaucoma

**C** Keratitis

**D** Retinal detachment

Presbyopia power · Hard

**323. A presbyopic patient's near point has receded to 50 cm. What power of converging lens is needed to read comfortably at 25 cm?**

**A** +4.0 D

**B** +0.5 D

**C** −2.0 D

**D** +2.0 D

Simple microscope · Medium

**324. Where must the object be placed for a simple microscope to give a virtual, erect, magnified image?**

**A** Exactly at 2F on the object side

**B** Beyond 2F on the object side

**C** At infinity

**D** Between the optical centre C and principal focus F

FALSE statement: loupes · Devil

**325. Which statement about loupes and magnifiers is FALSE?**

**A** 10× is the standard for grading diamond clarity

**B** 35 mm slides are best viewed at about 5×

**C** Hand magnifiers are typically 2× to 6×

**D** For dental diagnosis an ideal magnification is above 10×

FALSE statement: colour blindness · Devil

**326. Which statement about colour deficiency is FALSE?**

**A** Tritanomaly is reduced blue sensitivity and extremely rare

**B** Trichromacy uses all three cone types correctly

**C** Deuteranomaly is reduced sensitivity to red light and is the most common form

**D** The Ishihara test uses pseudo-isochromatic plates

Eye tests · Medium

**327. Contrast sensitivity testing is particularly useful in cataract because it:**

**A** Tests discrimination of grey shades, which cataract impairs

**B** Measures the fluid pressure inside the eye in mmHg

**C** Dilates the pupil so the retina can be examined fully

**D** Predicts how well a patient will see after lens removal

TEM resolution · Medium

**328. TEM resolves finer detail than a light microscope mainly because:**

**A** Electrons are heavier than photons so they are slower to deflect

**B** The specimen is thicker than 100 nm

**C** Electrons have a smaller de Broglie wavelength than visible light

**D** A fluorescent screen magnifies the image optically Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 92

Magnifying glass · Easy

**329. Typical magnifying power of a hand magnifying glass is:**

**A** 2× to 6×

**B** 20× to 60×

**C** 100× to 200×

**D** 1000× to 3000×

Convex lens calculation · Hard

**330. An object stands 30 cm from a convex lens of f = 10 cm. The image is:**

**A** Real, inverted, 15 cm from the lens, half the object size

**B** Real, inverted, 30 cm from the lens, same size as the object

**C** Virtual, erect, 15 cm from the lens, half the object size

**D** Real, inverted, 7.5 cm from the lens, a quarter the object size

## Answers — Set 1 · Q1–10

**321.** B — False: only one side of the mirror needs grinding and polishing, which is an advantage over lenses.

**322.** A — Presbyopia is one of the five listed defects, alongside myopia, hypermetropia, astigmatism and cataract.

**323.** D — 1/f = 1/0.25 − 1/0.50 = 4 − 2 = +2.0 D (f = 50 cm).

**324.** D — Only inside the focal length does a convex lens give a virtual, erect and magnified image.

**325.** D — False: the lecture gives up to 2× as ideal for dental diagnosis, since higher magnification narrows the field of view.

**326.** C — False: deuteranomaly is reduced sensitivity to green light; reduced red sensitivity is protanomaly.

**327.** A — Cataracts commonly reduce the ability to separate similar shades of gray.

**328.** C — Resolution is limited by wavelength, and the electron de Broglie wavelength is far smaller than visible light wavelengths.

**329.** A — Magnifying glasses typically have low power, about 2×–6×.

**330.** A — $1/v = 1/10 - 1/30$ gives $v = 15$ cm and $m = v/u = 0.5$; the object is beyond 2F1, so the image is real, inverted and diminished between F2 and 2F2.

## 2. Set 2 · Q11–20

Presbyopia vs hypermetropia · Medium

**331. Presbyopia and hypermetropia are corrected with the same type of lens because both:**

**A** Need extra converging power for near vision

**B** Need diverging power for far vision

**C** Involve an overlong eyeball

**D** Involve unequal corneal curvature

FALSE statement: myopia · Devil

**332. Which statement about myopia is FALSE?**

**A** It is caused by increased focal length of the fully relaxed eye lens

**B** The image of a far object forms before the retina

**C** A concave lens of suitable focal length is the correction

**D** A larger eyeball can be a cause

Magnifying power definition · Medium

**333. The magnifying power of a simple microscope is defined as the ratio of:**

**A** Angle subtended by the image to that by the object, both at distance d

**B** Focal length of the lens to the object distance

**C** Size of the image to the size of the lens

**D** Near point of the eye to the lens thickness

FALSE statement: SEM · Devil

**334. Which statement about the scanning electron microscope is FALSE?**

**A** The beam scans a raster pattern over the specimen

**B** Secondary electrons are detected in the most common mode

**C** Conventional instruments observe specimens in high vacuum

**D** Its magnification is set by the power of the objective lens

Convex lens movement · Devil

**335. An object is moved from 40 cm to 15 cm in front of a convex lens (f = 10 cm). How do the image distance and magnification change?**

**A** Image from 13.3 cm to 6 cm; magnification from 0.33 to 0.4

**B** Image from 30 cm to 13.3 cm; magnification from 2 to 0.33

**C** Image from 13.3 cm to 30 cm; magnification from 0.33 to 2

**D** Image from 20 cm to 20 cm; magnification stays at 1

Concave lens images · Medium

**336. For an object at infinity, a concave lens forms an image that is:**

**A** Real, inverted and point-like at the second focus F2

**B** Virtual, inverted and enlarged at 2F1

**C** Real, erect and diminished at the optical centre

**D** Virtual, erect and point-like at the first focus F1 Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 93

Myopia optics · Medium

**337. In an uncorrected myopic eye viewing a distant object, the image forms:**

**A** In front of the retina

**B** Exactly on the retina

**C** Behind the retina

**D** On the cornea surface

Ishihara interpretation · Devil

**338. A patient reads 21 on the plate where normal viewers see 74. What is the most appropriate conclusion?**

**A** A red-green deficiency (dichromacy or anomalous trichromacy) is likely

**B** Monochromacy is confirmed, since nothing was seen

**C** Tritanomaly is confirmed, being the commonest blue-light defect

**D** The result indicates an early cataract

Cataract · Easy

**339. A cataract is best described as:**

**A** Raised fluid pressure inside the eye

**B** Inability to tell red from green

**C** Clouding of the normally clear lens

**D** Loss of lens power with age only

Convex lens images · Easy

**340. When an object is at infinity, a convex lens forms an image that is:**

**A** Virtual, erect and enlarged at F1

**B** Real, inverted and highly diminished at F2

**C** Real, inverted and enlarged at 2F2

**D** Virtual, erect and diminished at O

## Answers — Set 2 · Q11–20

**331.** A — Both leave near objects unable to be focused on the retina, so a converging lens is added.

**332.** A — False: increased focal length of the relaxed lens is the lecture's cause of hypermetropia, not myopia.

**333.** A — It is β/α, the ratio of angles subtended at the eye when both are at the least distance of distinct vision.

**334.** D — False: unlike optical and transmission electron microscopes, SEM magnification depends on the scan coil current, not objective lens power. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics

**335.** C — u = 40: 1/v = 1/10 − 1/40 gives v = 13.3 cm, m = 0.33; u = 15: v = 30 cm, m = 2; the image moves out and grows.

**336.** D — A concave lens gives a virtual, erect, highly diminished image at F1 for an object at infinity.

**337.** A — Rays from far objects are over-converged and meet before the retina, so the retinal image is blurred.

**338.** A — The lecture says such viewers may read 21, indicating a red-green colour deficiency.

**339.** C — Cataract is clouding of the normally clear lens, like looking through a cloudy window.

**340.** B — For an object at infinity the image is at the second focus F2, real, inverted and point-like.

## 3. Set 3 · Q21–30

Eye tests · Medium

**341. A raised reading on tonometry may indicate:**

**A** Cataract

**B** Glaucoma

**C** Astigmatism

**D** Deuteranomaly

Myopia causes · Medium

**342. Which pair lists the two possible causes of myopia given in the lecture?**

**A** Smaller eyeball, or longer focal length of relaxed lens

**B** Larger eyeball, or shorter focal length of relaxed lens

**C** Weak ciliary muscles, or cloudy lens proteins

**D** Uneven corneal curvature, or retinal detachment

Simple microscope · Easy

**343. The image formed by a simple microscope is:**

**A** Real, inverted and magnified

**B** Real, inverted and diminished

**C** Virtual, inverted and diminished

**D** Virtual, erect and magnified

Magnifier limits · Medium

**344. Why does the image quality of a simple magnifier become poor at higher magnification?**

**A** Diffraction effects from the wave nature of electrons

**B** Optical aberrations, chiefly spherical aberration of the lens

**C** Loss of the raster pattern across the viewed image

**D** Excess vacuum pressure within the specimen chamber Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 94

Convex lens calculation · Hard

**345. An object is 15 cm from a convex lens of f = 10 cm. The image formed is:**

**A** Real, inverted, 6 cm beyond the lens, 0.4 times the object size

**B** Real, inverted, 30 cm beyond the lens, twice the object size

**C** Virtual, erect, 30 cm on the object side, twice the object size

**D** Real, inverted, 20 cm beyond the lens, same size as the object

Myopia · Easy

**346. Myopia is also known as which of the following?**

**A** Long sightedness

**B** Short sightedness

**C** Old sight

**D** Colour deficiency

Hypermetropia power · Hard

**347. A hypermetropic eye has its near point at 100 cm. Which lens power brings reading material to 25 cm into clear focus?**

**A** +5.0 D

**B** +1.0 D

**C** +3.0 D

**D** +4.0 D

Magnifying power · Hard

**348. A hand lens of focal length 10 cm is used with the eye relaxed (image at infinity). Taking d = 25 cm, the magnifying power is:**

**A** 3.5

**B** 2.5

**C** 0.4

**D** 250

Hypermetropia cause · Medium

**349. The lecture attributes hypermetropia to:**

**A** Decreased focal length of the relaxed eye lens

**B** Loss of cone pigment sensitivity

**C** Increased focal length of the fully relaxed eye lens

**D** Increase in the distance of retina from the lens

Compound microscope · Easy

**350. Standard eyepieces of a compound microscope typically have a magnifying power of:**

**A** 4×

**B** 10×

**C** 40×

**D** 100×

### Answers — Set 3 · Q21–30

**341.** B — Tonometry measures fluid pressure in the eye, and increased pressure may be a sign of glaucoma.

**342.** B — Retina too far from the lens, or an over-powerful (short focal length) relaxed lens, both put the focus in front of the retina.

**343.** D — With the object between C and F, the image is virtual, erect and magnified at distance d.

**344.** B — The lecture says aberrations, especially spherical aberration, degrade high-power single lenses.

**345.** B — 1/v = 1/10 − 1/15 gives v = 30 cm and m = 2; the object is between F1 and 2F1, so the image is real, inverted, enlarged and beyond 2F2 (20 cm).

**346.** B — Myopia is short sightedness: near objects are clear but far objects are blurred.

**347.** C — 1/f = 1/0.25 − 1/1.0 = 4 − 1 = +3.0 D; the lens puts a virtual image of the 25 cm object at 100 cm.

**348.** B — With the image at infinity, m = d/f = 25/10 = 2.5.

**349.** C — A longer focal length means rays are not bent enough, so they would focus behind the retina.

**350.** B — Standard oculars are 10×, with optional 5×–30×.

## 4. Set 4 · Q31–40

Astronomical telescope · Hard

**351. An astronomical telescope has an objective of focal length 120 cm and an eyepiece of 2 cm. In normal adjustment, the lens separation is:**

**A** 118 cm

**B** 240 cm

**C** 60 cm

**D** 122 cm

Astigmatism · Medium

**352. Why does an astigmatic eye give blurry, distorted vision at all distances?**

**A** Light always focuses in front of the retina

**B** Light is absorbed by clouded lens proteins

**C** The ciliary muscles cannot relax at all

**D** Light focuses at more than one point on the retina Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 95

Combined defects · Devil

**353. A 62-year-old myope needs spectacles for both distance and reading. Which design is most suitable?**

**A** A single strong convex lens for all viewing distances

**B** Bifocal: concave upper segment, weaker or converging lower one

**C** A single strong concave lens used for every distance

**D** A cylindrical lens with its axis set vertically

Chromatic aberration · Devil

**354. Why does a mirror objective eliminate chromatic aberration?**

**A** The law of reflection does not depend on wavelength

**B** The paraboloid shape sends all colours to the eyepiece

**C** The mirror absorbs all but one wavelength

**D** Reflection occurs inside the glass at a fixed depth

FALSE statement: convex lens images · Devil

**355. Which statement about image formation by a convex lens is FALSE?**

**A** An object at F1 gives an image at infinity

**B** An object beyond 2F1 gives a diminished real image between F2 and 2F2

**C** An object between F1 and O gives a virtual, erect, enlarged image

**D** An object at 2F1 gives a real, inverted, enlarged image at 2F2

Magnifying power · Hard

**356. A simple microscope has f = 5 cm and forms its image at the least distance of distinct vision, 25 cm. Its magnifying power is:**

**A** 6

**B** 5

**C** 30

**D** 4

Lens combination · Devil

**357. A convex lens of f = 20 cm is in contact with a concave lens of f = −50 cm. The net power is:**

**A** +7.0 D

**B** −3.3 D

**C** +3.0 D

**D** −3.0 D

De Broglie wavelength · Devil

**358. An electron accelerated through 100 kV has a non-relativistic de Broglie wavelength λ ≈ 1.226/√V nm (V in volts). The value is about:**

**A** 39 pm

**B** 3.9 pm

**C** 0.39 pm

**D** 390 pm

Hypermetropia power · Hard

**359. A hypermetropic patient's near point is 40 cm. What converging lens lets her read at 25 cm?**

**A** +1.5 D

**B** +6.5 D

**C** +2.5 D

**D** +4.0 D

Loupe applications · Medium

**360. Why is dental loupe magnification ideally limited to about 2× for diagnosis?**

**A** Higher magnification makes stains look like cavities

**B** Loupes above 2× do not exist

**C** Higher magnification narrows the field of view and makes diagnosis difficult

**D** Higher magnification removes the need for illumination Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 96

### Answers — Set 4 · Q31–40

**351.** D — In normal adjustment the final image is at infinity, so the lenses are separated by fo + fe = 122 cm.

**352.** D — Different corneal curvatures bring different meridians to different foci, so no single sharp image forms at any distance.

**353.** B — Distance needs diverging power for myopia, while reading needs added converging power for presbyopia, hence a bifocal.

**354.** A — Reflection angles equal incidence angles for every wavelength, unlike refraction, where the index varies with colour.

**355.** D — False: an object at 2F1 gives an image of the same size as the object at 2F2.

**356.** A — m = 1 + d/f = 1 + 25/5 = 6, since the object sits at about 4.2 cm from the lens.

**357.** C — P = 1/0.20 + 1/(−0.50) = 5 − 2 = +3.0 D.

**358.** B — $\lambda = 1.226/\sqrt{(10^5)}$ nm = 1.226/316 nm = 0.0039 nm = 3.9 pm, about 140,000 times shorter than 550 nm light.

**359.** A — 1/f = 1/0.25 − 1/0.40 = 4.0 − 2.5 = +1.5 D.

**360.** C — Too much magnification shrinks the field of view, so the lecture sets about 2× as ideal.

## 5. Set 5 · Q41–50

Magnifier calculation · Devil

**361. A lens has f = 4 cm and d = 25 cm. Its magnifying power is respectively (relaxed eye, image at infinity) and (image at 25 cm):**

**A** 7.25 and 6.25

**B** 6.25 and 5.25

**C** 25 and 26

**D** 6.25 and 7.25

Colour blindness · Medium

**362. Tritanomaly is characterised by:**

**A** Reduced sensitivity to red light, very common

**B** Reduced sensitivity to green light, most common

**C** Reduced sensitivity to blue light, extremely rare

**D** Complete absence of all colour perception

SEM · Easy

**363. A scanning electron microscope forms an image by:**

**A** Passing a broad electron beam through an ultrathin slice

**B** Focusing visible light with an objective lens

**C** Scanning the sample surface with a focused electron beam

**D** Bouncing X-rays off a concave mirror

SEM magnification calculation · Devil

**364. A 15 cm wide SEM display shows a 50 µm wide scanned region. The raster is then reduced to 5 µm. The magnifications are:**

**A** 3,000× then 300×

**B** 300× then 3,000×

**C** 3,000× then 30,000×

**D** 30,000× then 300,000×

FALSE statement: hypermetropia · Devil

**365. Which statement about hypermetropia is FALSE?**

**A** Far objects are seen clearly

**B** The near point shifts closer to the eye than 25 cm

**C** Spectacles use a convex lens

**D** The relaxed lens has an increased focal length

Myopia · Easy

**366. A person with myopia can see clearly which objects?**

**A** Those at infinity only

**B** Those at every distance

**C** Those lying near the eye

**D** Those beyond 25 cm only

FALSE statement: compound microscope · Devil

**367. Which statement about the compound microscope is FALSE?**

**A** Standard eyepieces are usually 10×

**B** The condenser sits under the stage

**C** The objective has a large aperture and moderate focal length

**D** Binocular heads often have a diopter adjustment ring

SEM magnification · Hard

**368. An SEM operator displays a raster on a 12 cm wide screen at 3,000,000× (the top of the lecture's range). What width of specimen is being scanned?**

**A** 4 nm

**B** 400 nm

**C** 4 µm

**D** 40 nm 

Colour blindness · Medium

**369. Normal colour vision, called trichromacy, depends on:**

**A** Rods only working in bright light

**B** All three types of cone working correctly

**C** Two cone types plus rods

**D** A single cone type of broad sensitivity

Reflecting telescope · Hard

**370. A reflecting telescope has a mirror about 200 inch in diameter; a refracting telescope has a 5 inch objective. Light-gathering power scales with aperture area. The ratio is about:**

**A** 40

**B** 800

**C** 1,600

**D** 40,000

### Answers — Set 5 · Q41–50

**361.** D — Image at infinity gives d/f = 6.25; image at 25 cm gives 1 + d/f = 7.25.

**362.** C — The prefix trit- refers to blue; the condition is extremely rare.

**363.** C — SEM scans a focused beam in a raster pattern and builds the image from detected signals.

**364.** C — 0.15 m / 50 μm = 3,000×; reducing the raster tenfold raises it to 30,000×.

**365.** B — False: the near point shifts away from the eye, so it is no longer at 25 cm.

**366.** C — A myopic eye sees near objects distinctly while far objects are blurred.

**367.** C — False: the objective has a very small focal length and short aperture; moderate focal length with large aperture describes the eyepiece.

**368.** D — Raster width = screen width / magnification = 0.12 m / $3\times10^{6}$ = $4\times10^{-8}$ m = 40 nm.

**369.** B — Trichromats use all three cone types correctly; the lecture names them trichromats.

**370.** C — Ratio = $(200/5)^2 = 40^2$ = 1,600, explaining the brighter image of the large mirror.

## 6. Set 6 · Q51–60

Myopia mechanism · Hard

**371. How does a concave spectacle lens let a myopic eye see distant objects?**

**A** It converges parallel rays to bring the focus onto the retina

**B** It diverges parallel rays so they appear to come from the eye's far point

**C** It shortens the eyeball by pressing on the cornea

**D** It strengthens the ciliary muscles for accommodation

Electron vs light resolution · Hard

**372. A light microscope resolves about 200 nm, while the best conventional SEM in the lecture reaches 0.4 nm. The SEM improvement factor is about:**

**A** 50

**B** 5,000

**C** 0.002

**D** 500

SEM magnification · Medium

**373. In an SEM, image magnification is controlled mainly by:**

**A** The focal length of the objective lens

**B** Current to the x,y scanning coils changing the raster size

**C** The thickness of the specimen section

**D** The wavelength of the illuminator bulb

Magnifying power · Hard

**374. A magnifier is rated 4× when the image is at 25 cm (m = 1 + d/f). Its focal length is about:**

**A** 6.3 cm

**B** 12.5 cm

**C** 8.3 cm

**D** 100 cm

Myopia correction power · Hard

**375. A myopic patient has a far point of 50 cm. Ignoring the spectacle-eye gap, which lens lets her see distant objects clearly?**

**A** Concave, power −2.0 D (f = −50 cm)

**B** Convex, power +2.0 D (f = +50 cm)

**C** Concave, power −0.5 D (f = −200 cm)

**D** Concave, power −5.0 D (f = −20 cm)

Simple microscope · Easy

**376. A simple microscope consists of:**

**A** Two converging lenses in a tube

**B** A concave mirror and a plane mirror

**C** A single converging lens of small focal length

**D** A diverging lens of large focal length Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 98

Eye tests · Devil

**377. Which pair of tests answers: what vision can be expected after cataract removal, and is the eye pressure raised (possible glaucoma)?**

**A** Contrast sensitivity and pupil dilation

**B** Glare testing and refraction

**C** Visual acuity chart and Ishihara plates

**D** Potential acuity testing and tonometry

Compound microscope · Medium

**378. Total magnification of a compound microscope with a 10× eyepiece and a 40× objective is:**

**A** 400×

**B** 50×

**C** 30×

**D** 4000×

Concave lens calculation · Hard

**379. An object is 20 cm in front of a concave lens of focal length 10 cm. The image formed is:**

**A** Virtual, erect, about 6.7 cm from the lens, one-third the object size

**B** Virtual, erect, 20 cm from the lens, same size as the object

**C** Real, inverted, about 6.7 cm behind the lens, one-third the size

**D** Virtual, erect, 30 cm from the lens, 1.5 times the object size

Myopia correction · Easy

**380. Which type of spectacle lens is used to correct myopia?**

**A** Convex lens

**B** Cylindrical lens

**C** Bifocal converging lens

**D** Concave lens

## Answers — Set 6 · Q51–60

**371.** B — The diverging lens forms a virtual image of the distant object at the far point, which the myopic eye can focus on the retina.

**372.** D — 200 nm / 0.4 nm = 500.

**373.** B — Smaller raster on the specimen over a fixed screen gives higher magnification, set by scan coil current or deflector voltage.

**374.** C — 4 = 1 + 25/f gives 25/f = 3, so f = 8.3 cm.

**375.** A — The lens must put a virtual image of infinity at 50 cm, so f = −0.5 m and P = 1/f = −2.0 D.

**376.** C — A magnifying glass is one converging lens of short focal length.

**377.** D — Potential acuity estimates vision without the cataract; tonometry measures fluid pressure inside the eye.

**378.** A — Total magnification is the product: 10 × 40 = 400×.

**379.** A — With f = −10 cm and u = −20 cm, 1/v = −1/10 − 1/20 = −3/20, so v = −6.7 cm and m = v/u = 1/3; it lies between F1 and O as the lecture states.

**380.** D — A concave (diverging) lens of suitable focal length corrects myopia. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 109

## 7. Set 7 · Q61–70

Presbyopia power · Devil

**381. An otherwise normal 60-year-old has a near point of 80 cm. What lens power allows reading at 25 cm, and what drawback follows?**

**A** +5.25 D; near vision blurs, so bifocals are used

**B** +2.75 D; distant vision blurs, so bifocals are used

**C** +1.25 D; no drawback arises

**D** +2.75 D; distant vision is improved as well

Compound microscope · Medium

**382. In a compound microscope the objective lens has:**

**A** Large focal length and large aperture

**B** Moderate focal length and large aperture

**C** Infinite focal length and no aperture

**D** Very small focal length and small aperture

Hypermetropia · Easy

**383. For a hypermetropic eye, the near point is:**

**A** Shifted closer to the eye than 25 cm

**B** Shifted away from the eye beyond 25 cm

**C** Exactly at 25 cm as in a normal eye

**D** Located at infinity for every person

Eye tests · Medium

**384. Why is the pupil dilated with drops during a cataract assessment?**

**A** To measure the visual acuity chart distance

**B** To reduce glare symptoms during testing

**C** To examine the lens and retina for other conditions limiting vision

**D** To lower the fluid pressure in the eye Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 99

Astigmatism · Easy

**385. Astigmatism arises when the:**

**A** Cornea has different curvature in different directions

**B** Eyeball is too long

**C** Lens loses elasticity with age

**D** Cones fail to detect red light

Simple microscope calculation · Hard

**386. An object is held 5 cm from a convex lens of focal length 10 cm. What is the image?**

**A** Real, inverted, 10 cm beyond the lens, magnified 2×

**B** Virtual, erect, 10 cm on the object side, magnified 2×

**C** Virtual, erect, 3.3 cm on the object side, diminished

**D** Real, inverted, 3.3 cm beyond the lens, diminished

Compound microscope · Hard

**387. A 3 µm long bacillus is viewed with a 10× eyepiece and a 100× oil immersion objective. Its apparent length is:**

**A** 0.3 mm

**B** 30 mm

**C** 0.03 mm

**D** 3 mm

Colour blindness · Easy

**388. Which form of colour deficiency is the most common?**

**A** Protanomaly

**B** Tritanomaly

**C** Monochromacy

**D** Deuteranomaly

Hypermetropia correction · Easy

**389. Which spectacle lens corrects hypermetropia?**

**A** Convex lens of suitable focal length

**B** Concave lens of suitable focal length

**C** Cylindrical lens with suitable axis

**D** Plane glass of uniform thickness

Ishihara plate · Medium

**390. On the lecture's Ishihara plate, a viewer with dichromacy or anomalous trichromacy may read the number as:**

**A** 74, where normal viewers see 21

**B** 12, where normal viewers see 21

**C** Nothing, where normal viewers see 74

**D** 21, where normal viewers see 74

## Answers — Set 7 · Q61–70

**381.** B — 1/0.25 − 1/0.80 = 4.00 − 1.25 = +2.75 D, but a converging lens blurs distant objects, hence bifocals.

**382.** D — The objective is a short focal length lens with a small aperture; the eyepiece has moderate focal length and large aperture.

**383.** B — In hypermetropia the near point moves away and is no longer at the 25 cm least distance of distinct vision.

**384.** C — Dilation lets the ophthalmologist look at lens and retina to find other causes of poor vision.

**385.** A — Different corneal curvatures in different directions make light focus at more than one point.

**386.** B — The object lies between O and F1, so 1/v = 1/10 − 1/5 gives v = −10 cm and m = 2, the magnifier condition.

**387.** D — Total magnification is 10 × 100 = 1000×, and 3 µm × 1000 = 3000 µm = 3 mm.

**388.** D — Deuteranomaly, reduced sensitivity to green light, is the most common form. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 110

**389.** A — A convex (converging) lens supplies the extra converging power the hypermetropic eye lacks.

**390.** D — The plate shows 74 to normal viewers; red-green deficient viewers may read 21.

## 8. Set 8 · Q71–80

FALSE statement: TEM · Devil

**391. Which statement about transmission electron microscopy is FALSE?**

**A** Specimens are usually bulk blocks several millimetres thick

**B** The electron beam may damage biological samples

**C** The field of view is relatively small

**D** Sample preparation is time-consuming with low throughput

Presbyopia correction · Easy

**392. Which lenses are used to remove presbyopia?**

**A** Concave lenses only

**B** Cylindrical lenses only

**C** Plano lenses with a tint

**D** Bifocal lenses with converging power Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 100

Compound microscope · Hard

**393. A haematology scientist needs a total magnification of 600× with a 15× eyepiece. Which objective is required?**

**A** 100×

**B** 10×

**C** 40×

**D** 4×

Ishihara test · Easy

**394. The Ishihara test is used mainly to detect:**

**A** Red-green colour deficiencies

**B** Raised eye pressure

**C** Cataract density

**D** Corneal curvature errors

Near point with spectacles · Devil

**395. A myopic person has a far point of 40 cm and a near point of 10 cm. She wears a −2.5 D lens to see distant objects. With the lens, how close can an object be and still be seen clearly (thin lens at the eye)?**

**A** About 13.3 cm

**B** About 10 cm

**C** About 8 cm

**D** About 30 cm

Astigmatism correction · Easy

**396. Astigmatism can be corrected using a:**

**A** Spherical concave lens

**B** Cylindrical lens of suitable radius and axis

**C** Spherical convex lens

**D** Bifocal lens

Presbyopia · Easy

**397. Presbyopia results mainly from:**

**A** Increase in the size of the eyeball

**B** Different corneal curvature in different directions

**C** Weakening of ciliary muscles and loss of lens elasticity

**D** Clouding of the eye lens proteins

Astronomical telescope · Hard

**398. An astronomical telescope in normal adjustment has an objective of focal length 150 cm and an eyepiece of focal length 3 cm. Its angular magnifying power is:**

**A** 153

**B** 450

**C** 50

**D** 0.02

Reflecting telescope · Easy

**399. In a Cassegrain reflecting telescope the objective lens is replaced by:**

**A** A convex lens of small aperture

**B** A plane mirror at 45°

**C** A diverging lens of long focal length

**D** A concave parabolic mirror of large aperture

Myopia correction power · Hard

**400. A myopic student can see clearly only up to 80 cm. What is the power of the spectacle lens needed for distant vision?**

**A** −0.80 D

**B** −1.25 D

**C** +1.25 D

**D** −12.5 D

## Answers — Set 8 · Q71–80

**391.** A — False: the specimen is usually an ultrathin section less than 100 nm thick, or a suspension on a grid.

**392.** D — Converging (bifocal) lenses are employed, as in hypermetropia.

**393.** C — Total magnification is the product, so the objective = 600/15 = 40×, the standard high-dry objective.

**394.** A — It uses pseudo-isochromatic plates to screen for red-green deficiencies.

**395.** A — The lens must give a virtual image at 10 cm: $1/u = 1/v - 1/f = -1/10 + 1/40 = -3/40$, so u = 13.3 cm.

**396.** B — A cylindrical lens with suitable radius of curvature and axis corrects the unequal curvature.

**397.** C — With age the ciliary muscles weaken and the lens loses elasticity, so accommodation falls.

**398.** C — Angular magnification in normal adjustment is $f_o/f_e = 150/3 = 50$.

**399.** D — A large concave parabolic mirror is the objective, free from chromatic and spherical aberrations.

**400.** B — f = −0.80 m, so $P = 1/(-0.80) = -1.25$ D.

**Module 6: Lecture 6 — Physics of Hearing** — 80 questions

## 1. Set 1 · Q1–10

Inverse square law · Devil

**401. A listener moves from 1 m to 4 m from a small source radiating uniformly in open space. By how much does the sound level fall?**

**A** About 6 dB

**B** About 12 dB

**C** About 24 dB

**D** About 16 dB

Audiology · Easy

**402. Which description best fits an audiologist?**

**A** A hearing healthcare professional who identifies, diagnoses and treats auditory and vestibular problems of the ear

**B** A surgeon who treats diseases of the ear, nose and throat and completes five years of ENT residency

**C** A laboratory scientist who measures the frequency of ultrasound pulses in imaging departments

**D** A physicist who designs piezoelectric transducers for diagnostic imaging machines

HVL · Hard

**403. A 3.5 MHz transducer is used in soft tissue with an attenuation coefficient of 0.5 dB/cm per MHz. What is the half value layer thickness?**

**A** 0.58 cm

**B** 5.3 cm

**C** 6.0 cm

**D** 1.7 cm

Half value layer · Medium

**404. Which statement about the half value layer (HVL) thickness is correct?**

**A** It is the thickness that reduces beam intensity to zero

**B** It is the thickness that reduces beam intensity by 10 dB

**C** It is the thickness that doubles the beam intensity

**D** It is the thickness that reduces beam intensity by half, a 3 dB loss

Transducer materials · Devil

**405. Which statement about transducer materials is FALSE?**

**A** Quartz is naturally piezoelectric and was first used as a stable resonator in timing devices

**B** PZT ceramics have a low Q, which suits the production of short pulses

**C** Piezo-composites mix a ceramic with a non-piezoelectric polymer and offer lower impedance

**D** Synthetic crystals are less efficient than natural quartz at converting mechanical to electrical energy

Attenuation · Devil

**406. A 3 MHz beam in soft tissue (0.7 dB/cm per MHz) is reflected from an interface 6 cm deep. What is the total attenuation of the echo?**

**A** 12.6 dB

**B** 2.1 dB

**C** 25.2 dB

**D** 42.0 dB

Interference · Medium

**407. Two sound waves of the same frequency and amplitude meet exactly half a cycle out of phase. What is the result?**

**A** They cancel, giving no output

**B** They add to twice the amplitude

**C** They produce a wave of double frequency

**D** They produce a louder note Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 113

Curie point · Medium

**408. What happens to a piezoelectric crystal heated above its Curie point?**

**A** It becomes more sensitive

**B** Its density doubles

**C** It loses its piezoelectric properties

**D** It starts to emit light

Propagation speed · Easy

**409. Which value is the speed of sound in soft tissue listed in the lecture table?**

**A** 1.54 mm/μs

**B** 0.33 mm/μs

**C** 4.0 mm/μs

**D** 0.5 mm/μs

Duty factor · Hard

**410. Pulse duration is 1 μs and pulse repetition period is 500 μs. What is the duty factor, and is it typical?**

**A** 0.002, which lies in the typical 0.001 to 0.01 range

**B** 0.02, which lies in the typical 0.001 to 0.01 range

**C** 0.0002, which lies in the typical 0.001 to 0.01 range

**D** 500, which is far above the typical range

## Answers — Set 1 · Q1–10

**401.** B — Correct: intensity falls by $4^2 = 16$, and $10 \log 16 \approx 12$ dB.

**402.** A — Correct: the lecture defines an audiologist as a hearing healthcare professional dealing with the auditory and vestibular areas of the ear.

**403.** D — Correct: coefficient = 0.5 × 3.5 = 1.75 dB/cm, so HVL = 3 dB ÷ 1.75 dB/cm ≈ 1.7 cm.

**404.** D — Correct: HVL reduces intensity by one half, which equals 3 dB of attenuation.

**405.** D — Correct (the false statement): the lecture says man-made crystals are cheaper, more durable and more efficient in this conversion.

**406.** C — Correct: coefficient 0.7 × 3 = 2.1 dB/cm and the path is 6 + 6 = 12 cm, giving 25.2 dB.

**407.** A — Correct: out-of-phase waves exactly cancel when added (destructive interference).

**408.** C — Correct: above the Curie temperature the crystal loses its piezoelectric properties.

**409.** A — Correct: soft tissue is 1.54 mm/μs (1540 m/s).

**410.** A — Correct: DF = PD ÷ PRP = 1 ÷ 500 = 0.002, inside the typical range of 0.001 to 0.01.

## 2. Set 2 · Q11–20

Decibels · Medium

**411. The lecture says a 30 dB increase corresponds to what change in sound energy?**

**A** A 1000-fold increase

**B** A 30-fold increase

**C** A 300-fold increase

**D** A 100-fold increase

Doppler effect · Devil

**412. Which statement about the Doppler effect is FALSE?**

**A** A source and receiver moving at the same velocity in the same direction still show a shift

**B** A source moving toward a stationary receiver raises the received frequency

**C** A stationary source with a moving receiver can produce a frequency shift

**D** At the instant a passing source is level with the observer the pitch equals the emitted pitch

Pulse duration · Medium

**413. A pulse contains 3 cycles and each cycle has a period of 0.5 μs. What is the pulse duration?**

**A** 1.5 μs

**B** 0.17 μs

**C** 3.5 μs

**D** 6 μs

Decibels · Devil

**414. An echo has been attenuated by 18 dB. By what factors have its intensity and its amplitude fallen?**

**A** Intensity about 18-fold and amplitude about 4.2-fold

**B** Intensity about 63-fold and amplitude about 63-fold

**C** Intensity about 7.9-fold and amplitude about 63-fold

**D** Intensity about 63-fold and amplitude about 7.9-fold

Pulsed sound · Devil

**415. A scanner has a PRF of 5 kHz and transmits for 0.4% of the time. How long does the transducer listen in each pulse repetition period?**

**A** 0.8 µs

**B** 198.0 µs

**C** 199.2 µs

**D** 192.0 µs Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 114

Imaging depth · Medium

**416. A sonographer increases the imaging depth on the scanner. What happens to the PRF?**

**A** It increases because the beam travels faster

**B** It stays the same because PRF is set by the tissue

**C** It increases to keep the image bright

**D** It decreases because the receiving time gets longer

Frequency and period · Medium

**417. A source oscillates with a period of 0.1 s. What is its frequency, and is it audible?**

**A** 10 Hz, which is infrasound and not audible

**B** 10 Hz, which lies within the audible range

**C** 0.1 Hz, which is infrasound and not audible

**D** 100 Hz, which lies within the audible range

Interference · Devil

**418. Two waves of the same frequency, with amplitudes 3 and 1 units, meet exactly out of phase. What is the result relative to the stronger wave alone?**

**A** Amplitude 2 units, with power about 44% of the stronger wave alone

**B** Amplitude 4 units, with power about 178% of the stronger wave alone

**C** Amplitude 0 units, so the waves cancel completely

**D** Amplitude 2 units, with power about 67% of the stronger wave alone

Frequency and period · Easy

**419. What is the relationship between period T and frequency f?**

**A** $T = f$

**B** $T = f^2$

**C** $T = 1/f$

**D** $T = 2f$

Sound intensity · Easy

**420. What is the SI unit of sound intensity as defined by I = P/A?**

**A** W

**B** $W/m^2$

**C** Pa

**D** dB

### Answers — Set 2 · Q11–20

**411.** A — Correct: every 10 dB is a factor of 10, so 30 dB is 10×10×10 = 1000 times.

**412.** A — Correct (the false statement): with no relative motion between them the received frequency equals the emitted frequency, so no shift occurs.

**413.** A — Correct: pulse duration = period × cycles per pulse = 0.5 × 3 = 1.5 µs, within the 0.5 to 3 µs clinical range.

**414.** D — Correct: intensity factor = 10^(18/10) ≈ 63, and amplitude falls by its square root, √63 ≈ 7.9.

**415.** C — Correct: PRP = 200 µs, PD = 0.004 × 200 = 0.8 µs, and the listening time is 200 − 0.8 = 199.2 µs.

**416.** D — Correct: deeper imaging needs a longer listening time, so fewer pulses per second can be sent and PRF drops.

**417.** A — Correct: f = 1/T = 1/0.1 = 10 Hz, which is below 20 Hz and therefore infrasound.

**418.** A — Correct: out-of-phase waves subtract to 3 − 1 = 2 units, and power ∝ amplitude² gives (2/3)² ≈ 0.44.

**419.** C — Correct: period and frequency are reciprocals, T = 1/f and f = 1/T.

**420.** B — Correct: power in watts divided by area in m² gives W/m².

## 3. Set 3 · Q21–30

Attenuation · Medium

**421. Which list contains all the mechanisms that make up attenuation in the lecture?**

**A** Absorption, refraction and diffraction only

**B** Absorption, scattering and mode conversion (also reflection)

**C** Scattering and polarization only

**D** Reflection and the Doppler shift only

Earth structure · Medium

**422. Longitudinal earthquake waves pass through the centre of the Earth while transverse waves do not. What does the lecture conclude?**

**A** The Earth is believed to have a solid core only

**B** The Earth is believed to have a liquid core

**C** The Earth has no density variation inside

**D** Transverse waves are absorbed by the crust only

Propagation speed · Easy

**423. What is the speed of sound in air at 0 °C given in the lecture?**

**A** 1540 m/s

**B** 33 m/s

**C** 3320 m/s

**D** 332 m/s Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 115

Pulse repetition · Medium

**424. A system has a pulse repetition period of 200 μs. What is its pulse repetition frequency?**

**A** 50 kHz

**B** 5 kHz

**C** 0.5 kHz

**D** 200 Hz

Imaging depth · Hard

**425. What is the maximum PRF that lets echoes from 15 cm depth return before the next pulse, taking v = 1540 m/s?**

**A** About 10.3 kHz

**B** About 5.1 kHz

**C** About 2.6 kHz

**D** About 51 kHz

ENT · Easy

**426. Otolaryngologists are commonly called ENTs because they treat problems of which structures?**

**A** Eyes, nerves and tongue

**B** Ear, nose and throat

**C** Ear, neck and teeth

**D** Esophagus, nerves and thyroid

Inverse square law · Hard

**427. A source of net power 0.5 W radiates uniformly in all directions. What is the intensity at 2 m?**

**A** $2.0 \times 10^{-2}$ W/m²

**B** 0.125 W/m²

**C** $9.9 \times 10^{-3}$ W/m²

**D** $4.0 \times 10^{-2}$ W/m²

Decibels · Hard

**428. Heavy traffic is 80 dB and a whisper is 20 dB. By what factor is the traffic sound more intense?**

**A** 60 times

**B** 1,000,000 times

**C** 600 times

**D** 1,000 times

Wave types · Medium

**429. Why can a transverse wave NOT propagate through a liquid or gas?**

**A** Liquids and gases are too dense to allow any particle displacement at all

**B** Liquid and gas particles are bound too tightly to move perpendicular to the wave

**C** Adjacent particles slide past each other, so one particle cannot drag its neighbours sideways

**D** Transverse waves always need a vacuum, which a fluid does not provide

Piezoelectricity · Easy

**430. What does the word piezoelectric mean?**

**A** Heat electricity

**B** Pressure electricity

**C** Sound light

**D** Magnetic vibration

### Answers — Set 3 · Q21–30

**421.** B — Correct: attenuation includes absorption, scattering and mode conversion, and reflection is also listed as a cause.

**422.** B — Correct: transverse waves cannot travel through a fluid, so their absence beyond the core suggests a liquid core.

**423.** D — Correct: sound travels at 332 m/s in air at 0 °C. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 126

**424.** B — Correct: PRF = 1/PRP = 1/200 µs = 5000 Hz = 5 kHz.

**425.** B — Correct: round trip = 30 cm, time = 0.30 ÷ 1540 ≈ 195 µs, so PRF ≈ 1 ÷ 195 µs ≈ 5.1 kHz.

**426.** B — Correct: ENT stands for ear, nose and throat.

**427.** C — Correct: $I = P/4\pi r^2 = 0.5 \div (4\pi \times 4) = 0.5 \div 50.27 \approx 9.9 \times 10^{-3}$ W/m².

**428.** B — Correct: the difference is 60 dB, six steps of 10 dB, so $10^6$ times the energy.

**429.** C — Correct: shear motion needs tightly bound particles; in fluids neighbours easily slide past each other.

**430.** B — Correct: piezoelectric literally means pressure electricity; the effect was reported by Pierre Curie in 1880.

## 4. Set 4 · Q31–40

Pulse duration · Hard

**431. A pulse has 2 cycles at 4 MHz. What is its duration?**

**A** 2 µs

**B** 8 µs

**C** 0.5 ms

**D** 0.5 µs Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 116

Wavelength · Medium

**432. A 5 MHz ultrasound beam travels in soft tissue at 1.54 mm/μs. What is its wavelength?**

**A** 3.08 mm

**B** 0.0308 mm

**C** 1.54 mm

**D** 0.308 mm

Acoustic impedance · Devil

**433. Bone has density 1900 kg/m³ and sound speed 4000 m/s, while soft tissue has density 1000 kg/m³ and speed 1540 m/s. How many times larger is the impedance of bone?**

**A** About 2.6 times

**B** About 4.9 times

**C** About 1.9 times

**D** About 24 times

Doppler effect · Devil

**434. Why is the frequency received higher when a sound source approaches a stationary observer?**

**A** Each successive crest is emitted closer to the observer, so crests arrive at shorter intervals

**B** The source moving faster makes the sound travel faster through the medium

**C** The observer's ear amplifies waves coming from a moving source

**D** The medium compresses the waves as the source pushes air forward at the speed of sound

Echo timing · Devil

**435. Pulses cross 2 cm of fat (1.45 mm/μs) then 3 cm of soft tissue (1.54 mm/μs) to reach a reflector. What is the true round-trip time?**

**A** 64.9 μs

**B** 33.3 μs

**C** 133.1 μs

**D** 66.5 μs

Attenuation · Hard

**436. An echo comes from a reflector 5 cm deep. The beam is 5 MHz and soft tissue attenuates at 0.5 dB/cm per MHz. How much attenuation does the echo suffer on the round trip?**

**A** 25 dB

**B** 12.5 dB

**C** 2.5 dB

**D** 50 dB

Pulse duration · Devil

**437. A scanner transmits 1% of the time at a PRF of 8 kHz. What is the pulse duration?**

**A** 12.5 µs

**B** 0.125 µs

**C** 1.25 µs

**D** 125 µs

Imaging depth · Devil

**438. The tolerable round-trip attenuation is 60 dB. For a 5 MHz beam in soft tissue (0.5 dB/cm per MHz), what is the maximum imaging depth?**

**A** 24 cm

**B** 12 cm

**C** 6 cm

**D** 4.8 cm

Imaging trade-off · Hard

**439. A deep abdominal structure is poorly visualised with a 10 MHz probe. Why does switching to 3.5 MHz help, and what is the cost?**

**A** Lower frequency means less attenuation and deeper penetration, but poorer image quality

**B** Lower frequency means more attenuation and deeper penetration, with better image quality

**C** Lower frequency raises the speed of sound and improves resolution at depth

**D** Lower frequency shortens the wavelength, improving resolution but reducing depth Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 117

Duty factor · Medium

**440. A pulse lasts 2 µs and the pulse repetition frequency is 5 kHz. What is the duty factor?**

**A** 0.1 (10%)

**B** 0.001 (0.1%)

**C** 0.01 (1%)

**D** 10

## Answers — Set 4 · Q31–40

**431.** D — Correct: PD = cycles ÷ frequency = 2 ÷ $4\times10^6$ Hz = 0.5 µs. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 127

**432.** D — Correct: λ = v/f = 1.54 mm/µs ÷ 5 MHz = 0.308 mm.

**433.** B — Correct: Z bone = $7.6 \times 10^6$ and Z soft tissue = $1.54 \times 10^6$, a ratio of about 4.9.

**434.** A — Correct: each crest has a shorter trip than the last, so the arrival interval shrinks and the pitch rises.

**435.** D — Correct: one way = 20/1.45 + 30/1.54 ≈ 13.79 + 19.48 = 33.27 µs, and doubling gives 66.5 µs.

**436.** A — Correct: coefficient 2.5 dB/cm × (5 cm there + 5 cm back) = 25 dB.

**437.** C — Correct: PRP = 1/8000 = 125 µs and PD = 0.01 × 125 = 1.25 µs.

**438.** B — Correct: 2.5 dB/cm one way means 5 dB per cm of depth for the round trip, and 60 ÷ 5 = 12 cm.

**439.** A — Correct: attenuation rises with frequency, so 3.5 MHz penetrates deeper but with longer wavelength and SPL, giving lower resolution.

**440.** C — Correct: duty factor = PD × PRF = $2\times10^{-6}$ s × 5000 Hz = 0.01, i.e. 1%.

## 5. Set 5 · Q41–50

Curie point · Devil

**441. Using the lecture's Curie temperatures (328 °C for PZT and 573 °C for quartz), what happens to elements heated to 400 °C?**

**A** The quartz loses its piezoelectric properties while the PZT keeps them

**B** Both lose their piezoelectric properties at once

**C** Both keep their piezoelectric properties until 573 °C

**D** The PZT loses its piezoelectric properties while the quartz keeps them

Power and amplitude · Medium

**442. The operator doubles the amplitude of the transmitted wave. What happens to the power?**

**A** It becomes twice as large

**B** It stays the same

**C** It becomes four times larger

**D** It becomes eight times larger

Transducer materials · Easy

**443. Which material is the most common piezoelectric material in diagnostic imaging transducers?**

**A** Quartz

**B** Barium sulphate

**C** Lead zirconate titanate (PZT)

**D** Silicon dioxide gel

Attenuation · Devil

**444. Which statement about attenuation in soft tissue is FALSE?**

**A** Absorption, which converts sound energy to heat, is the dominant mechanism

**B** Higher frequencies suffer greater attenuation and therefore less imaging depth

**C** The attenuation coefficient in dB/cm is independent of frequency

**D** The total loss depends on both the frequency and the distance travelled

Transducer physics · Devil

**445. A transducer element is driven by a voltage pulse and then senses the returning echo. Which pairing of effects is correct?**

**A** Transmission uses the direct piezoelectric effect and reception uses the reverse piezoelectric effect

**B** Transmission uses the reverse piezoelectric effect and reception uses the direct piezoelectric effect

**C** Both transmission and reception use the reverse piezoelectric effect at different times

**D** Transmission uses the Curie effect and reception uses the reverse piezoelectric effect

ENT training · Easy

**446. According to the lecture, how long is the training path to become an ENT doctor?**

**A** Two years of medical school followed by three years of ENT residency

**B** Five years of medical school followed by four years of ENT residency

**C** Four years of medical school followed by five years of ENT residency

**D** Four years of medical school followed by one year of ENT residency

Duty factor · Devil

**447. A scanner images to 10 cm depth using 2 µs pulses and the fastest possible PRF (v = 1540 m/s). What is the duty factor?**

**A** About 0.031, above the typical 0.001 to 0.01 range

**B** About 0.0077, within the typical 0.001 to 0.01 range

**C** About 0.015, above the typical 0.001 to 0.01 range

**D** About 0.15, far above the typical range Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 118

Echo timing · Hard

**448. An echo is received from an interface 7.7 cm deep in soft tissue (1.54 mm/µs). How long after transmission does it arrive?**

**A** 50 µs

**B** 200 µs

**C** 10 µs

**D** 100 µs

Decibels · Medium

**449. By how many decibels does the sound energy change when it doubles?**

**A** About 1 dB

**B** About 3 dB

**C** About 10 dB

**D** About 6 dB

Penetration · Hard

**450. Using HVL = 3 dB ÷ coefficient and a coefficient of 0.5 dB/cm per MHz, how does the HVL at 6 MHz compare with that at 2 MHz?**

**A** It is three times as thick (9 cm versus 3 cm)

**B** It is the same (3 cm in both)

**C** It is one third as thick (1 cm versus 3 cm)

**D** It is one sixth as thick (0.5 cm versus 3 cm)

## Answers — Set 5 · Q41–50

**441.** D — Correct: 400 °C is above 328 °C but below 573 °C, so only PZT passes its Curie point.

**442.** C — Correct: power is proportional to (amplitude)², so doubling amplitude gives $2^2 = 4$ times the power.

**443.** C — Correct: PZT is the most common piezoelectric ceramic in diagnostic imaging transducers.

**444.** C — Correct (the false statement): the lecture states the attenuation coefficient is directly related to frequency, roughly 0.5 to 1.1 dB/cm per MHz.

**445.** B — Correct: an applied voltage makes the element vibrate (reverse effect) and sound striking it generates a voltage (direct effect).

**446.** C — Correct: the slide states four years of medical school then five years of ENT residency.

**447.** C — Correct: round trip 20 cm takes ≈ 129.9 µs, so DF = 2 ÷ 129.9 ≈ 0.015, a little above the typical range.

**448.** D — Correct: round trip is 154 mm, and 154 mm ÷ 1.54 mm/µs = 100 µs.

**449.** B — Correct: each doubling of energy corresponds to roughly 3 dB, since 10 log 2 ≈ 3.01.

**450.** C — Correct: coefficients are 3 dB/cm and 1 dB/cm, giving HVLs of 1 cm and 3 cm.

## 6. Set 6 · Q51–60

Acoustic velocity · Hard

**451. In a tissue that is more compressible (less stiff) but otherwise has similar density, what happens to the speed of sound?**

**A** It increases, because compressible tissue passes pressure faster

**B** It decreases, because speed rises with stiffness

**C** It stays the same, because speed depends only on frequency

**D** It increases, because compressibility and stiffness are the same

Duty factor · Hard

**452. A scanner uses a 4 kHz PRF with 2 µs pulses. What fraction of time does it listen?**

**A** 0.8%, since it listens only briefly

**B** 98%, since it transmits 2% of the time

**C** 92%, since it transmits 8% of the time

**D** 99.2%, since it transmits only 0.8% of the time

Pulsed sound · Medium

**453. In pulsed ultrasound imaging, what does the transducer do during the long off cycle?**

**A** It transmits the next sound pulse

**B** It listens and receives the returning echoes

**C** It cools down to prevent loss of piezoelectricity

**D** It converts electrical energy to sound continuously

Wavelength range · Hard

**454. Clinical wavelengths in soft tissue range from 0.1 to 0.8 mm. Using 1.54 mm/µs, what frequency range does this imply?**

**A** About 0.19 MHz to 1.5 MHz

**B** About 19 MHz to 150 MHz

**C** About 1.9 MHz to 15 MHz

**D** About 0.8 MHz to 5 MHz

Acoustic impedance · Hard

**455. Soft tissue has density 1000 kg/m³ and sound speed 1540 m/s. What is its acoustic impedance?**

**A** $1.54 \times 10^{6}$ kg/(m²·s)

**B** $1.54 \times 10^{3}$ kg/(m²·s)

**C** $2.37 \times 10^{9}$ kg/(m²·s)

**D** $6.5 \times 10^{-1}$ kg/(m²·s) Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 119

Loudness · Easy

**456. On the decibel scale shown in the lecture, what are the thresholds of hearing and pain?**

**A** 20 dB and 100 dB

**B** 0 dB and 60 dB

**C** 0 dB and 120 dB

**D** 10 dB and 140 dB

Decibels · Devil

**457. The amplitude of an echo falls from 1.0 to 0.1 units. How much attenuation is this?**

**A** 10 dB

**B** 40 dB

**C** 30 dB

**D** 20 dB

Doppler effect · Medium

**458. In which situation is NO Doppler frequency shift produced?**

**A** Source and receiver move at the same velocity in the same direction

**B** The source moves while the receiver is stationary

**C** The receiver moves while the source is stationary

**D** The source moves toward the receiver

Power and amplitude · Hard

**459. Attenuation reduces a wave's amplitude to one third of its starting value. What happens to its power?**

**A** It falls to one ninth

**B** It falls to one third

**C** It falls to one sixth

**D** It falls to one half

ENT training · Easy

**460. What is a fellowship in the context of ENT training?**

**A** The first four years of medical school before residency begins

**B** A surgical procedure used to treat masses in the neck

**C** A national licensing examination taken before entering residency

**D** Further training after residency to sub-specialize in one aspect of ENT

### Answers — Set 6 · Q51–60

**451.** B — Correct: the lecture ties velocity to density and stiffness; compressibility is the opposite of stiffness, so more compressible means slower.

**452.** D — Correct: DF = $2\times10^{-6} \times 4000 = 0.008$, so transmitting is 0.8% and listening is 99.2%.

**453.** B — Correct: the on cycle speaks briefly and the long off cycle is used to listen for echoes with the same transducer.

**454.** C — Correct: $f = v/\lambda$ gives $1.54 \div 0.8 \approx 1.9$ MHz and $1.54 \div 0.1 = 15.4$ MHz.

**455.** A — Correct: $Z = \rho v = 1000 \times 1540 = 1.54 \times 10^6$ kg/(m²·s), about 1.54 MRayl.

**456.** C — Correct: threshold of hearing is 0 dB and threshold of pain is 120 dB.

**457.** D — Correct: power ∝ amplitude², so the power falls 100-fold, and 10 log 100 = 20 dB.

**458.** A — Correct: with no relative motion between source and receiver the received frequency equals the emitted frequency.

**459.** A — Correct: power ∝ amplitude², so $(1/3)^2 = 1/9$.

**460.** D — Correct: some ENT doctors undertake fellowship after residency to become further sub-specialized.

## 7. Set 7 · Q61–70

Wave across a boundary · Devil

**461. A 4 MHz beam passes from soft tissue (1.54 mm/μs) into lung (0.5 mm/μs). What happens to its frequency and wavelength?**

**A** Frequency falls to 1.3 MHz and wavelength stays 0.385 mm

**B** Frequency stays 4 MHz and wavelength falls from 0.385 mm to 0.125 mm

**C** Frequency rises to 12.3 MHz and wavelength stays 0.385 mm

**D** Frequency and wavelength both fall by the same factor of about 3

Spatial pulse length · Medium

**462. A pulse has 3 cycles and each wavelength is 0.3 mm. What is the spatial pulse length?**

**A** 0.1 mm

**B** 3.3 mm

**C** 0.09 mm

**D** 0.9 mm

Wave types · Easy

**463. Sound waves in air are best described as which type of wave?**

**A** Transverse, with disturbance perpendicular to the direction of wave motion

**B** Longitudinal, with disturbance parallel to the direction of wave motion

**C** Electromagnetic, with electric and magnetic fields at right angles

**D** Shear, with particles dragging tightly bound neighbours sideways Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 120

Attenuation · Medium

**464. Why is the attenuation coefficient higher in bone and in lung than in soft tissue?**

**A** Bone is a great scatterer and lung is a great absorber

**B** Both are great reflectors with zero absorption

**C** Bone is a great absorber and lung is a great scatterer

**D** Both have lower density, so energy leaks away

Energy transformation · Easy

**465. Which phenomenon turns light into sound?**

**A** The photoacoustic effect

**B** Sonoluminescence

**C** The Doppler effect

**D** Mode conversion

Wavelength · Hard

**466. The speed of sound in fat is 1.45 mm/μs. What is the wavelength of 5 MHz ultrasound in fat?**

**A** 0.31 mm

**B** 0.29 mm

**C** 0.10 mm

**D** 2.9 mm

Wave speed · Hard

**467. Which statement about particles and wave speed in a sound wave is correct?**

**A** Particles travel along with the wave at the wave speed

**B** Particle speed always equals the product of frequency and wavelength

**C** Particles move at the speed of sound in the direction of propagation

**D** Particle motion is not the same as wave speed, and particles need not move in the wave's direction

Source dependence · Easy

**468. Which acoustic parameter is determined only by the sound source and not by the medium?**

**A** Wavelength

**B** Propagation speed

**C** Spatial pulse length

**D** Frequency

Hearing chain · Easy

**469. Which sequence correctly describes the first steps of human hearing in the lecture?**

**A** Sound wave, vibration of the eardrum, amplification by the ear bones, conversion to nerve impulses in the cochlea

**B** Sound wave, amplification by the cochlea, vibration of the ear bones, conversion to nerve impulses in the eardrum

**C** Sound wave, conversion to nerve impulses in the ear bones, vibration of the cochlea, amplification by the eardrum

**D** Sound wave, nerve impulses in the eardrum, amplification by the cochlea, vibration of the ear bones

Inverse square law · Medium

**470. A point source radiates sound uniformly. If you move from 2 m to 4 m away, what happens to the intensity?**

**A** It falls to one half

**B** It falls to one eighth

**C** It stays the same

**D** It falls to one quarter

### Answers — Set 7 · Q61–70

**461.** B — Correct: the source fixes the frequency; only speed and wavelength change, with λ = 0.5 ÷ 4 = 0.125 mm.

**462.** D — Correct: SPL = cycles per pulse × wavelength = 3 × 0.3 = 0.9 mm. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 131

**463.** B — Correct: sound is a longitudinal wave; particles oscillate parallel to the direction of propagation.

**464.** C — Correct: the lecture states bone absorbs strongly while lung scatters strongly (air-filled alveoli).

**465.** A — Correct: photoacoustic phenomena convert light into sound.

**466.** B — Correct: λ = 1.45 mm/μs ÷ 5 MHz = 0.29 mm, slightly shorter than in soft tissue (0.308 mm).

**467.** D — Correct: the lecture notes particles oscillate and in general do not move with the wave or in its direction (transverse waves move them sideways).

**468.** D — Correct: frequency (and period) is set by the source and is unchanged by the medium.

**469.** A — Correct: the eardrum vibrates, the bones amplify the vibration and the cochlea converts it to nerve impulses.

**470.** D — Correct: $I = P/4\pi r^2$, so doubling r divides intensity by $2^2 = 4$. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 132

## 8. Set 8 · Q71–80

Decibels · Devil

**471. The loudness scale runs from 0 dB at the threshold of hearing to 120 dB at the threshold of pain. How many times more intense is the pain level?**

**A** $10^{12}$ times

**B** 120 times

**C** $10^{10}$ times

**D** $10^{24}$ times Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 121

Acoustic ranges · Easy

**472. What is the approximate range of audible sound frequencies shown in the lecture?**

**A** 2 Hz to 2,000 Hz

**B** 200 Hz to 200,000 Hz

**C** 20 kHz to 30 MHz

**D** 20 Hz to 20,000 Hz

Propagation speed · Hard

**473. At 20 °C, use 332 m/s at 0 °C and 0.6 m/s per degree Celsius. What is the wavelength of a 2 kHz sound in air?**

**A** 0.166 m

**B** 1.72 m

**C** 0.172 m

**D** 0.0172 m

Wave formula · Easy

**474. Which equation links wave speed v, frequency f and wavelength λ?**

**A** $v = f\lambda$

**B** $v = f/\lambda$

**C** $v = \lambda/f^2$

**D** $v = f + \lambda$

Spatial pulse length · Devil

**475. A 3 MHz pulse of 4 cycles travels in soft tissue (1.54 mm/μs). What is its spatial pulse length?**

**A** 2.05 mm

**B** 1.03 mm

**C** 0.51 mm

**D** 6.16 mm

Acoustic impedance · Easy

**476. How is acoustic impedance Z calculated?**

**A** $Z = \rho/v$, the density divided by the speed of sound in the tissue

**B** $Z = \rho v$, the density multiplied by the speed of sound in the tissue

**C** $Z = v/\rho$, the speed of sound divided by the density of the tissue

**D** $Z = \rho v^2$, the density multiplied by the square of the sound speed

Wave types · Easy

**477. In which media can transverse waves occur according to the lecture?**

**A** In solids, liquids and gases

**B** Only in liquids and gases

**C** Only in solids

**D** Only in gases

Spatial pulse length · Hard

**478. A transducer's frequency is doubled while the number of cycles per pulse and the tissue stay the same. What happens to the spatial pulse length?**

**A** It is doubled, worsening axial resolution

**B** It is unchanged because it depends only on the source

**C** It is halved, improving axial resolution

**D** It is quadrupled because wavelength follows frequency squared

EM vs acoustic · Easy

**479. Which statement distinguishes acoustic waves from electromagnetic waves?**

**A** Acoustic waves travel in a vacuum, whereas electromagnetic waves need a medium

**B** Acoustic waves consist of oscillating electric and magnetic fields

**C** Acoustic waves are transverse in every medium they travel through

**D** Acoustic waves require a material medium, whereas electromagnetic waves do not Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 122

Wavelength · Hard

**480. A 2 MHz beam travels in bone, where the speed is 4.0 mm/μs. What is the wavelength?**

**A** 0.5 mm

**B** 2.0 mm

**C** 8.0 mm

**D** 0.2 mm

## Answers — Set 8 · Q71–80

**471.** A — Correct: 120 dB is twelve steps of 10 dB, each a tenfold energy change, so $10^{12}$ times.

**472.** D — Correct: audible sound lies between 20 Hz and 20 kHz.

**473.** C — Correct: v = 332 + 0.6 × 20 = 344 m/s, then λ = 344 ÷ 2000 = 0.172 m.

**474.** A — Correct: speed equals frequency multiplied by wavelength (also v = λ/T).

**475.** A — Correct: λ = 1.54 ÷ 3 = 0.513 mm and SPL = 4 × 0.513 ≈ 2.05 mm.

**476.** B — Correct: acoustic impedance is the product of density and speed of sound.

**477.** C — Correct: transverse (shear) waves need tightly bound particles, so they occur only in solids.

**478.** C — Correct: λ = v/f halves, so SPL = cycles × λ halves; shorter SPL gives better axial resolution.

**479.** D — Correct: sound needs a material medium; EM waves are self-propagating and need none.

**480.** B — Correct: λ = v/f = 4.0 mm/μs ÷ 2 MHz = 2.0 mm (4000 m/s ÷ $2\times10^{6}$ Hz = 0.002 m).

**Module 7: Lecture 7 — Hemodynamics** — 80 questions

## 1. Set 1 · Q1–10

Parallel flow division · Devil

**481. Two parallel vessels have equal length and viscosity. One has radius r and the other has radius 2r. What fraction of the total flow passes through the wider vessel?**

**A** About 80%

**B** About 94%

**C** About 89%

**D** About 67%

Definition · Easy

**482. Which statement best defines hemodynamics as presented in the lecture?**

**A** The physical study of flowing blood and of the solid structures, such as arteries, through which it flows

**B** The chemical study of blood composition and the plasma proteins it carries in circulation

**C** The study of how oxygen and carbon dioxide are exchanged across the alveolar membrane

**D** The study of how blood cells are produced in the bone marrow and released into plasma

Series-parallel network · Hard

**483. A circuit has a 20 unit resistor in series with two parallel 10 unit branches, which are in series with a 5 unit resistor. With a total ΔP of 90 mmHg, what is the flow in the same units?**

**A** 2

**B** 3.6

**C** 9

**D** 3

Reynolds dependence · Medium

**484. If the viscosity of blood doubles while velocity, diameter and density stay the same, what happens to the Reynolds number?**

**A** It is doubled

**B** It is quadrupled

**C** It is unchanged

**D** It is halved

False statement: Poiseuille · Devil

**485. Which statement about the validity of Poiseuille's equation in real circulation is FALSE?**

**A** It assumes steady laminar flow in a long rigid cylindrical tube

**B** It assumes the fluid has a constant viscosity, which blood does not strictly show

**C** It fails above the critical Reynolds number as flow becomes turbulent

**D** It holds exactly for pulsatile turbulent flow in elastic arteries

Anaemia and turbulence · Devil

**486. In severe anaemia, viscosity falls from 3.5 to 2.1 mPa·s and mean velocity rises by 50% because cardiac output increases, with diameter and density unchanged. If Re was 2000 before, what is it now?**

**A** 3000, which is exactly at the turbulence threshold

**B** 3333, which is just above the turbulence threshold

**C** 5000, which is above the turbulence threshold

**D** 1200, which is well within the laminar range

Vessel length · Medium

**487. If the length of a vessel is doubled while its radius, the viscosity and the pressure gradient stay the same, the flow becomes:**

**A** Half of its original value

**B** Double its original value

**C** One sixteenth of its value

**D** Unchanged, as flow depends on radius Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 135

Capillary wall · Medium

**488. In the blood vessel anatomy slide, which wall layer is the only one present in capillaries?**

**A** Smooth muscle

**B** Elastic tissue

**C** Endothelium

**D** Fibrous tissue

Kinetic energy · Easy

**489. The lecture gives the kinetic energy of flowing blood as KE = ½ × mass × velocity². How does KE depend on velocity?**

**A** KE is proportional to the square of velocity

**B** KE is directly proportional to velocity

**C** KE is inversely proportional to velocity

**D** KE is independent of velocity and depends only on mass

Bernoulli numeric · Hard

**490. Blood (ρ = 1060 kg/m³) speeds up from 1 m/s in a wide section to 2 m/s in a narrow section. Ignoring height changes, by how much does static pressure fall? (1 mmHg = 133.3 Pa)**

**A** About 12 mmHg

**B** About 4 mmHg

**C** About 16 mmHg

**D** About 24 mmHg

## Answers — Set 1 · Q1–10

**481.** B — Correct. The flow ratio is $2^4 = 16 : 1$, so the wider vessel takes $16/17 \approx 0.94$ of the total.

**482.** A — Correct. The slide defines hemodynamics as the physical study of flowing blood and the vessels that carry it, which includes arterial pressure and cardiac output.

**483.** D — Correct. The parallel pair gives 5, so total R = 20 + 5 + 5 = 30 and Q = 90/30 = 3.

**484.** D — Correct. Re = vdρ/η, so Re is inversely proportional to viscosity.

**485.** D — Correct choice, since this is the false statement. The equation is derived for steady laminar flow in a rigid straight tube, so it only approximates arteries.

**486.** C — Correct. Re ∝ v/η, so Re = 2000 × 1.5 / 0.6 = 5000, explaining the flow murmurs heard in anaemic patients.

**487.** A — Correct. Q ∝ 1/l, so doubling length doubles resistance and halves flow.

**488.** C — Correct. Capillaries have an average wall thickness of about 0.5 μm and consist of endothelium only, which favours exchange.

**489.** A — Correct. Doubling velocity makes the kinetic energy four times greater.

**490.** A — Correct. $\Delta P = \frac{1}{2}\rho(v_2^2 - v_1^2) = 0.5 \times 1060 \times (4 - 1) = 1590$ Pa ≈ 11.9 mmHg.

## 2. Set 2 · Q11–20

Capillary velocity · Medium

**491. Why is blood velocity lowest in the capillaries even though each capillary is extremely narrow?**

**A** Their combined cross-sectional area is far greater than that of the aorta

**B** Capillary walls have the highest resistance of all vessels in the body

**C** Cardiac output is much lower at the capillaries than at the aorta

**D** Red cells stick to the endothelium and stop moving through the lumen

False statement: Bernoulli · Devil

**492. Which statement about Bernoulli's principle and continuity in a narrowed artery is FALSE?**

**A** Because the flow is continuous, the pressure at the narrowing must rise as velocity rises

**B** Continuity requires velocity to rise where the cross-sectional area falls at constant flow

**C** Total energy per unit volume is conserved in the ideal case along a streamline

**D** Real viscous losses mean the pressure does not fully recover after the narrowing

Bernoulli in a constriction · Medium

**493. In the tube with narrow section B, velocity is 100, 200 and 100 cm/s at A, B and C. Where is the static pressure lowest in the ideal case?**

**A** At the narrow section, where the velocity is highest

**B** At the wide inlet section, where the velocity is lowest

**C** At the outlet, because the blood has travelled furthest

**D** At all three sections, because the flow rate is constant

Bernoulli at a stenosis · Devil

**494. Blood (ρ = 1060 kg/m³) passes a stenosis, with velocity rising from 0.5 m/s to 2.0 m/s. Ignoring losses and height, what is the fall in static pressure? (1 mmHg = 133.3 Pa)**

**A** About 9 mmHg

**B** About 30 mmHg

**C** About 1 mmHg

**D** About 15 mmHg

Capillary transit time · Devil

**495. Mean capillary velocity is 0.03 cm/s. How long does an erythrocyte take to traverse a capillary 0.5 mm long?**

**A** About 17 s

**B** About 0.6 s

**C** About 1.7 s

**D** About 0.017 s Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 136

Stagnant hypoxia · Medium

**496. According to the lecture, what condition results if blood flow velocity is too slow?**

**A** Anaemic hypoxia

**B** Hypoxic hypoxia

**C** Histotoxic hypoxia

**D** Stagnant hypoxia

Flow calculation · Medium

**497. A vessel segment has an inlet pressure of 120 mmHg, an outlet pressure of 20 mmHg and a resistance of 20 mmHg·min/L. What is the flow?**

**A** 5 L/min

**B** 0.2 L/min

**C** 7 L/min

**D** 6 L/min

Spherical aneurysm · Devil

**498. A saccular aneurysm of radius 2 cm is modelled as a sphere at 120 mmHg (1 mmHg = 133.3 Pa). Using T = PR/2, what is the wall tension?**

**A** About 160 N/m

**B** About 320 N/m

**C** About 80 N/m

**D** About 1.6 N/m

Ohm's law analogy · Easy

**499. The lecture compares blood flow to Ohm's law with Q = ΔP / R. Which electrical variable corresponds to flow Q and which to pressure P?**

**A** Flow corresponds to voltage V and pressure corresponds to current I

**B** Flow corresponds to charge q and pressure corresponds to resistance R

**C** Flow corresponds to current I and pressure corresponds to voltage V

**D** Flow corresponds to resistance R and pressure corresponds to charge q

Turbulent flow · Easy

**500. According to the lecture, turbulent blood flow is characterised by:**

**A** Movement in only the axial direction along parallel layers

**B** Irregular movement in axial, radial and circumferential directions

**C** Movement in a perfectly parabolic profile with zero velocity at the centre

**D** A total absence of any pressure gradient between the two ends

### Answers — Set 2 · Q11–20

**491.** A — Correct. Because v = Q/A and the total capillary area is huge, velocity falls, which gives time for exchange.

**492.** A — Correct choice, since this is the false statement. In the ideal case, static pressure falls when velocity rises, because kinetic energy is gained at the expense of pressure.

**493.** A — Correct. The kinetic term (15 mmHg) is largest at B, so the static pressure term is smallest there.

**494.** D — Correct. $\Delta P = \frac{1}{2}\rho(v_2^2 - v_1^2) = 0.5 \times 1060 \times (4 - 0.25) \approx 1988$ Pa ≈ 14.9 mmHg.

**495.** C — Correct. Length is 0.05 cm, so t = 0.05/0.03 ≈ 1.7 s, which allows time for gas and nutrient exchange.

**496.** D — Correct. Slow flow leaves tissue short of oxygen delivery even when arterial oxygen content is normal.

**497.** A — Correct. $\Delta P = 120 - 20 = 100$ mmHg and $Q = \Delta P/R = 100/20 = 5$ L/min.

**498.** A — Correct. $T = 0.5 \times 120 \times 133.3 \times 0.02 \approx 160$ N/m, which is half the tension of a cylinder of the same radius.

**499.** C — Correct. The table pairs pressure with voltage, flow with current, volume with charge and resistance with resistance.

**500.** B — Correct. In turbulence the fluid moves in all three directions, creating eddies.

## 3. Set 3 · Q21–30

Parallel resistance · Medium

**501. Three vessels with R = 5, 10 and 20 are arranged in parallel. What is their combined resistance?**

**A** 35

**B** About 2.86

**C** About 11.7

**D** 5

Resistance and flow · Medium

**502. If the pressure gradient across a vascular bed stays constant while its resistance doubles, what happens to blood flow?**

**A** It doubles because resistance drives flow

**B** It falls to half its original value

**C** It falls to a quarter of its original value

**D** It stays the same because pressure is unchanged

Velocity · Easy

**503. How is the mean velocity of blood in a vessel related to flow (Q) and cross-sectional area (A)?**

**A** $v = Q \times A$

**B** $v = A / Q$

**C** $v = Q / A^2$

**D** $v = Q / A$ Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 137

Turbulence and flow · Medium

**504. For a given perfusion pressure, how does turbulent flow compare with laminar flow?**

**A** Turbulence increases the flow obtained for that pressure

**B** Turbulence reduces the flow obtained for that pressure

**C** Turbulence has no effect on the flow obtained for that pressure

**D** Turbulence removes the need for any pressure gradient

Continuity in capillaries · Hard

**505. Mean aortic velocity is 30 cm/s with a cross-sectional area of 3 $cm^2$, and the total capillary cross-section is 3000 $cm^2$. What is the mean capillary velocity?**

**A** 0.3 cm/s

**B** 0.03 cm/s

**C** 0.003 cm/s

**D** 30 cm/s

Cardiovascular system · Easy

**506. In the organ-systems slide, what are the functions of the two components of the cardiovascular system?**

**A** The heart stores blood and the blood vessels pump it through the tissues around the body

**B** The heart pumps blood and the blood vessels transport it throughout the body

**C** The heart filters blood and the vessels digest nutrients that are absorbed into the plasma

**D** The heart transports blood and the vessels produce the pressure that drives circulation

Parallel flow · Hard

**507. Two vascular beds with resistances 20 and 5 mmHg·min/L are in parallel across a pressure gradient of 50 mmHg. What is the total flow?**

**A** 2 L/min

**B** 10 L/min

**C** 12.5 L/min

**D** 4 L/min

Critical velocity · Hard

**508. Taking critical Re = 3000, η = 3.5 mPa·s and ρ = 1060 kg/m³, what is the velocity at which turbulence begins in an aorta of diameter 2.5 cm?**

**A** About 0.79 m/s

**B** About 0.40 m/s

**C** About 4.0 m/s

**D** About 0.040 m/s

Pressure-flow graph · Medium

**509. On the lecture graph of flow against perfusion pressure, how do the low-resistance and high-resistance lines differ?**

**A** The low-resistance line is flatter, giving less flow for each mmHg of ΔP

**B** Both lines have the same slope but start from different intercepts

**C** The low-resistance line is steeper, giving more flow for each mmHg of ΔP

**D** The high-resistance line is steeper because friction increases the flow

Pascal's principle · Easy

**510. In the slide on pressure in a vessel, Pascal's principle says that pressure in a fluid is:**

**A** Exerted only in the direction of flow

**B** Exerted equally in all directions

**C** Exerted only on the vessel wall nearest to the heart

**D** Greatest at the centre of the lumen and zero at the wall

## Answers — Set 3 · Q21–30

**501.** B — Correct. 1/Rx = 1/5 + 1/10 + 1/20 = 0.35, so Rx = 2.86.

**502.** B — Correct. Since Q = ΔP/R, doubling R at constant ΔP halves Q.

**503.** D — Correct. Velocity is directly proportional to flow and inversely proportional to cross-sectional area. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 148

**504.** B — Correct. Once the critical Reynolds number is exceeded, energy is wasted in eddies and flow falls below the laminar line.

**505.** B — Correct. Q = 90 cm³/s, and v = Q/A = 90/3000 = 0.03 cm/s, so velocity falls a thousandfold.

**506.** B — Correct. The slide states the heart pumps blood while the vessels transport it to all body regions.

**507.** C — Correct. 1/Rx = 1/20 + 1/5 = 0.25, so Rx = 4 and Q = 50/4 = 12.5 L/min (10 through the low-resistance bed and 2.5 through the other).

**508.** B — Correct. v = Re·η/(ρd) = 3000 × 0.0035 / (1060 × 0.025) ≈ 0.396 m/s.

**509.** C — Correct. The slope of the Q-versus-ΔP line is 1/R, so lower resistance means a steeper line.

**510.** B — Correct. The pressure pushes equally on the wall in every direction, not only along the flow.

## 4. Set 4 · Q31–40

Aneurysm mechanism · Hard

**511. Using the Laplace law, why does an aneurysm tend to keep enlarging once it forms?**

**A** A larger radius lowers wall tension, which lets the wall relax and balloon

**B** A larger radius raises blood viscosity, which pushes on the wall more

**C** A larger radius makes the flow laminar, which weakens the endothelium

**D** A larger radius raises wall tension at the same pressure, which stretches the wall further Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 138

Velocity and area · Medium

**512. In the tube drawing, flow Q = 10 mL/s passes through segments with cross-sectional areas of 2, 10 and 1 cm². What are the velocities in these segments?**

**A** 0.2 cm/s, 1 cm/s and 0.1 cm/s

**B** 20 cm/s, 100 cm/s and 10 cm/s

**C** 5 cm/s, 10 cm/s and 1 cm/s

**D** 5 cm/s, 1 cm/s and 10 cm/s

Mean laminar velocity · Devil

**513. In laminar flow with a parabolic profile, the mean velocity is half the axial maximum. If the axial velocity in an aorta of area 3 cm² is 60 cm/s, what is the flow?**

**A** 10.8 L/min

**B** 5.4 L/min

**C** 2.7 L/min

**D** 21.6 L/min

False statement: viscosity · Devil

**514. Which statement about blood viscosity is FALSE?**

**A** Blood is a Newtonian fluid, so its viscosity is the same at every shear rate

**B** Viscosity rises steeply as haematocrit increases

**C** Apparent viscosity falls in tubes of about 6 to 8 µm diameter

**D** Viscosity is measured in poise or in Pa·s

Wall shear stress · Devil

**515. Blood of viscosity 3.5 mPa·s flows at 5 mL/s in a vessel of radius 2 mm. Using wall shear stress = 4ηQ/(πr³), what is the value?**

**A** About 5.6 Pa

**B** About 0.35 Pa

**C** About 28 Pa

**D** About 2.8 Pa

Reynolds calculation · Hard

**516. For blood with ρ = 1060 kg/m³ and η = 3.5 mPa·s flowing at 0.5 m/s in a vessel of internal diameter 2 cm, what is the Reynolds number and what does it imply?**

**A** About 3030, just above the turbulence threshold

**B** About 1510, which keeps the flow laminar

**C** About 303, which keeps the flow laminar

**D** About 30 300, which means gross turbulence

Stenosis and bruit · Devil

**517. Flow in a carotid artery has Re = 1800. At constant flow, plaque narrows the lumen diameter to one third. What is Re at the stenosis and what is the clinical consequence?**

**A** 16 200, which is gross turbulence due to the ninefold velocity

**B** 600, which keeps the flow silent and laminar

**C** 5400, turbulence that may be heard as a bruit

**D** 1800, which stays laminar and has no effect

Lowering Reynolds number · Devil

**518. Which single change would LOWER the Reynolds number in a blood vessel, making turbulence less likely?**

**A** A rise in the mean velocity of flow

**B** A rise in haematocrit that increases blood viscosity

**C** A widening of the internal diameter of the vessel

**D** A rise in the density of the blood Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 139

Compliance calculation · Hard

**519. A vein segment takes up 150 mL as pressure rises from 10 to 40 mmHg. Using C = ΔV/ΔP, what is its compliance?**

**A** 5 mL/mmHg

**B** 0.2 mL/mmHg

**C** 3.75 mL/mmHg

**D** 15 mL/mmHg

Velocity profile · Medium

**520. In the parabolic velocity profile of laminar blood flow, where is the velocity highest and lowest?**

**A** Highest at the vessel wall and zero at the centre of the lumen

**B** Equal across the whole lumen, like a plug moving as one

**C** Highest at the centre of the lumen and zero at the vessel wall

**D** Highest just inside the wall and lowest at the centre

## Answers — Set 4 · Q31–40

**511.** D — Correct. T = P × R, so as R rises the tension rises, causing more stretch and a positive feedback loop.

**512.** D — Correct. v = Q/A gives 10/2 = 5, 10/10 = 1 and 10/1 = 10 cm/s.

**513.** B — Correct. Mean v = 30 cm/s, Q = 3 × 30 = 90 mL/s, which equals 5.4 L/min.

**514.** A — Correct choice, since this is the false statement. Blood is non-Newtonian: red cell aggregation at low shear raises its viscosity, and the viscosity falls as shear rises.

**515.** D — Correct. $\tau = 4 \times 0.0035 \times 5\times10^{-6} / (\pi \times (2\times10^{-3})^3) \approx 2.79$ Pa.

**516.** A — Correct. $Re = \rho vd/\eta = 1060 \times 0.5 \times 0.02 / 0.0035 \approx 3029$, which exceeds 3000.

**517.** C — Correct. Area falls ninefold, so v rises ×9, and d falls to 1/3, so Re = 1800 × 9 / 3 = 5400, above 3000.

**518.** B — Correct. $Re = \rho vd/\eta$, so a rise in viscosity lowers Re while all other factors are held constant.

**519.** A — Correct. $\Delta P = 30$ mmHg, so C = 150/30 = 5 mL/mmHg.

**520.** C — Correct. The concentric layers move fastest in the middle (Vmax) and the layer at the wall has V = 0.

## 5. Set 5 · Q41–50

Cannula gauge · Devil

**521. A phlebotomist replaces a 21G cannula (internal radius 0.4 mm) with an 18G cannula (internal radius 0.6 mm), of the same length, using the same pressure and fluid. By what factor does the flow rise?**

**A** About 3.4 times

**B** About 2.25 times

**C** About 1.5 times

**D** About 5.1 times

Hematocrit · Medium

**522. How do anaemia and polycythaemia change blood viscosity and therefore resistance to flow?**

**A** Anaemia raises viscosity and resistance, while polycythaemia lowers both

**B** Both conditions lower viscosity because plasma volume is altered

**C** Anaemia lowers viscosity and resistance, while polycythaemia raises both

**D** Neither condition affects viscosity because plasma viscosity is fixed

Resistance equation · Easy

**523. Which expression gives the resistance to blood flow from Poiseuille's equation, and which variable has the most powerful effect?**

**A** $R = \pi r^4 / 8\eta l$, and the length has the most powerful effect

**B** $R = 8\eta r / \pi l^4$, and the viscosity has the most powerful effect

**C** $R = 8\eta l / \pi r^4$, and the radius has the most powerful effect

**D** $R = 8\pi\eta l / r^2$, and the radius has a squared effect

Polycythaemia and pressure · Devil

**524. Cardiac output stays constant at 5 L/min and vessel dimensions are unchanged. Polycythaemia raises blood viscosity by 40%. If the pressure gradient was 90 mmHg, what is it now?**

**A** 64 mmHg

**B** 130 mmHg

**C** 126 mmHg

**D** 144 mmHg

False statement: laminar flow · Devil

**525. Which statement about laminar flow is FALSE?**

**A** The velocity profile is parabolic with the maximum velocity on the axis

**B** Layers at the wall move fastest because the endothelium drags them along

**C** Fluid moves in parallel concentric layers sliding over each other

**D** It is favoured when the Reynolds number is low, below about 2000 Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 140

Ohm's law · Easy

**526. Ohm's law, as stated in the lecture, says that the current through a conductor between two points is:**

**A** Inversely proportional to the voltage across the two points

**B** Proportional to the square of the length of the conductor between them

**C** Directly proportional to the voltage across the two points

**D** Independent of voltage and determined only by the conductor temperature

Fluid RC time constant · Devil

**527. A compliant vessel has resistance 1.5 mmHg·s/mL and capacitance (compliance) 2 mL/mmHg. By analogy with an electrical RC circuit, what is its time constant?**

**A** 0.75 s

**B** 1.33 s

**C** 3.0 s

**D** 6.0 s

Compensating for viscosity · Hard

**528. If blood viscosity doubles, by what factor must the vessel radius increase to restore the original flow at the same ΔP and length?**

**A** About 41% larger

**B** About 100% larger

**C** About 50% larger

**D** About 19% larger

Fahraeus-Lindqvist · Medium

**529. According to the Fahraeus-Lindqvist effect, what happens to the apparent viscosity of blood as the tube diameter shrinks toward the capillary range?**

**A** It increases steadily as the tube becomes narrower

**B** It decreases, reaching a minimum at roughly 6 to 8 μm

**C** It stays constant because blood is a Newtonian fluid

**D** It decreases until it reaches zero in the smallest capillaries

Poiseuille numeric · Hard

**530. Using $Q = \pi \Delta P\, r^4 / (8\eta l)$, what is the flow in a tube of radius 0.5 mm and length 10 cm with $\Delta P = 100$ Pa and $\eta = 3.5$ mPa·s?**

**A** About 112 μL/s

**B** About 0.44 μL/s

**C** About 7 μL/s

**D** About 7 mL/s

### Answers — Set 5 · Q41–50

**521.** D — Correct. $Q \propto r^4$, so $(0.6/0.4)^4 = 1.5^4 \approx 5.06$.

**522.** C — Correct. Viscosity rises steeply with haematocrit and resistance is proportional to viscosity.

**523.** C — Correct. Because r is raised to the fourth power, small changes in radius dominate the resistance.

**524.** C — Correct. $\Delta P = Q \times R$, and $R \propto \eta$, so $\Delta P = 90 \times 1.4 = 126$ mmHg.

**525.** B — Correct choice, since this is the false statement. The wall layer is held almost stationary by friction, and the fastest layer is on the axis.

**526.** C — Correct. I is proportional to V, and its fluid analogue is flow being proportional to the pressure difference.

**527.** C — Correct. $\tau = R \times C = 1.5 \times 2 = 3.0$ s, and the units cancel to seconds.

**528.** D — Correct. Flow $\propto r^4/\eta$, so $r^4$ must double, giving r × 2^(1/4) = 1.19.

**529.** B — Correct. The slide states apparent viscosity falls as the tube narrows and reaches a minimum around 6 to 8 μm.

**530.** C — Correct. $Q = \pi \times 100 \times (5\times10^{-4})^4 / (8 \times 0.0035 \times 0.1) \approx 7.0\times10^{-9}$ m³/s = 7 μL/s.

## 6. Set 6 · Q51–60

Parallel occlusion · Hard

**531. Four identical vessels supply a tissue in parallel at constant ΔP. If one vessel is totally blocked, total flow becomes:**

**A** 25% of the original value

**B** 75% of the original value

**C** 67% of the original value

**D** 50% of the original value

Pressure drop site · Hard

**532. Why does the largest fall in mean arterial pressure occur across the arterioles?**

**A** Their walls are thicker than the aorta so they absorb pressure as elastic energy

**B** Their blood has the highest viscosity of any vessel in the circulation

**C** Their total cross-section is the largest so the pressure spreads out

**D** Their small radius gives a very high resistance because $R \propto 1/r^4$ Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 141

Shear thinning · Medium

**533. On the viscosity versus shear-rate curve, what happens to blood viscosity as shear rate rises, and why?**

**A** It rises as red cells clump together at higher shear

**B** It falls toward a plateau as red cell aggregates break up and cells align

**C** It stays constant, as blood behaves as a Newtonian fluid

**D** It falls to zero as plasma separates from the cells

Kinetic energy in stenosis · Hard

**534. At constant flow, a segment of artery narrows to half its radius. By what factor does the kinetic energy per unit volume of blood rise in the narrowing?**

**A** 4 times

**B** 8 times

**C** 16 times

**D** 2 times

Poiseuille radius · Hard

**535. A vessel is constricted so that its radius falls by 20% while length, viscosity and pressure gradient are unchanged. Flow becomes about:**

**A** 41% of the original value

**B** 64% of the original value

**C** 51% of the original value

**D** 80% of the original value

Reynolds number · Easy

**536. Above what Reynolds number does the lecture say turbulence will occur?**

**A** Greater than 30

**B** Greater than 300

**C** Greater than 3000

**D** Greater than 30 000

Selective dilation · Devil

**537. Four identical parallel beds each have R = 8 units. One bed dilates so that its resistance falls to 4 units, with the same ΔP. By how much does total flow rise?**

**A** 50%

**B** 12.5%

**C** 100%

**D** 25%

Viscosity definition · Medium

**538. Newton's definition of viscosity in the lecture is η = shear stress / shear rate. What does this tell us?**

**A** Viscosity is the internal friction that slows a fluid's flow, measured in poise

**B** Viscosity is the pressure needed to open a vessel, measured in mmHg

**C** Viscosity is the speed of the fastest layer, measured in cm/s

**D** Viscosity is the volume of fluid per second, measured in L/min

Fahraeus-Lindqvist mechanism · Hard

**539. Which mechanism best explains the fall in apparent viscosity in narrow tubes (Fahraeus-Lindqvist effect)?**

**A** Red cells migrate to the axis, leaving a low-viscosity plasma layer by the wall

**B** Red cells lyse in narrow tubes, so that haemoglobin lowers the viscosity

**C** The plasma proteins are filtered out at the wall and thin the blood

**D** Shear forces at the wall freeze the outer layer, leaving a thin lumen Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 142

Laplace law · Easy

**540. According to the lecture, the Laplace law states that the tension in the walls of a container depends on:**

**A** The viscosity of the contents and the length of the container only

**B** The velocity of the contents and the density of the container wall

**C** The temperature of the contents and the colour of the wall material

**D** Both the pressure of the container's contents and its radius

## Answers — Set 6 · Q51–60

**531.** B — Correct. Conductance is proportional to the number of open vessels, so 3 of 4 gives 3/4.

**532.** D — Correct. Arterioles are the main resistance vessels, so most of the pressure is dissipated across them.

**533.** B — Correct. At low shear, red cells aggregate and viscosity is high; at high shear they disperse, deform and align, reaching about 3.5 mPa·s.

**534.** C — Correct. Area falls to a quarter, so v rises fourfold, and KE $\propto v^2$ gives $4^2 = 16$.

**535.** A — Correct. $Q \propto r^4$, so $(0.8)^4 = 0.41$, which is a fall of roughly 59%.

**536.** C — Correct. The slide says that Re greater than 3000 means turbulence will occur.

**537.** D — Correct. Conductance goes from 4/8 = 0.5 to 3/8 + 1/4 = 0.625, so total R falls from 2 to 1.6 and flow rises by 2/1.6 = 1.25.

**538.** A — Correct. It is the mechanical property resisting flow, expressed as force per area divided by velocity gradient.

**539.** A — Correct. Axial accumulation of red cells creates a cell-poor plasma sleeve, which lowers the effective viscosity in the tube.

**540.** D — Correct. Wall tension T = P × R for a cylinder, so it depends on internal pressure and radius.

## 7. Set 7 · Q61–70

False statement: analogies · Devil

**541. Which statement about the hydraulic-electrical analogy is FALSE?**

**A** Pressure difference is analogous to voltage and flow is analogous to current

**B** Fluid capacitance is analogous to electrical resistance because both oppose steady flow

**C** Volume is analogous to electrical charge

**D** Vessels in series add their resistances, as resistors in series do

Atherosclerosis · Medium

**542. Which change at a plaque-narrowed artery section follows from continuity and Bernoulli's principle?**

**A** Velocity falls and static pressure rises at the narrowing

**B** Velocity and static pressure both rise at the narrowing

**C** Velocity and static pressure are unchanged at the narrowing

**D** Velocity rises and static pressure falls at the narrowing

Poiseuille law · Easy

**543. Poiseuille's law says the steady flow through a narrow tube varies directly as the pressure and the fourth power of the radius, and inversely as:**

**A** The density of the fluid and the cross-sectional area of the tube

**B** The length of the tube and the coefficient of viscosity

**C** The wall thickness of the tube and the temperature of the fluid

**D** The tension in the wall and the pressure outside the tube

Laplace sphere · Medium

**544. For the same internal pressure P and radius R, how does wall tension in a spherical vessel compare with a cylindrical vessel?**

**A** It is twice as great, T = 2PR against T = PR

**B** It is the same, because both have the same P and R

**C** It is half as great, T = PR/2 against T = PR

**D** It is four times smaller, T = PR/4 against T = PR

Pressure gradient · Easy

**545. The pressure gradient (ΔP) along a vessel is correctly written as:**

**A** $\Delta P = P_1 - P_2$, expressed in mmHg

**B** $\Delta P = P_1 + P_2$, expressed in mmHg

**C** $\Delta P = P_1 \times P_2$, expressed in $mmHg^2$

**D** $\Delta P = P_1 \div P_2$, expressed in mmHg

Turbulent flow law · Hard

**546. In the turbulent regime, flow rises roughly with the square root of the pressure gradient. If ΔP is quadrupled, flow in that regime:**

**A** Roughly quadruples

**B** Roughly doubles

**C** Rises by about 40%

**D** Rises about eightfold Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 143

Total peripheral resistance · Hard

**547. Mean arterial pressure is 93 mmHg, right atrial pressure is 3 mmHg and cardiac output is 5 L/min. What is the total peripheral resistance?**

**A** 18.6 mmHg·min/L

**B** 0.056 mmHg·min/L

**C** 450 mmHg·min/L

**D** 18 mmHg·min/L

Fluid capacitance · Easy

**548. In the fluid-electrical analogy table, fluid capacitance is defined as:**

**A** C = ΔP/Q, the pressure change per unit flow

**B** C = ΔP/ΔV, the pressure change per unit volume change

**C** C = Q × ΔP, the flow multiplied by the pressure change

**D** C = ΔV/ΔP, the volume change per unit pressure change

Bernoulli principle · Easy

**549. Bernoulli's principle states that an increase in the speed of a fluid occurs simultaneously with:**

**A** A decrease in static pressure or a decrease in the fluid's potential energy

**B** An increase in static pressure and an increase in the fluid's potential energy

**C** An increase in the tube length and a decrease in the viscosity of the fluid

**D** A decrease in the fluid's kinetic energy while its static pressure is unchanged

Radius and flow · Medium

**550. In the lecture example at the same pressure of 100 mmHg, tubes of diameter 1, 2 and 4 carry 1, 16 and 256 mL/min. What does this show?**

**A** Flow rises in direct proportion to the radius at constant pressure

**B** Flow rises with the square of the radius at constant pressure

**C** Flow rises with the cube of the radius at constant pressure

**D** Flow rises with the fourth power of the radius at constant pressure

## Answers — Set 7 · Q61–70

**541.** B — Correct choice, since this is the false statement. Capacitance stores volume, as electrical capacitance stores charge, whereas resistance corresponds to vascular resistance.

**542.** D — Correct. The same flow through a smaller area needs a higher velocity, and the extra kinetic energy comes at the expense of pressure.

**543.** B — Correct. $Q = \pi \Delta P\, r^4 / (8\eta l)$, so flow falls with longer tubes and more viscous fluid.

**544.** C — Correct. The lecture gives T = PR for a cylinder and T = PR/2 for a sphere.

**545.** A — Correct. It is the difference between pressure at the beginning and at the end of the vessel.

**546.** B — Correct. $Q \propto \sqrt{\Delta P}$, and $\sqrt{4} = 2$, which is why turbulence is so inefficient compared with laminar flow.

**547.** D — Correct. $R = \Delta P/Q = (93 - 3)/5 = 18$ mmHg·min/L.

**548.** D — Correct. Compliance or capacitance of a vessel tells how much volume it stores for a given pressure rise.

**549.** A — Correct. This is the energy-conservation trade-off between kinetic energy and pressure/potential energy.

**550.** D — Correct. Doubling the diameter multiplies the flow by $2^4 = 16$, and the next doubling gives 256.

## 8. Set 8 · Q71–80

Focal stenosis resistance · Devil

**551. The middle third of a uniform artery is narrowed to half its radius, with length, viscosity and the rest of the artery unchanged. By what factor does the total resistance of the artery rise?**

**A** 6 times

**B** 16 times

**C** 5.3 times

**D** 2 times

Cardiac output · Easy

**552. In the lecture, blood flow in the whole circulation is equated to the cardiac output. Cardiac output equals:**

**A** Stroke volume ÷ heart rate

**B** Stroke volume + heart rate

**C** Mean arterial pressure × heart rate

**D** Stroke volume × heart rate

Laplace comparison · Hard

**553. An aorta (radius 1.25 cm, pressure 100 mmHg) and a capillary (radius 4 µm, pressure 25 mmHg) are compared using T = P × R. How many times greater is the aortic wall tension?**

**A** About 1250 times

**B** About 125 000 times

**C** About 12 500 times

**D** About 500 times

Laminar flow · Easy

**554. How does the lecture characterise laminar blood flow?**

**A** Smooth, regular patterns of particles moving in parallel layers

**B** Chaotic swirling motion with eddy currents in every direction

**C** Flow that reverses direction with each heartbeat in all vessels

**D** Flow that occurs only when the vessel diameter is exactly 1 mm Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 144

Hydrostatic pressure · Devil

**555. A standing person has a mean arterial pressure of 100 mmHg at heart level. Using ρ = 1060 kg/m³ and g = 9.81 m/s², what is the pressure in an artery of the foot 1.3 m below the heart, ignoring flow?**

**A** About 200 mmHg

**B** About 100 mmHg

**C** About 130 mmHg

**D** About 0 mmHg

Flow and pressure gradient · Easy

**556. On the slide, vessel 1 has ΔP = 40 mmHg and vessel 2 has ΔP = 80 mmHg (same resistance). What is the flow in vessel 2 compared with vessel 1?**

**A** Half as great, because flow is inversely proportional to ΔP

**B** Twice as great, because flow is directly proportional to ΔP

**C** Four times as great, because flow is proportional to ΔP squared

**D** The same, because flow depends only on the absolute pressure at the start

Blood flow · Easy

**557. Blood flow (Q) is defined as the quantity of blood passing a given point in the circulation per unit time. Which expression and unit is correct?**

**A** Q = time ÷ volume, commonly in min/L

**B** Q = pressure × time, commonly in mmHg·s

**C** Q = volume ÷ time, commonly in L/min

**D** Q = distance ÷ time, commonly in cm/s

Viscosity and radius · Hard

**558. In polycythaemia, viscosity rises by 50%. If compensatory dilation widens the radius by 10% at the same ΔP and length, what happens to flow?**

**A** About 46% higher than before

**B** About 33% lower than before

**C** Almost unchanged, about 2% lower

**D** About 10% higher than before

Series resistance · Easy

**559. Using the series-resistance slide, with R = 20, 50, 20, 6 and 4 for the segments in sequence, what is the total resistance?**

**A** 20

**B** 5

**C** 0.2

**D** 100

Poiseuille combined · Hard

**560. A vessel has both its radius and its length doubled, with the same viscosity and the same pressure gradient. What happens to the flow?**

**A** It rises sixteenfold

**B** It rises eightfold

**C** It rises fourfold

**D** It remains unchanged

## Answers — Set 8 · Q71–80

**551.** A — Correct. The narrowed third has 16 times its old resistance, so the total is 2/3 + (1/3 × 16) = 6 times the original.

**552.** D — Correct. Each beat ejects a stroke volume and the product with beats per minute gives L/min.

**553.** C — Correct. (100 × 12 500 µm) / (25 × 4 µm) = 1 250 000 / 100 = 12 500, which explains why capillaries survive with a wall of endothelium only.

**554.** A — Correct. Laminar flow has concentric layers sliding smoothly, and it helps reduce energy losses.

**555.** A — Correct. ρgh = 1060 × 9.81 × 1.3 ≈ 13 520 Pa ≈ 101 mmHg, which adds to 100 mmHg at heart level.

**556.** B — Correct. $Q \propto \Delta P$, so doubling the gradient from 40 to 80 mmHg doubles the flow.

**557.** C — Correct. Flow is volume per unit time; at the level of the whole body it is the cardiac output in L/min.

**558.** C — Correct. Flow $\propto r^4/\eta = (1.1)^4 / 1.5 = 1.464 / 1.5 \approx 0.976$.

**559.** D — Correct. In series the resistances add: 20 + 50 + 20 + 6 + 4 = 100.

**560.** B — Correct. The $r^4$ term gives ×16 and the doubled length gives ÷2, so the net change is 16/2 = 8.

**Module 8: Lecture 8 — Bioelectricity** — 80 questions

## 1. Set 1 · Q1–10

Ion channels · Devil

**561. Which statement about membrane ion channels is FALSE?**

**A** active channels are subdivided into transmitter-gated and voltage-gated

**B** passive leakage channels open or close in response to various signals

**C** each channel type is selective for the ions it lets pass

**D** open gated channels let ions diffuse along their electrochemical gradient

Definition · Easy

**562. Bioelectricity is best defined as:**

**A** electrical currents and potentials generated by or occurring within living cells, tissues and organisms

**B** electrical power supplied to hospital equipment from the national grid

**C** static charge that accumulates on the skin of a patient in dry weather

**D** electromagnetic radiation emitted by laboratory analysers and monitors

Hyperkalemia · Hard

**563. In a patient whose extracellular K+ rises from 5 mM to 8 mM ([K+]i = 140 mM, RT/F = 26.7 mV), E(K) changes by about:**

**A** -13 mV, from -89 mV to -102 mV, moving cells away from threshold

**B** +13 mV, from -89 mV to -76 mV, moving cells away from threshold

**C** +26 mV, from -89 mV to -63 mV, bringing cells closer to threshold

**D** +13 mV, from -89 mV to -76 mV, bringing cells closer to threshold

Action potential · Medium

**564. The lecture states that the nerve impulse is always the same regardless of the type or source of stimulus. This means that:**

**A** a stronger stimulus makes the action potential taller

**B** a weaker stimulus makes the action potential slower

**C** only electrical stimuli can produce an action potential

**D** a stronger stimulus does not make a bigger action potential

Lab application · Devil

**565. A pathologist reviews an ECG, an EMG and an EEG from three patients. Which pairing of finding and test is correct?**

**A** a missing P wave is a finding of the EEG

**B** delayed ventricular repolarization is shown by the P wave

**C** brain wave patterns are assessed using the EMG

**D** slowed conduction with scattered signals in neuropathy is seen on EMG

Nernst equation · Devil

**566. At 20 °C (RT/F = 25.3 mV) rather than 37 °C (26.7 mV), E(K) for [K+]o = 5 mM and [K+]i = 140 mM is closest to:**

**A** -89 mV, unchanged because temperature does not enter

**B** -94 mV, a larger magnitude because RT/F is smaller

**C** -84 mV, a smaller magnitude because RT/F is smaller

**D** -84 mV, a smaller magnitude because the ratio changes

Goldman equation · Medium

**567. In the Goldman expression, the chloride terms are written as [Cl]i in the numerator and [Cl]o in the denominator because:**

**A** Cl- is an anion, so its concentration ratio is inverted relative to cations

**B** Cl- is actively pumped in the opposite direction by the Na+/K+ pump

**C** Cl- concentration is always higher inside the cell

**D** the permeability of Cl- is negative Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 157

EMG electrodes · Medium

**568. What is the main disadvantage of surface electrodes in EMG?**

**A** they cannot detect any electrical activity from muscle

**B** they are painful because they penetrate the skin

**C** they suit only superficial muscle and pick up activity over too wide an area

**D** they record only the heart rhythm

Action potential · Easy

**569. The total amplitude of an action potential, from -70 mV to +30 mV, is:**

**A** 100 mV

**B** 30 mV

**C** 70 mV

**D** 140 mV

Ohm's law · Hard

**570. A single open channel passes 2 pA of current and the local membrane resistance is 50 GΩ. The voltage change V = I × R is:**

**A** 100 mV

**B** 10 mV

**C** 1 V

**D** 25 mV

## Answers — Set 1 · Q1–10

**561.** B — This is false: passive leakage channels are always open; it is the active (gated) channels that open and close in response to signals.

**562.** A — This is the lecture definition: currents and potentials arising within living cells, tissues and organisms.

**563.** D — E(K) at 8 mM = 26.7 × ln(8/140) = -76.4 mV; this is about 13 mV less negative, so the resting potential moves toward threshold.

**564.** D — The action potential is constant in size once threshold is reached, whatever the stimulus.

**565.** D — The lecture says peripheral neuropathy scatters and desynchronizes EMG signals because regenerating fibers conduct slowly.

**566.** C — E(K) = 25.3 × ln(5/140) = 25.3 × (-3.33) ≈ -84 mV; the concentration ratio is unchanged, only the RT/F prefactor falls with temperature.

**567.** A — For an anion the sign of the charge flips the ratio, giving inside over outside.

**568.** C — Surface electrodes only reach superficial muscles and lack spatial selectivity.

**569.** A — From -70 mV to +30 mV is a swing of 100 mV.

**570.** A — V = 2 × 10^-12 A × 50 × 10^9 Ω = 0.1 V = 100 mV.

## 2. Set 2 · Q11–20

Nernst equation · Medium

**571. In E(K) = (RT/nF) ln([K]o/[K]i), what does the term n represent?**

**A** the valence of the ion, which is +1 for K+

**B** the number of potassium channels in the membrane

**C** the number of moles of K+ in the cell

**D** the number of action potentials per second

Goldman equation · Devil

**572. Using PK : PNa : PCl = 1 : 1/75 : 1 with [K+]o 5/[K+]i 140, [Na+]o 145/[Na+]i 12, [Cl-]o 110/[Cl-]i 10 mM and RT/F = 26.7 mV, the Goldman potential is closest to:**

**A** -72 mV

**B** -80 mV

**C** -64 mV

**D** -89 mV

Depolarizing phase · Medium

**573. During the depolarizing phase of an action potential:**

**A** sodium permeability increases and the membrane potential reverses

**B** potassium permeability increases and sodium permeability decreases

**C** all voltage-gated channels are closed

**D** the Na+/K+ pump stops working

Nernst equation · Devil

**574. Calcium ([Ca2+]o = 2 mM, [Ca2+]i = 0.0001 mM, n = +2) at 37 °C (RT/F = 26.7 mV) has an equilibrium potential of about:**

**A** +264 mV

**B** +66 mV

**C** -132 mV

**D** +132 mV

EEG/ENG · Devil

**575. Which statement is TRUE about EEG and related recordings?**

**A** an EEG resolves the activity of single neuron groups with very high resolution

**B** an EMG records neuron activity of the brain through scalp sensors

**C** an EEG is a type of ENG that records general brain activity without distinguishing groups of neurons

**D** an ENG is recorded only from the heart through the skin Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 158

Neuropathy · Medium

**576. In peripheral neuropathy the EMG signals become scattered and desynchronized because:**

**A** regenerating fibers conduct faster than healthy axons

**B** all motor units fire exactly together

**C** muscle fibers stop having any membrane potential

**D** regenerating fibers conduct slowly and affected neurons are harder to excite

Electrochemical gradient · Medium

**577. The electrochemical gradient that drives ion movement through an open channel is made of:**

**A** an electrical gradient and a chemical (concentration) gradient combined

**B** a thermal gradient and a pressure gradient combined

**C** a chemical gradient only, since charge does not matter

**D** an electrical gradient only, since concentration does not matter

ENG velocity · Devil

**578. Two stimulation points are 18 cm apart. Latencies are 7.5 ms and 4.5 ms. The conduction velocity is:**

**A** 60 m/s

**B** 6 m/s

**C** 600 m/s

**D** 24 m/s

Resting potential · Easy

**579. In the resting state the neuron membrane is described as:**

**A** depolarized, with the cytoplasmic side positive

**B** hyperpolarized, with no ion movement

**C** polarized, with the cytoplasmic side negative

**D** unpolarized, with equal charge on both sides

Na+/K+ pump · Easy

**580. The sodium-potassium pump helps maintain the ionic difference by:**

**A** actively moving Na+ into the cell and K+ out of the cell

**B** actively moving Na+ out of the cell and K+ into the cell

**C** passively letting Na+ and K+ flow down their gradients

**D** moving large anionic proteins across the membrane

### Answers — Set 2 · Q11–20

**571.** A — n is the charge number (valence) of the ion; for K+ it is +1.

**572.** A — Ratio = (5 + 1.93 + 10)/(140 + 0.16 + 110) = 16.93/250.16 = 0.0677; 26.7 × ln(0.0677) ≈ -72 mV.

**573.** A — Na+ entry causes the rapid rise and reversal toward +30 mV.

**574.** D — E(Ca) = (26.7/2) × ln(2/0.0001) = 13.35 × 9.90 ≈ +132 mV.

**575.** C — The lecture describes EEG as a particular ENG with several head electrodes and no high resolution of separate neuron groups.

**576.** D — Slow conduction and altered excitability delay and spread arrival of impulses at the muscle.

**577.** A — Ions move toward opposite charge (electrical) and from high to low concentration (chemical); the net drive is both together.

**578.** A — v = 0.18 m ÷ 0.003 s = 60 m/s (equal to 6 cm/ms).

**579.** C — At rest there is a steady potential difference across the membrane, so the membrane is polarized.

**580.** B — The pump uses energy to export Na+ and import K+, maintaining the gradients.

## 3. Set 3 · Q21–30

Threshold · Medium

**581. If the resting potential is -70 mV and threshold lies +15 to +20 mV above it, the neuron must depolarize to about:**

**A** -85 to -90 mV

**B** -55 to -50 mV

**C** +15 to +20 mV

**D** -15 to -20 mV

Resting permeability · Medium

**582. At rest the membrane is about 75 times more permeable to K+ than to Na+. What is the main consequence?**

**A** the resting potential lies close to the Na+ equilibrium potential

**B** the resting potential lies close to the K+ equilibrium potential

**C** the resting potential is exactly 0 mV

**D** the resting potential cannot be negative

Hyperpolarization · Easy

**583. Hyperpolarization is best described as:**

**A** a decrease in membrane potential, making the inside less negative

**B** a reversal of the potential to positive values

**C** the opening of all sodium channels

**D** an increase in membrane potential, making the inside more negative Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 159

Repolarizing phase · Medium

**584. The repolarizing phase of the action potential is caused by:**

**A** increased sodium permeability and decreased potassium permeability

**B** decreased sodium permeability and increased potassium permeability

**C** increased chloride permeability alone

**D** closing of all potassium channels

Threshold · Hard

**585. A neuron hyperpolarizes from -70 mV to -85 mV. Taking threshold as about -55 to -50 mV (fixed absolute values), how much extra depolarization is now needed to reach threshold?**

**A** 15 to 20 mV

**B** 30 to 35 mV

**C** 45 to 50 mV

**D** 10 to 15 mV

Ions vs electrons · Easy

**586. What is the key difference between bioelectric current and the current used to produce light, heat or power?**

**A** bioelectric current is a flow of electrons, whereas standard electricity is a flow of ions

**B** bioelectric current is a flow of ions, whereas standard electricity is a movement of electrons

**C** bioelectric current is carried by protons only, whereas standard electricity uses neutrons

**D** bioelectric current flows one way only, whereas standard electricity always alternates

Nernst equation · Hard

**587. A patient with a low plasma K+ of 2 mM has [K+]i = 140 mM. Using RT/F = 26.7 mV at 37 °C, E(K) is closest to:**

**A** -89 mV

**B** -70 mV

**C** -113 mV

**D** +113 mV

ENG neuropathy · Hard

**588. In a segment 0.24 m long, healthy fibers conduct at 60 m/s. If regenerating fibers conduct at 30 m/s over the same segment and distance, the latency difference between the two points:**

**A** halves, from 4 ms to 2 ms

**B** doubles, from 4 ms to 8 ms

**C** stays at 4 ms because distance is unchanged

**D** rises from 4 ms to 16 ms

Ion balance · Medium

**589. Why are negatively charged proteins (A-) important in the cell cytosol?**

**A** they carry the Na+ out of the cell during the pump cycle

**B** they make the membrane freely permeable to chloride

**C** they balance the positive charge of intracellular cations, mainly K+

**D** they open voltage-gated sodium channels at threshold

Action potential · Easy

**590. Which list gives the four main phases of an action potential in order?**

**A** resting state, repolarizing phase, depolarizing phase, undershoot

**B** resting state, depolarizing phase, repolarizing phase, undershoot

**C** depolarizing phase, resting state, undershoot, repolarizing phase

**D** undershoot, resting state, depolarizing phase, repolarizing phase

### Answers — Set 3 · Q21–30

**581.** B — -70 + 15 = -55 mV and -70 + 20 = -50 mV.

**582.** B — The ion with the higher permeability dominates, so the resting potential sits near E(K), which is negative.

**583.** D — In hyperpolarization the inside becomes more negative than the resting potential. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 170

**584.** B — Sodium entry stops while K+ leaves, restoring the negative interior.

**585.** B — From -85 mV to -55 mV is 30 mV and to -50 mV is 35 mV.

**586.** B — In living tissue the charge carriers are ions such as Na+ and K+; in wires they are free electrons.

**587.** C — E(K) = 26.7 × ln(2/140) = 26.7 × (-4.25) ≈ -113 mV, more negative than the normal value.

**588.** B — Time = distance ÷ velocity: 0.24/60 = 4 ms and 0.24/30 = 8 ms, so slowing velocity by half doubles the conduction time.

**589.** C — A- are trapped inside because the membrane is impermeable to them, and they offset intracellular K+.

**590.** B — The lecture lists resting state, depolarizing phase, repolarizing phase and undershoot.

## 4. Set 4 · Q31–40

Threshold · Hard

**591. A neuron at rest (-70 mV) has threshold +15 to +20 mV above rest. A stimulus depolarizes it by 12 mV and then, in a separate trial, by 18 mV. What follows?**

**A** an action potential at both; the larger one is bigger

**B** no action potential at either; the neuron needs 100 mV

**C** a small action potential at 12 mV and a full one at 18 mV

**D** no action potential at 12 mV; an action potential is likely at 18 mV Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 160

Ion balance · Medium

**592. In the extracellular fluid, the positive charge of Na+ and other cations is balanced chiefly by:**

**A** potassium ions (K+)

**B** negatively charged cytoplasmic proteins

**C** bicarbonate ions only

**D** chloride ions (Cl-)

Nernst equation · Devil

**593. Extracellular Na+ is reduced to half (72.5 mM) while the intracellular value stays 12 mM. How does E(Na) change at 37 °C (RT/F = 26.7 mV)?**

**A** it falls by about 37 mV, from +66.5 to +29 mV

**B** it falls by about 18.5 mV, from +66.5 to +48 mV

**C** it rises by about 18.5 mV, from +66.5 to +85 mV

**D** it stays unchanged, because the cell is permeable to Na+

Goldman equation · Devil

**594. If the K+ : Na+ permeability ratio doubles from 75 : 1 to 150 : 1 (chloride ignored, standard concentrations, RT/F = 26.7 mV), the potential changes from about -80 mV to about:**

**A** -84 mV, hyperpolarizing slightly toward E(K)

**B** -89 mV, exactly E(K)

**C** -75 mV, depolarizing slightly

**D** -160 mV, doubling the value

Neuropathy · Devil

**595. Motor units conduct at speeds ranging from 20 to 60 m/s over a 0.24 m segment. The spread in arrival time between fastest and slowest is:**

**A** 4 ms, shorter than the SMU potential

**B** 12 ms, the transit time of the slowest unit

**C** 16 ms, equal to twice the slowest unit's time

**D** 8 ms, comparable to the 3-15 ms duration of an SMU potential

ENG velocity · Hard

**596. A motor nerve is stimulated at two sites 240 mm apart. The longer latency is 8.2 ms and the shorter latency is 4.2 ms. The conduction velocity is:**

**A** 60 m/s

**B** 29 m/s

**C** 30 m/s

**D** 120 m/s

Depolarization · Devil

**597. A neuron at -70 mV is made to reach +10 mV during the upstroke. Which statement is TRUE?**

**A** the membrane is hyperpolarized because the value is now positive

**B** the membrane is repolarizing because the potential has crossed 0 mV

**C** the inside is less negative than rest, so depolarization has occurred even though the sign is positive

**D** depolarization has not occurred because positive values are not allowed

Nernst equation · Devil

**598. Which statement correctly describes the effect of ion valence n in E = (RT/nF) ln([ion]o/[ion]i)?**

**A** n counts the channels open, so more channels give larger E

**B** n carries the sign and size of the charge, so Cl- uses n = -1 and Ca2+ uses n = +2

**C** n is always +1 because the equation is only for K+

**D** n is the number of action potentials per second

Voltage-gated channels · Hard

**599. Tetrodotoxin selectively blocks voltage-gated Na+ channels. If applied to a neuron, the expected result is:**

**A** no depolarizing phase is evoked, yet the resting potential remains

**B** the resting potential collapses to 0 mV at once

**C** the repolarizing phase lengthens and the peak grows

**D** the resting potential rises well above threshold Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 161

Undershoot · Medium

**600. The undershoot (after-hyperpolarization) occurs because:**

**A** sodium permeability stays high after repolarization

**B** the Na+/K+ pump has been inhibited

**C** potassium permeability continues to be high after repolarization

**D** all channels are closed and the membrane is leaky

## Answers — Set 4 · Q31–40

**591.** D — Threshold lies between -55 and -50 mV; 12 mV reaches only -58 mV, 18 mV reaches -52 mV, within the threshold range, and the impulse is then the standard size. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 171

**592.** D — Cl- is the main balancing anion outside the cell.

**593.** B — ΔE = 26.7 × ln(0.5) = -18.5 mV, so E(Na) = +48 mV; a lower action potential peak would be expected.

**594.** A — Ratio = (5 + 145/150)/(140 + 12/150) = 5.97/140.08 = 0.0426; 26.7 × ln(0.0426) ≈ -84 mV.

**595.** D — Fast: 0.24/60 = 4 ms; slow: 0.24/20 = 12 ms; difference = 8 ms, enough to scatter and desynchronize the summed signal.

**596.** A — v = D/(L1 - L2) = 0.240 m ÷ 0.004 s = 60 m/s.

**597.** C — Depolarization is a reduction in membrane potential and includes events where the inside becomes positive.

**598.** B — The valence scales and signs the term; for anions n is negative, for divalent cations the value is halved.

**599.** A — The upstroke needs Na+ entry through voltage-gated channels; the resting potential depends largely on leak channels and the pump.

**600.** C — Continued K+ efflux makes the inside briefly more negative than rest.

## 5. Set 5 · Q41–50

Motor unit · Devil

**601. Which statement about a single motor unit (SMU) is TRUE?**

**A** its fibers are packed together in a distinct bundle apart from other units

**B** it fires only when stimulated through the sensory nerve

**C** the volume conductor consists only of the fibers of that same unit

**D** its fibers form a distributed bioelectric source inside a volume conductor of other muscle fibers

Nernst equation · Medium

**602. If extracellular K+ rises from 5 mM to 10 mM with [K+]i = 140 mM, E(K) at 37 °C becomes about:**

**A** -89 mV

**B** -95 mV

**C** -70 mV

**D** -100 mV

ENG · Easy

**603. An electroneurogram (ENG) differs from an EMG in that the ENG records electrical activity of:**

**A** muscles, while the EMG records neurons

**B** the heart, while the EMG records the brain

**C** neurons, while the EMG records muscular activity

**D** the retina, while the EMG records the cochlea

Hypokalemia · Devil

**604. When extracellular K+ falls from 5 mM to 3 mM ([K+]i = 140 mM, RT/F = 26.7 mV), E(K) shifts by about:**

**A** +14 mV, from -89 mV to -75 mV, moving cells closer to threshold

**B** -27 mV, from -89 mV to -116 mV, moving cells further from threshold

**C** -14 mV, from -89 mV to -103 mV, moving cells further from threshold

**D** -14 mV, from -89 mV to -103 mV, moving cells closer to threshold

Goldman equation · Devil

**605. What PK : PNa ratio is needed to give exactly -70 mV with [K+]o 5/[K+]i 140, [Na+]o 145/[Na+]i 12 mM, chloride ignored and RT/F = 26.7 mV?**

**A** about 75 : 1, exactly as stated in the lecture

**B** about 28 : 1, so the lecture's 75 : 1 gives a more negative value

**C** about 8 : 1, so the lecture's 75 : 1 gives a less negative value

**D** about 280 : 1, so the lecture's 75 : 1 gives a less negative value

ECG · Easy

**606. On an ECG trace, the P wave represents:**

**A** depolarization of the ventricles

**B** repolarization of the ventricles

**C** depolarization of the atria

**D** repolarization of the atria

EMG properties · Devil

**607. Which description of the evoked single-motor-unit potential is FALSE?**

**A** triphasic waveform with duration of 3-15 ms

**B** amplitude of 20-2000 μV

**C** biphasic waveform, 3-15 s long, amplitude 20-2000 mV

**D** discharge frequency of 6-30 per second Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 162

EMG · Hard

**608. A single motor unit discharges at 20 per second and each triphasic potential lasts 10 ms. What fraction of time is occupied by the potential?**

**A** 5 %

**B** 10 %

**C** 50 %

**D** 20 %

Nernst equation · Medium

**609. Using RT/F ≈ 26.7 mV at 37 °C, [K+]o = 5 mM and [K+]i = 140 mM, E(K) is closest to:**

**A** +89 mV

**B** -89 mV

**C** -70 mV

**D** -35 mV

ENG latency · Hard

**610. Why does the ENG subtract the shorter latency from the longer one before dividing into the distance?**

**A** it converts milliseconds into seconds

**B** it removes the stimulus voltage from the measurement

**C** it cancels the shared delay from the distal nerve and neuromuscular transmission

**D** it averages the velocities of sensory and motor fibers

### Answers — Set 5 · Q41–50

**601.** D — The lecture notes that SMU fibers are interspersed with fibers of other units and sit in a volume conductor made of all other active and inactive fibers.

**602.** C — E(K) = 26.7 × ln(10/140) = 26.7 × (-2.64) ≈ -70.5 mV, so it becomes less negative.

**603.** C — The ENG visualizes neuron activity in the central or peripheral nervous system; the EMG visualizes muscle activity.

**604.** C — E(K) at 3 mM = 26.7 × ln(3/140) = -102.6 mV, which is 13.6 mV more negative and hyperpolarizes cells away from threshold.

**605.** B — Solve (5 + 145r)/(140 + 12r) = e^(-70/26.7) = 0.0727 where r = PNa/PK: r ≈ 0.036, so PK/PNa ≈ 28; at 75 : 1 the value is -80 mV.

**606.** C — The P wave is the electrical signal of atrial depolarization.

**607.** C — The lecture gives a triphasic waveform of 3-15 ms and 20-2000 µV; the units and phases here are wrong.

**608.** D — Interval = 1/20 s = 50 ms; 10 ms/50 ms = 0.20, or 20 %.

**609.** B — E(K) = 26.7 × ln(5/140) = 26.7 × (-3.33) ≈ -89 mV.

**610.** C — Both latencies contain the same terminal conduction and transmission time; only the extra time over the known distance remains.

## 6. Set 6 · Q51–60

Na+/K+ pump · Hard

**611. The pump is inhibited by a drug. Immediately, the resting potential changes little, but over a long period it:**

**A** becomes more negative as K+ builds inside

**B** runs down as Na+ and K+ gradients dissipate

**C** stays unchanged forever, since leak channels maintain gradients

**D** moves exactly to +30 mV as in an action potential

Undershoot · Hard

**612. During the undershoot of an action potential, the membrane potential is closest to:**

**A** E(Na), because sodium permeability remains high

**B** E(Cl), because chloride channels open

**C** 0 mV, because all permeabilities fall

**D** E(K), because potassium permeability remains high

ENG stimulus · Medium

**613. The desirable stimulus for sensory nerve field potentials is brief and intense, about 100 V and 100-300 µs, because it:**

**A** excites only the small slow pain fibers of the nerve

**B** excites large fast fibers while sparing pain fibers and nearby muscle

**C** drives long muscle contractions that improve the recorded signal

**D** keeps the limb moving so that artifacts are reduced

Nernst equation · Hard

**614. Chloride is an anion (n = -1) with [Cl-]o = 110 mM and [Cl-]i = 10 mM. At 37 °C with RT/F = 26.7 mV, E(Cl) is closest to:**

**A** +64 mV

**B** -32 mV

**C** -64 mV

**D** -96 mV Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 163

Goldman equation · Hard

**615. A neuron has [K+]o = 5 mM, [K+]i = 140 mM, [Na+]o = 145 mM, [Na+]i = 12 mM, PK : PNa = 75 : 1, and chloride is ignored. Using RT/F = 26.7 mV, the resting potential from the Goldman equation is closest to:**

**A** -80 mV

**B** -89 mV

**C** -72 mV

**D** -0.4 mV

Depolarization · Easy

**616. Depolarization of a neuron means that the inside of the membrane becomes:**

**A** more negative than the resting potential

**B** exactly equal to the outside at all times

**C** less negative than the resting potential

**D** impermeable to all ions

Chloride distribution · Devil

**617. If Cl- is freely permeable and passively distributed at a resting potential of -70 mV with [Cl-]o = 110 mM, the internal [Cl-] at equilibrium is about:**

**A** 11 mM

**B** 80 mM

**C** 110 mM

**D** 8 mM

ENG conduction velocity · Medium

**618. A motor nerve is stimulated at two points 300 mm apart. Latencies are 6.0 ms and 3.0 ms. The conduction velocity is:**

**A** 100 m/s

**B** 50 m/s

**C** 200 m/s

**D** 33 m/s

EMG amplitude · Hard

**619. A single-motor-unit potential of 150 µV is amplified 2000 times. The output amplitude is:**

**A** 0.3 V
**B** 3 V
**C** 30 mV
**D** 0.03 V

ECG · Easy

**620. Which ECG component represents depolarization of the ventricles?**

**A** the P wave
**B** the T wave
**C** the baseline between beats
**D** the QRS complex

### Answers — Set 6 · Q51–60

**611.** B — The pump restores the gradients that leak currents erode; without it the gradients fall and the potential decays toward zero.

**612.** D — Continuing K+ efflux pushes the potential toward E(K) near -89 mV, below the -70 mV rest.

**613.** B — A brief intense stimulus recruits large fast fibers and avoids pain and muscle activity.

**614.** C — E(Cl) = (26.7/(-1)) × ln(110/10) = -26.7 × 2.40 ≈ -64 mV.

**615.** A — Ratio = (5 + 145/75)/(140 + 12/75) = 6.933/140.16 = 0.0495; 26.7 × ln(0.0495) ≈ -80 mV.

**616.** C — Depolarization is a reduction in membrane potential, and it includes events where the potential becomes positive.

**617.** D — At equilibrium E(Cl) = -70 mV: ln([Cl]o/[Cl]i) = 70/26.7 = 2.62, so the ratio is 13.8 and [Cl]i = 110/13.8 ≈ 8 mM.

**618.** A — v = D/(L1 - L2) = 0.300 m / 0.003 s = 100 m/s.

**619.** A — 150 × 10^-6 V × 2000 = 0.30 V.

**620.** D — The QRS complex marks ventricular depolarization. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 175

## 7. Set 7 · Q61–70

Ohm's law · Devil

**621. A neuron has input resistance 100 MΩ and rests at -70 mV with threshold -55 mV. Which listed current is the lowest that reaches threshold?**

**A** 0.10 nA, giving a 10 mV depolarization to -60 mV
**B** 0.16 nA, giving a 16 mV depolarization to -54 mV
**C** 0.12 nA, giving a 12 mV depolarization to -58 mV
**D** 0.20 nA, giving a 20 mV depolarization to -50 mV

Channel classes · Medium

**622. Which pair correctly names the two classes of active (gated) channels?**

**A** transmitter-gated and leak

**B** voltage-gated and passive

**C** passive and leak

**D** transmitter-gated and voltage-gated Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 164

EEG · Easy

**623. An electroencephalogram (EEG) is a recording of:**

**A** electrical activity of the heart picked up by chest sensors

**B** electrical activity of the brain picked up by sensors on the scalp

**C** electrical activity of skeletal muscle picked up by needles

**D** blood flow in the brain measured by sound waves

Stimulation · Medium

**624. Which of these can change the membrane potential of a neuron?**

**A** only a change in the temperature of the fluid around the cell

**B** only a change in the thickness of the myelin sheath around the axon

**C** altered permeability to any ion, or altered ion concentrations across the membrane

**D** nothing, because the potential is fixed at -70 mV

Neuron structure · Easy

**625. Most neurons have which three main structural parts?**

**A** a cell body, an axon and dendrites

**B** a nucleus, a sarcomere and an axon

**C** a cell body, a myelin disc and a cilium

**D** dendrites, a flagellum and a Golgi tail

Resting potential · Hard

**626. Resting potential is about -70 to -80 mV, yet E(K) is about -89 mV. The main reason it is less negative than E(K) is that:**

**A** a large outward Cl- leak, since Cl- is concentrated inside

**B** a small inward Na+ leak pulls the potential slightly toward positive

**C** K+ has no permeability at rest, so E(K) is irrelevant

**D** the Na+/K+ pump moves K+ outward and Na+ inward

Goldman equation · Hard

**627. If PCl is made very large compared with PK and PNa, the Goldman potential approaches:**

**A** E(K), the potassium equilibrium potential

**B** E(Na), the sodium equilibrium potential

**C** 0 mV, because the terms cancel out

**D** E(Cl), from the [Cl]i/[Cl]o term

Ion channels · Easy

**628. A passive (leakage) ion channel is one that is:**

**A** opened only by a transmitter

**B** opened only by a change in voltage

**C** permanently closed until the cell dies

**D** always open

ECG · Easy

**629. The T wave on an ECG represents:**

**A** repolarization of the ventricles

**B** depolarization of the atria

**C** depolarization of the ventricles

**D** repolarization of the atria and ventricles together

Goldman equation · Medium

**630. What does the Goldman equation add compared with the Nernst equation?**

**A** it includes only the ion with the highest concentration

**B** it removes the temperature term from the calculation

**C** it applies only to the action potential peak

**D** it includes several ions weighted by their membrane permeabilities Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 165

## Answers — Set 7 · Q61–70

**621.** B — V = IR: 0.16 × 10^-9 × 10^8 = 16 mV, bringing the cell to -54 mV, above the threshold of -55 mV.

**622.** D — Active channels are subdivided into transmitter-gated and voltage-gated.

**623.** B — EEG uses small scalp sensors to pick up the electrical signals produced by the brain.

**624.** C — The lecture lists altered permeability and altered ion concentrations as the two ways to change the potential.

**625.** A — The lecture states that most neurons have a cell body, an axon and dendrites.

**626.** B — The membrane is slightly permeable to Na+ (about 1/75 of K+), and Na+ influx depolarizes the cell a little.

**627.** D — The ion with the highest permeability dominates; the Cl- term is [Cl]i/[Cl]o, which equals the Nernst potential for Cl-.

**628.** D — The lecture defines passive leakage channels as always open. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 176

**629.** A — The T wave is the recovery (repolarization) of the ventricles after the QRS complex.

**630.** D — The Goldman equation sums contributions of K+, Na+ and Cl- using permeability coefficients P.

## 8. Set 8 · Q71–80

Action potential · Devil

**631. Which statement about the action potential is FALSE?**

**A** a stronger stimulus produces an action potential of greater amplitude

**B** the impulse is the same regardless of the type or source of stimulus

**C** the potential swings about 100 mV, from -70 mV to +30 mV

**D** generation is identical in neurons and skeletal muscle cells

Excitable cells · Easy

**632. Which three tissue classes contain excitable cells according to the lecture?**

**A** nervous, epithelial and connective tissue

**B** muscular, adipose and glandular tissue

**C** epithelial, bone and nervous tissue

**D** nervous, muscular and glandular tissue

Goldman equation · Hard

**633. If PNa rises to 20 times PK at the peak of an action potential (chloride ignored, [K+]o = 5, [K+]i = 140, [Na+]o = 145, [Na+]i = 12 mM, RT/F = 26.7 mV), the Goldman potential is closest to:**

**A** +67 mV

**B** +30 mV

**C** +54 mV

**D** -54 mV

Ion distribution · Easy

**634. Compared with the extracellular fluid, the cell cytosol has:**

**A** high K+ and low Na+ concentration

**B** high Na+ and low K+ concentration

**C** high Na+ and high K+ concentration

**D** low Na+ and low K+ concentration

Action potential · Devil

**635. In a nerve with [K+]o 5/[K+]i 140 and [Na+]o 145/[Na+]i 12 mM (RT/F = 26.7 mV), what PNa : PK ratio gives an action potential peak of +30 mV with chloride ignored?**

**A** about 4 : 1, which is far below the idealised 20 : 1 that gives +54 mV

**B** about 40 : 1, ten times the value giving +54 mV

**C** about 1 : 4, so K+ still dominates at the peak

**D** about 0.036 : 1, the same as at rest

Resting potential · Easy

**636. The resting membrane potential of a typical neuron, measured inside relative to outside, is about:**

**A** +70 mV

**B** -70 mV

**C** -7 mV

**D** -700 mV

EMG · Easy

**637. Electromyography (EMG) is mainly used to assess:**

**A** the rhythm of the heart and its conduction pathway

**B** the general electrical activity of the whole brain

**C** the health of muscles and the motor neurons that control them

**D** the speed of blood flow through peripheral arteries

ECG · Hard

**638. An ECG shows normal QRS complexes and T waves but no identifiable P waves. This pattern means:**

**A** atria are depolarizing normally, but ventricular depolarization is absent

**B** ventricles depolarize but never repolarize in this trace

**C** ventricles depolarize normally, but atrial depolarization is not visible

**D** atrial repolarization is simply too large to see here Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 166

Ohm's law · Easy

**639. The lecture relates the voltage change across a membrane to current and resistance by:**

**A** V = I ÷ R

**B** V = R ÷ I

**C** V = I + R

**D** V = I × R

Nernst equation · Hard

**640. With [Na+]o = 145 mM, [Na+]i = 12 mM and RT/F = 26.7 mV (n = +1), the sodium equilibrium potential E(Na) is closest to:**

**A** -67 mV

**B** +67 mV

**C** +89 mV

**D** +6.7 mV

## Answers — Set 8 · Q71–80

**631.** A — This is false: the nerve impulse is always the same size once threshold is reached.

**632.** D — Excitable cells belong to nervous, muscular and glandular tissue; they show a resting potential and fire action potentials when stimulated.

**633.** C — Ratio = (5 + 20 × 145)/(140 + 20 × 12) = 2905/380 = 7.64; 26.7 × ln 7.64 ≈ +54 mV.

**634.** A — Cytosol is rich in K+ and poor in Na+ relative to the extracellular fluid.

**635.** A — Solve (5 + 145r)/(140 + 12r) = e^(30/26.7) = 3.08, giving r ≈ 3.9; K+ still limits the peak below E(Na) = +67 mV.

**636.** B — Two microelectrodes and a voltmeter give about -70 mV, with the cytoplasmic side negative compared with the outside.

**637.** C — EMG evaluates muscles and the nerve cells (motor neurons) that control them.

**638.** C — P = atrial depolarization, QRS = ventricular depolarization, T = ventricular repolarization; present QRS and T with no P implies an atrial problem.

**639.** D — Voltage equals current times resistance (Ohm's law).

**640.** B — E(Na) = 26.7 × ln(145/12) = 26.7 × 2.49 ≈ +66.5 mV; Na+ is more concentrated outside, so the ratio exceeds 1 and the sign is positive.

**Module 9: Lecture 9 — Homeostasis** — 80 questions

## 1. Set 1 · Q1–10

Heat storage · Devil

**641. A person's heat production exceeds heat loss by 100 W for 1 h (mass 70 kg, c = 3470 J/(kg·K)). With no other change, core temperature rises by about:**

**A** 0.15 °C

**B** 1.5 °C

**C** 15 °C

**D** 5.1 °C

Definition of homeostasis · Easy

**642. Homeostasis is best defined as the ability of the body to:**

**A** Maintain a relatively stable internal environment

**B** Keep every internal variable fixed at one exact value

**C** Adapt its external environment to suit the body

**D** Eliminate all fluctuations in body chemistry at once

Conduction · Hard

**643. Heat flows through a 1.0 cm tissue layer (k = 0.2 W/(m·K), area 1.5 m²) with 4 °C temperature difference. What is the rate of heat conduction?**

**A** 12 W

**B** 1200 W

**C** 0.12 W

**D** 120 W

Heat transfer · Medium

**644. A fan cools a student's skin mainly by increasing which heat transfer mechanism?**

**A** Conduction through bone

**B** Radiation from the fan blades

**C** Metabolism in skeletal muscle

**D** Convection, and evaporation of sweat

Interacting loops · Devil

**645. An athlete in the heat loses sweat and becomes dehydrated, so ADH rises. Which statement is TRUE?**

**A** ADH release stops sweating immediately

**B** The two loops conflict as one is positive

**C** ADH removes any need for thermoregulation

**D** Both are negative loops; sweating still cools

FALSE statement · Devil

**646. Which statement about homeostatic control components is FALSE?**

**A** The control centre determines the set point

**B** The variable is the factor being regulated

**C** The effector monitors the environment and detects stimuli

**D** The afferent pathway carries input to the control centre

Blood glucose · Medium

**647. In the glucose diagram, once blood glucose falls back to the set point, insulin release:**

**A** Diminishes, because the stimulus has been reduced

**B** Increases, because glucose is now normal

**C** Remains high until glycogen is depleted

**D** Is replaced by oxytocin release Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 179

Ovulation · Medium

**648. In the ovulation example, the dominant follicle releases oestrogen which stimulates LH and FSH release. This is positive feedback because:**

**A** Gonadotropins stop the follicle from producing oestrogen

**B** Gonadotropins convert oestrogen into insulin

**C** Gonadotropins promote further follicular growth and more oestrogen

**D** Gonadotropins remove the dominant follicle at once

Positive feedback · Easy

**649. In the lecture, lactation is a positive feedback loop because:**

**A** Feeding stimulates milk production, which promotes further feeding

**B** Milk production shuts off as soon as feeding begins

**C** Milk production is unrelated to infant feeding

**D** Feeding lowers hormone levels that make milk

Diabetes insipidus · Hard

**650. A patient lacking ADH production passes large volumes of dilute urine and becomes dehydrated. Which interpretation fits?**

**A** Water is not retained because the signal to conserve it is missing

**B** Excess ADH is causing too much water retention

**C** Insulin deficiency is stimulating water retention

**D** Positive feedback is driving ADH release higher

## Answers — Set 1 · Q1–10

**641.** B — $Q = 100 \times 3600 = 3.6\times10^5$ J; $\Delta T = Q/(mc) = 3.6\times10^5/242900 \approx 1.5$ °C, enough to trigger corrective effectors.

**642.** A — The lecture defines homeostasis as maintaining a relatively stable internal environment, with variables fluctuating only within narrow limits.

**643.** D — $P = kA\Delta T/d = 0.2 \times 1.5 \times 4 / 0.01 = 120$ W.

**644.** D — Moving air removes the warm layer next to the skin (convection) and speeds evaporation of sweat.

**645.** D — Thermoregulation and osmoregulation operate simultaneously, each opposing its own deviation.

**646.** C — Monitoring and detecting stimuli is the function of the receptor, not the effector.

**647.** A — The output turns down the original stimulus, so the stimulus for insulin release diminishes and homeostasis returns.

**648.** C — More oestrogen drives more LH and FSH, driving further follicular growth, so the change is amplified.

**649.** A — Suckling stimulates milk production, which in turn supports more feeding until the baby stops.

**650.** A — ADH normally promotes water retention in dehydration; without it, water is lost despite rising plasma osmolality.

## 2. Set 2 · Q11–20

Why positive loops end · Medium

**651. Why does a positive feedback loop such as labour eventually stop?**

**A** The stimulus is removed, such as when the baby is delivered

**B** The set point is reached and the effector is switched off

**C** Receptors lose sensitivity because of high hormone levels

**D** Oxytocin is converted to insulin in the blood

FALSE statement · Devil

**652. Which statement about negative feedback is FALSE?**

**A** It amplifies the stimulus until the stimulus is removed

**B** It reverses the change detected by the receptor

**C** It promotes equilibrium around a set point

**D** It is typical of blood glucose regulation

Heat transfer · Medium

**653. Standing near a fire, the warmth on the face without touching or air movement is due to:**

**A** Radiation, via infrared electromagnetic waves

**B** Conduction, via molecular collisions in air

**C** Convection, via the circulation of blood

**D** Evaporation, via loss of sweat

FALSE statement · Devil

**654. Which statement about thermoregulation is FALSE?**

**A** A fall in temperature activates heating mechanisms

**B** The loop is a form of negative feedback

**C** A rise in temperature activates sweating

**D** A rise in temperature activates shivering to restore normal levels

Hypothalamic lesion · Devil

**655. A lesion destroys the hypothalamic temperature control centre but leaves skin thermoreceptors and sweat glands intact. What results?**

**A** Temperature is regulated normally by the receptors alone

**B** Sweat glands fail permanently

**C** Temperature is poorly regulated because the signals are not integrated

**D** Negative feedback changes to positive feedback Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 180

Classification · Medium

**656. Which pairing of process and feedback type matches the lecture?**

**A** Osmoregulation, positive feedback

**B** Thermoregulation, positive feedback

**C** Blood sugar regulation, positive feedback

**D** Lactation, positive feedback

Loop order · Medium

**657. Which sequence correctly orders the events in a negative feedback loop?**

**A** Stimulus, receptor, control center, effector, response

**B** Stimulus, effector, control center, receptor, response

**C** Receptor, stimulus, effector, control center, response

**D** Control center, stimulus, receptor, response, effector

Classification · Devil

**658. From the lecture's examples (thermoregulation, blood glucose, osmoregulation, childbirth, lactation, ovulation, blood clotting), how many are positive feedback?**

**A** Four

**B** Two

**C** Three

**D** Five

Blood glucose · Easy

**659. According to the lecture, which hormone lowers blood glucose when levels are high?**

**A** Glucagon

**B** Oxytocin

**C** Insulin

**D** Antidiuretic hormone

Positive feedback · Easy

**660. Which process is given in the lecture as an example of positive feedback?**

**A** Thermoregulation

**B** Childbirth

**C** Blood glucose regulation

**D** Osmoregulation

### Answers — Set 2 · Q11–20

**651.** A — Positive loops continue amplifying until the stimulus is removed; delivery ends cervical stretch and oxytocin release.

**652.** A — This describes positive feedback; negative feedback reduces the change instead of amplifying it.

**653.** A — Radiation carries heat as electromagnetic waves, needing no medium or contact.

**654.** D — Shivering produces heat and is activated by cold; a rise in temperature activates cooling such as sweating.

**655.** C — Receptors and effectors need a control centre to compare input with the set point and send output.

**656.** D — Feeding stimulates milk production, which promotes further feeding, so lactation is a positive loop.

**657.** A — A stimulus changes the variable, the receptor detects it, the control center processes it and the effector produces the response that feeds back.

**658.** A — Childbirth, lactation, ovulation and clotting are positive; the other three are negative.

**659.** C — Insulin released from the pancreas lowers blood glucose, e.g. by promoting uptake by cells and storage in the liver.

**660.** B — In childbirth, contractions stretch the uterine wall further, causing more contractions until birth occurs.

## 3. Set 3 · Q21–30

Control center · Medium

**661. Which structure acts as the main control center in human thermoregulation?**

**A** Pancreas

**B** Hypothalamus

**C** Cerebellum

**D** Adrenal cortex

Efferent pathway · Medium

**662. Output from the control center to the effector travels along the efferent pathway. In thermoregulation, this is best exemplified by:**

**A** Nerve impulses from skin thermoreceptors to the hypothalamus

**B** Nerve impulses from the hypothalamus to sweat glands

**C** Heat flowing from the core to the skin by blood

**D** Sweat evaporating from the skin surface

Positive feedback · Easy

**663. Which of these is listed in the lecture as positive feedback?**

**A** Insulin release after a meal

**B** Sweating during a hot day

**C** Shivering in a cold room

**D** Clotting, as platelets release factors 

Heat transfer · Medium

**664. Why does humid weather in Kumasi make it harder to stay cool by sweating?**

**A** Humid air has higher temperature than dry air always

**B** Air already holding much water vapour limits evaporation

**C** Sweat glands stop functioning above a threshold humidity

**D** Water cannot absorb heat when it evaporates in humid air

Childbirth · Hard

**665. An epidural that blocks sensory signals from the cervix would be expected to weaken labour contractions because it:**

**A** Blocks the efferent signal to the pancreas

**B** Interrupts the afferent signal that triggers oxytocin release

**C** Removes the set point for uterine contraction

**D** Converts the loop into negative feedback

Dynamic equilibrium · Easy

**666. The internal environment of the body is said to be in a:**

**A** Static state of equilibrium

**B** Dynamic state of equilibrium

**C** Permanent state of imbalance

**D** Closed state of isolation

Radiation · Hard

**667. Skin at 307 K (area 1.5 $m^2$, emissivity 0.97) faces surroundings at 293 K. Using $\sigma = 5.67\times10^{-8}$ $W/(m^2\cdot K^4)$, the net radiative heat loss is about:**

**A** 730 W

**B** 3.2 W

**C** 125 W

**D** 12 W

Blood pH · Hard

**668. In hypoventilation dissolved $CO_2$ rises to 1.8 mmol/L while bicarbonate stays at 24 mmol/L. The pH becomes about:**

**A** 7.40

**B** 7.23

**C** 7.58

**D** 6.90

Feedback type · Medium

**669. A person with a fever steps outside and sweats heavily as body temperature climbs. This sweating is an example of:**

**A** Positive feedback, as it follows a rise in temperature

**B** Positive feedback, as it is an active response

**C** Negative feedback, as it counteracts a rise in temperature

**D** Feedforward only, as it is unrelated to the temperature rise

Control mechanisms · Easy

**670. In the control loop diagram, information from the receptor to the control center travels along the:**

**A** Efferent pathway

**B** Afferent pathway

**C** Effector pathway

**D** Set point pathway Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 182

### Answers — Set 3 · Q21–30

**661.** B — The hypothalamus integrates temperature information and sets the response of effectors such as sweat glands and muscles.

**662.** B — Efferent output leaves the control center (hypothalamus) toward effectors such as sweat glands or skeletal muscle.

**663.** D — Platelets release clotting factors that attract more platelets to the injury, amplifying the response.

**664.** B — Evaporation depends on the vapour pressure gradient; humid air reduces it, so less heat is lost per unit sweat.

**665.** B — Stretch signals travel to the brain, causing pituitary release of oxytocin; blocking input reduces the stimulus.

**666.** B — Internal conditions vary but within relatively narrow limits, so equilibrium is dynamic.

**667.** C — $P = \varepsilon\sigma A(T^4 - T_0^4) = 0.97 \times 5.67\times10^{-8} \times 1.5 \times (307^4 - 293^4) \approx 125$ W.

**668.** B — $pH = 6.1 + \log_{10}(24/1.8) = 6.1 + 1.125 \approx 7.23$, an acidosis that breathing must correct.

**669.** C — Sweating opposes the rise by cooling the body, which is the defining feature of negative feedback.

**670.** B — The diagram labels input to the control center as sent along the afferent pathway.

## 4. Set 4 · Q31–40

Diabetes mellitus · Hard

**671. In a patient with no insulin secretion, blood glucose stays high after a meal. Which part of the loop has failed?**

**A** The receptor that normally monitors temperature

**B** The set point of the thermoregulatory loop

**C** The afferent pathway for blood clotting

**D** The effector response that would lower glucose

Feedback type · Medium

**672. Which statement best distinguishes positive from negative feedback?**

**A** Positive feedback is the main way set points are maintained

**B** Negative feedback amplifies the stimulus it detects

**C** Negative feedback has no receptor or effector

**D** Positive feedback moves the system away from its starting state

Set point shift · Devil

**673. Insulin-secreting cells respond only when glucose exceeds a much higher level than normal. The expected result is:**

**A** Glucose is regulated around a lower level

**B** Glucose is regulated around a higher level, still by negative feedback

**C** The loop becomes positive feedback

**D** Regulation is unaffected because the effector is unchanged

Water deprivation · Devil

**674. A patient has high plasma osmolality and dilute urine that becomes concentrated after synthetic ADH. The diagnosis is best:**

**A** Central diabetes insipidus, a failure of ADH production

**B** SIADH, an excess of ADH secretion

**C** Type 1 diabetes mellitus, a failure of insulin

**D** Normal osmoregulation in a dehydrated person

Acid-base · Devil

**675. In metabolic acidosis the bicarbonate falls to 12 mmol/L with $CO_2$ at 1.2 mmol/L (pH about 7.10). Hyperventilation lowers $CO_2$ to 0.6 mmol/L. The resulting pH is about:**

**A** 7.10

**B** 7.70

**C** 6.80

**D** 7.40

Blood pH · Hard

**676. Using pH = 6.1 + $\log_{10}([HCO_3^-]/[\text{dissolved } CO_2])$, with 24 mmol/L bicarbonate and 1.2 mmol/L dissolved $CO_2$, the blood pH is:**

**A** 7.40

**B** 7.10

**C** 7.70

**D** 6.10

Conduction · Devil

**677. Fat thickness doubles from 1 cm to 2 cm in the conduction example (k = 0.2 W/(m·K), area 1.5 m², ΔT = 4 °C). The new heat flow is:**

**A** 240 W

**B** 30 W

**C** 60 W

**D** 120 W Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 183

Hypoventilation · Devil

**678. Bicarbonate is 24 mmol/L and ventilation increases so dissolved $CO_2$ falls to 0.6 mmol/L. The pH is about:**

**A** 7.40

**B** 7.70

**C** 7.10

**D** 7.55

Hot environments · Hard

**679. When the air temperature exceeds skin temperature, which heat loss mechanism still works?**

**A** Evaporation of sweat

**B** Radiation to the surroundings

**C** Conduction to the air

**D** Convection to the air

Set point · Medium

**680. The set point of a homeostatic variable is best understood as:**

**A** The maximum value the variable can ever reach

**B** The value at which the receptor stops functioning

**C** The target value around which the variable is regulated

**D** The average output of the effector over a day

## Answers — Set 4 · Q31–40

**671.** D — Without insulin, the response that lowers glucose is not produced, so the negative loop cannot restore the set point.

**672.** D — Positive feedback amplifies the stimulus, driving the system away from its start, unlike negative feedback.

**673.** B — A higher trigger threshold shifts the working set point upward while the loop remains negative.

**674.** A — Concentration after ADH shows the kidneys can respond, so the fault lies in ADH secretion.

**675.** D — pH = 6.1 + $\log_{10}(12/0.6)$ = 6.1 + 1.30 = 7.40, a negative feedback correction through breathing.

**676.** A — The ratio is 20, $\log_{10}(20)$ = 1.30, so pH = 7.40, the homeostatic set point of blood pH.

**677.** C — Conduction is inversely proportional to thickness, so 120 W becomes 60 W.

**678.** B — pH = 6.1 + $\log_{10}(24/0.6)$ = 6.1 + 1.60 = 7.70, an alkalosis that moves the variable away from its set point.

**679.** A — Radiation, conduction and convection become heat gains when the surroundings are hotter; evaporation still removes heat.

**680.** C — Negative feedback loops counteract deviations from target values, called set points.

## 5. Set 5 · Q41–50

Hot humid exposure · Devil

**681. A person works in air at 40 °C and nearly 100% humidity. Why is hyperthermia likely despite intact thermoregulation?**

**A** The receptors reverse and call for heating

**B** Sweating produces extra metabolic heat

**C** ADH is secreted to raise body temperature

**D** All heat loss routes fail, overwhelming effectors

Osmoregulation · Medium

**682. After drinking a large volume of water, ADH release is expected to:**

**A** Be stimulated, so more water is retained

**B** Stay maximal, as water intake is a stimulus

**C** Be inhibited, so excess water can be excreted

**D** Be converted into oxytocin for dilution

Blood glucose · Easy

**683. In the blood glucose diagram, when blood glucose is high the liver:**

**A** Breaks down glycogen and releases glucose

**B** Releases insulin into the blood

**C** Takes up glucose and stores it as glycogen

**D** Secretes glucagon to lower the level

Labour · Devil

**684. Which intervention would be expected to terminate the labour positive feedback loop at the effector level?**

**A** Increasing the stretch of the cervix

**B** Infusing more oxytocin

**C** A drug blocking oxytocin action on the uterine muscle

**D** Delaying removal of the stimulus

FALSE statement · Devil

**685. Which statement about positive feedback is FALSE?**

**A** It moves the system away from its starting state

**B** It typically maintains a variable close to a set point

**C** It is exemplified by platelet aggregation in clotting

**D** It continues until the stimulus is removed Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 184

Control mechanisms · Easy

**686. In a homeostatic control mechanism, the 'variable' is:**

**A** The structure that detects the change

**B** The structure that responds to the stimulus

**C** The factor or event being regulated

**D** The region that sets the target value

Heat storage · Devil

**687. During 2 h of hard work, a 70 kg athlete (c = 3470 J/(kg·K)) with a 400 W excess of heat production and no sweating would warm by about:**

**A** 1.2 °C

**B** 6 °C

**C** 12 °C

**D** 24 °C

Loop components · Hard

**688. During exercise in a hot room, skin and hypothalamic thermoreceptors detect a rise in temperature. Which structures are the effectors?**

**A** The thermoreceptors in the skin

**B** The hypothalamus integrating the signals

**C** Core temperature itself

**D** Sweat glands and the blood vessels of the skin

Osmoregulation · Medium

**689. After several hours in the sun without drinking, a student feels thirsty. What happens to ADH secretion and why?**

**A** It decreases, so the kidneys retain water

**B** It increases, so the kidneys retain water

**C** It increases, so the kidneys excrete more water

**D** It stays unchanged, as ADH acts only on glucose

Muscle heat · Hard

**690. A cyclist's muscles are 25% efficient and deliver 150 W of mechanical power. How much heat does the body produce per second?**

**A** 150 W

**B** 600 W

**C** 450 W

**D** 37.5 W

## Answers — Set 5 · Q41–50

**681.** D — Hot air gives heat by conduction, convection and radiation, and saturated air stops evaporation.

**682.** C — When the body is hydrated, ADH release is inhibited and dilute urine removes excess water, which is negative feedback.

**683.** C — Under insulin influence the liver takes up glucose and stores it as glycogen, lowering blood glucose.

**684.** C — Blocking oxytocin's action stops contractions even while stretch signals continue.

**685.** B — Maintaining a set point is the role of negative feedback; positive loops amplify change.

**686.** C — The variable is the factor or event being regulated, such as temperature or blood glucose.

**687.** C — $Q = 400 \times 7200 = 2.88\times10^6$ J, and $\Delta T = Q/(mc) \approx 11.9$ °C, which is fatal and shows why effectors must act.

**688.** D — Effectors perform the response: sweat glands secrete sweat and cutaneous vessels dilate to lose heat.

**689.** B — Dehydration raises ADH secretion, increasing water retention to restore fluid balance.

**690.** C — Total power = 150/0.25 = 600 W; subtracting the 150 W of work leaves 450 W as heat.

## 6. Set 6 · Q51–60

Ovulation · Hard

**691. The ovulation positive feedback loop ends because:**

**A** Oestrogen is converted into insulin

**B** Ovulation removes the dominant follicle that supplies the stimulus

**C** The loop reaches a set point at which it stops

**D** LH and FSH inhibit all further hormone release

Sweat cooling · Hard

**692. A person sweats and evaporates 1.5 kg of sweat in one hour (latent heat $2.43\times10^6$ J/kg). The average cooling power is about:**

**A** 101 W

**B** 6.1 W

**C** 3650 W

**D** 1010 W Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 185

Blood clotting · Medium

**693. In blood clotting, the platelet plug grows larger as more platelets arrive. This is positive feedback because:**

**A** The output stops platelets arriving at the injury

**B** The output (clotting factors) amplifies the original stimulus

**C** The output returns clotting to a set point at once

**D** The output is detected by the pancreas

Malaria · Hard

**694. During a malaria fever the patient sweats profusely when the paroxysm ends. This reflects:**

**A** Positive feedback amplifying the fever

**B** Loss of receptor function in the skin

**C** Set point returning to normal, so cooling begins

**D** Insulin release in response to heat

Sweat and heat · Hard

**695. Evaporation must remove 600 W of heat. Taking the latent heat of vaporisation of sweat as $2.43\times10^6$ J/kg, what mass of sweat must evaporate per hour?**

**A** ≈ 0.89 kg

**B** ≈ 0.089 kg

**C** ≈ 8.9 kg

**D** ≈ 2.4 kg

Childbirth · Easy

**696. In the childbirth loop, which hormone is carried in the bloodstream to the uterus?**

**A** Insulin

**B** Glucagon

**C** Oxytocin

**D** Antidiuretic hormone

Clotting · Devil

**697. Why does the clotting positive feedback loop not run on throughout the circulation?**

**A** It reaches a set point of platelet number

**B** Insulin switches off the platelets

**C** Platelets stop releasing factors after one cycle

**D** It ends when the injury is sealed and the stimulus disappears

Shivering · Medium

**698. Shivering counteracts a fall in core temperature because:**

**A** Rapid muscle contractions convert chemical energy into heat

**B** Muscle contractions increase evaporation from the skin

**C** Muscle contractions dilate skin blood vessels

**D** Muscle contractions reduce the set point

Antagonistic hormones · Hard

**699. Why does glucose control use two opposing hormones, insulin and glucagon?**

**A** Deviations in both directions can be corrected

**B** Both hormones lower glucose to double the effect

**C** Glucagon stores glucose while insulin releases it

**D** Each hormone controls a different positive loop

Control mechanisms · Easy

**700. The receptor in a homeostatic loop:**

**A** Determines the set point at which the variable is held

**B** Provides the means to respond to the stimulus

**C** Is the factor whose level is being regulated

**D** Monitors the environment and responds to changes (stimuli) Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 186

### Answers — Set 6 · Q51–60

**691.** B — Once the follicle ruptures, its oestrogen stimulus ends, so the amplification stops.

**692.** D — Energy = 1.5 × 2.43×10⁶ = 3.6×10⁶ J, divided by 3600 s gives about 1010 W.

**693.** B — Platelets release clotting factors that recruit more platelets, enhancing the stimulus until the injury is sealed.

**694.** C — When the raised set point falls back, the body is above target and negative feedback activates sweating.

**695.** A — Energy per hour = 600 W × 3600 s = 2.16×10⁶ J; dividing by 2.43×10⁶ J/kg gives about 0.89 kg.

**696.** C — The brain stimulates the pituitary to secrete oxytocin, which is carried to the uterus to stimulate contractions.

**697.** D — Positive loops continue until the stimulus is removed; sealing the injury removes the signal.

**698.** A — Muscle contractions are inefficient and much of the chemical energy released becomes heat, raising body temperature.

**699.** A — Insulin corrects high glucose and glucagon corrects low glucose, giving two-way negative feedback control.

**700.** D — Receptors (sensors) detect stimuli and send the information onward to the control center.

## 7. Set 7 · Q61–70

Insulin overdose · Devil

**701. A diabetic injects too much insulin and glucose falls sharply. The body's counter-regulation depends mainly on:**

**A** Further insulin release to speed the decrease

**B** Glucagon-driven glycogen breakdown in the liver

**C** ADH-driven retention of water

**D** Oxytocin-driven uterine contraction

Vasomotor control · Medium

**702. When the body is overheated, skin blood vessels dilate. Which effect results?**

**A** Heat is conserved in the body core

**B** Metabolic heat production increases

**C** Sweat production is suppressed

**D** More heat is lost to the surroundings from the skin surface

Control mechanisms · Easy

**703. The effector in a homeostatic loop:**

**A** Monitors the environment for changes

**B** Provides the means to respond to the stimulus

**C** Determines the set point for the variable

**D** Carries input information to the control center

Heat transfer · Medium

**704. A patient lies on a cold metal examination table and loses heat through direct contact. This is:**

**A** Convection

**B** Radiation

**C** Conduction

**D** Evaporation

Thermoregulation · Easy

**705. In the lecture's thermoregulation diagram, which mechanism is activated when body temperature decreases?**

**A** Heating mechanisms such as shivering

**B** Cooling mechanisms such as sweating

**C** Both shivering and sweating together

**D** No mechanism, because the body tolerates the fall

Liver failure · Hard

**706. A patient with severe liver damage develops low blood glucose during a prolonged fast despite high glucagon levels. The most likely reason is:**

**A** The pancreas is releasing too much insulin as a response

**B** The liver cannot respond to glucagon by releasing glucose

**C** The receptors are detecting glucose as too high

**D** The set point has been lowered by positive feedback

Glucose tolerance · Hard

**707. After a glucose load, blood glucose in a patient remains high for hours before slowly falling. Which defect fits best?**

**A** Excessive glucagon-induced hypoglycaemia

**B** Too much ADH release

**C** Positive feedback of glucose on its own release

**D** A weak effector response to insulin

Blood glucose · Easy

**708. According to the lecture, which hormone raises blood glucose when levels are low?**

**A** Insulin

**B** Oxytocin

**C** Antidiuretic hormone

**D** Glucagon Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 187

Control mechanisms · Easy

**709. Which component determines the set point at which a variable is maintained?**

**A** Control center

**B** Receptor

**C** Effector

**D** Afferent pathway

Blood glucose · Medium

**710. After a carbohydrate meal at a canteen, blood glucose rises. Which response closes the negative feedback loop?**

**A** Pancreatic cells release glucagon and glucose rises

**B** The liver breaks down glycogen into glucose

**C** Cells reduce glucose uptake to conserve energy

**D** Pancreatic cells release insulin and glucose falls

### Answers — Set 7 · Q61–70

**701.** B — Low glucose is detected and glucagon makes the liver release glucose, a negative feedback correction.

**702.** D — Vasodilation brings warm blood near the skin, increasing radiative, convective and conductive loss. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 197

**703.** B — Effectors such as muscles and glands carry out the response that restores the variable.

**704.** C — Conduction is heat transfer by direct contact between objects of different temperatures.

**705.** A — A fall in body temperature activates heating mechanisms (shivering) which raise temperature back toward normal.

**706.** B — Glucagon acts on the liver to break down glycogen; a damaged effector cannot restore blood glucose.

**707.** D — A slow return to baseline suggests the negative feedback response is impaired, as in insulin resistance.

**708.** D — Glucagon from the pancreas stimulates the liver to break down glycogen and release glucose.

**709.** A — The control center compares the input with the set point and decides on the output.

**710.** D — High glucose is detected by insulin-secreting cells, insulin promotes uptake and storage and glucose returns to the set point. Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 198

## 8. Set 8 · Q71–80

Radiation · Devil

**711. The skin is at 307 K and the surroundings at 310 K (ε = 0.97, area 1.5 m², σ = 5.67×10⁻⁸ W/(m²·K⁴)). The net radiative exchange is about:**

**A** A gain of 29 W by the body

**B** A loss of 29 W by the body

**C** A gain of 290 W by the body

**D** A gain of 2.9 W by the body

Positive feedback · Easy

**712. Positive feedback is a response that:**

**A** Reverses the detected change, reducing it

**B** Holds the variable exactly at the set point

**C** Prevents any effector from being activated

**D** Reinforces the detected change, amplifying it

Fever · Hard

**713. During a fever, a patient feels cold and shivers although core temperature is 37.5 °C. The best explanation is that:**

**A** The receptors have stopped detecting temperature

**B** The effectors are using positive feedback

**C** The set point has been raised above the current temperature

**D** Core temperature is below the normal set point

Osmoregulation · Easy

**714. In osmoregulation, ADH is secreted:**

**A** To retain water when the body is dehydrated

**B** To excrete water when the body is overhydrated

**C** To raise blood glucose when it is low

**D** To stimulate uterine contractions at birth

SIADH · Devil

**715. A patient with excessive ADH secretion has low plasma sodium and dilute plasma, yet ADH remains high. Which explanation fits best?**

**A** The negative loop is broken because low osmolality no longer inhibits ADH release

**B** The loop has become positive because ADH removes water

**C** The effector cannot detect any stimulus

**D** ADH is lowering blood glucose by the same loop

Thermoregulation · Easy

**716. In the lecture's thermoregulation diagram, which mechanism is activated when body temperature increases?**

**A** Heating mechanisms such as shivering

**B** Cooling mechanisms such as sweating

**C** Heating mechanisms such as fat storage

**D** Mechanisms that raise the set point Way of Life MLS · Scrwjdom Quiz Engine · MLS 155 Biophysics 188

Negative feedback · Easy

**717. Negative feedback is a response that:**

**A** Reinforces the detected change, amplifying it

**B** Ignores the detected change until it is large

**C** Reverses the detected change, reducing it

**D** Switches off all receptors during the change

Runaway loops · Hard

**718. Why can positive feedback loops not be used to maintain a constant internal environment?**

**A** They have no receptors to detect changes

**B** They always oppose the original stimulus

**C** They amplify change and drive the system away from its start

**D** They respond only to blood sugar levels

Positive feedback · Easy

**719. A positive feedback loop continues to amplify the initial change until:**

**A** The set point is reached

**B** The receptor becomes saturated

**C** The control centre is bypassed

**D** The stimulus is removed

Heat capacity · Hard

**720. A 70 kg person with specific heat capacity 3470 J/(kg·K) gains 1.0 MJ of heat with no loss. By roughly how much does body temperature rise?**

**A** ≈ 0.41 °C

**B** ≈ 4.1 °C

**C** ≈ 14 °C

**D** ≈ 41 °C

## Answers — Set 8 · Q71–80

**711.** A — $P = \varepsilon\sigma A(T_0^4 - T^4) \approx +29$ W, positive because the surroundings are hotter, so radiation heats the body.

**712.** D — Positive feedback moves the system further from its starting state, amplifying the initial stimulus.

**713.** C — Pyrogens raise the hypothalamic set point, so the current temperature is read as too low and heating mechanisms operate.

**714.** A — ADH is secreted to retain water in dehydration, and its release is inhibited when the body is hydrated.

**715.** A — Hydration normally inhibits ADH release; if that inhibition fails, water retention continues despite dilution.

**716.** B — A rise in body temperature triggers cooling mechanisms (sweating), restoring normal temperature.

**717.** C — Negative feedback counteracts deviations from the set point, promoting equilibrium.

**718.** C — By amplifying the stimulus they push the variable further, and end only when the stimulus is removed.

**719.** D — The lecture states that positive loops keep amplifying until the stimulus is removed, as when birth occurs.

**720.** B — $\Delta T = Q/(mc) = 1.0\times10^6 / (70 \times 3470) \approx 4.1$ °C, which shows why heat loss effectors are vital.