2019 British Biology Olympiad

British Biology Olympiad Question Paper

90 minutes

68 marks

Write your name, school and exam centre details on the top of the answer sheet.

You may use a calculator.

You may use a dictionary to translate words from English. (Scientific dictionaries may not be used.)

You may use spare paper for rough work or calculations.

Use black ink or black ball-point pen.

The paper consists of 68 questions. One mark per question.

Some questions have more than one answer you need to choose. For some questions, you need to put the answers in the correct order.

No marks are subtracted for incorrect answers.

At the end of the exam when you have completed the test and have checked your answers, return all test materials to the invigilator.

Section 1: Quickfire

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1. Prokaryote and Eukaryote are two classes of living organisms.

Which of the following features is shared between them?

i) DNA
ii) ATP
iii) Ribosomes
iv) Mitochondria
v) Nuclei

A. i and ii
B. i, ii and iii
C. i, ii, iii, and iv
D. i, ii, iii, iv, and v
E. i and iii
F. iii, iv, and v

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2. Which organelle in a leaf is responsible for photosynthesis?

A. Nucleus
B. Mitochondria
C. Chloroplast
D. Peroxisome
E. Amyloplast

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3. Parts of living things which work together to achieve a goal are often grouped together.

Put the following groupings in order of size, from smallest to largest.

A. Cell
B. Organelle
C. Organ
D. Organism
E. Tissue

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4. When does chromosome crossing over occur?

A. Growth Phase
B. Synthesis Phase
C. Mitosis
D. Meiosis 1
E. Meiosis 2

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5. What do lipases break down?

A. Complex carbohydrates
B. Simple carbohydrates
C. Proteins
D. Fats
E. Vitamins

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6. Pavlov's dogs are famous for salivating when they heard a bell ring.

What is the best explanation for this?

A. The bell made the dogs hungry.
B. The dogs learnt that food appears when the bell rings.
C. The bell sounds like the dogs' food bowls.
D. The bell hurts the dogs' ears.
E. The dogs salivate after any loud noise.

Section 2: Biochemistry

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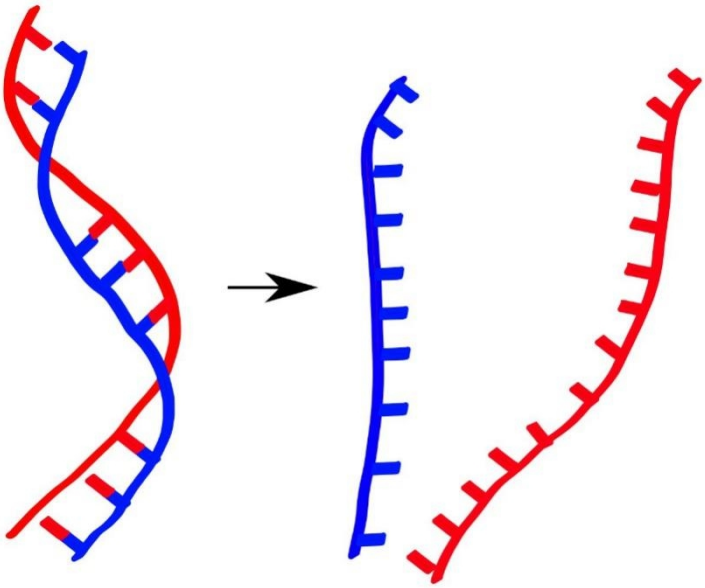
7. Heat causes the two strands of DNA helices to separate (melt / denature). G/C pairs form with 3 hydrogen bonds, whilst A/T pairs form with 2 hydrogen bonds.



Which of the following helices will denature at the highest temperature?

A. Short strand with a high proportion of A/T base pairs.
B. Long strand with a high proportion of A/T base pairs.
C. Short strand with a high proportion of G/C base pairs.
D. Long strand with a high proportion of G/C base pairs.

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8. Which of the following may be found in DNA but not in RNA?

A. 2'-hydroxy group
B. Pentose sugar
C. Phosphodiester bonds
D. Purines
E. Thymine

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9. Which of the following elements is NOT present in haemoglobin?

A. Iron
B. Oxygen
C. Nitrogen
D. Phosphorus
E. Hydrogen

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10. Humans have various stores of chemical energy. We store more of our energy reserves in some chemicals than others.

Put them in order from least energy stored to most energy stored.

A. Fat
B. Phospho-creatine
C. Liver glucose
D. ATP
E. Blood glucose
F. Protein

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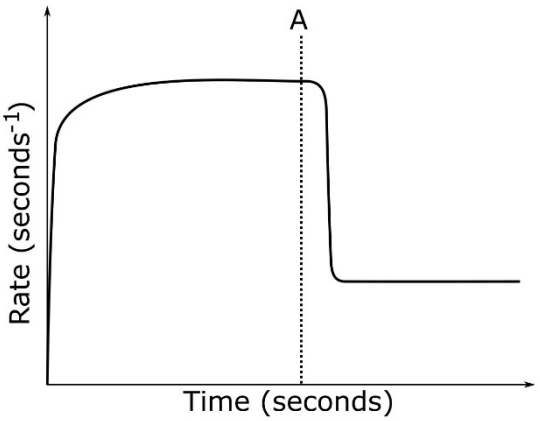
11. An enzyme was extracted from a bacterium native to Antarctica. The enzyme was mixed with an excess of substrates and the rate of reaction over time was measured.



What could have happened at time A?

A. The substrates ran out
B. An excess of non-competitive (allosteric) inhibitor was added
C. The reaction tube was placed in an ice-water bath
D. A large volume of water was added to the reaction
E. The reaction tube was placed in a warm-water bath

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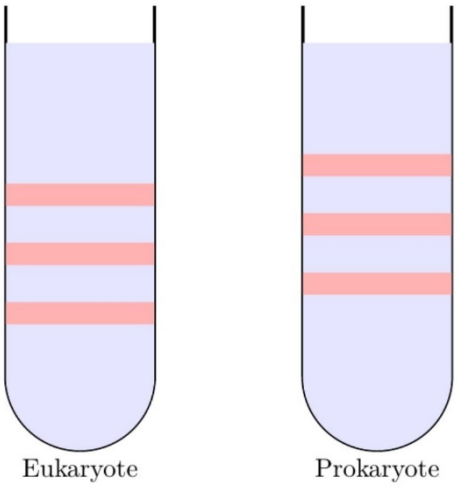
12. Particles can be put in a solution and then centrifuged. Bigger particles tend to move faster and sediment quicker.

Ribosomes taken from a eukaryotic organism and a prokaryotic organism were centrifuged and the following pattern was observed:



Which of the following is TRUE?

A. Eukaryotes and prokaryotes contain three types of ribosomes.
B. Eukaryotic ribosomes are smaller than prokaryotic ribosomes.
C. There are three subunits in these ribosomes.
D. Treatment with RNAse would alter the position of these bands.
E. Any particles with the same molecular weight will be found in the same band.

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13. Put the following structures in order of size, from smallest to largest.

A. Virus
B. Mitochondria
C. Amoeba
D. Plant cell vacuole
E. Nucleus

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14. Put the following structures in order of size, from smallest to largest.

A. Human DNA strand
B. Muscle actin filament
C. Glucose
D. Triglyceride
E. ATP
F. Ribosome

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15. Consider a plant cell. Different substances are found in different organelles.

Match the organelle to the substance associated with it.

1) Magnesium
2) Dissolved salt
3) DNA
4) RNA
5) Carbohydrates

A. Cell wall
B. Nucleus
C. Cytoplasm
D. Chloroplasts
E. Vacuole

Section 3: Circulation

16. Cows ferment grass in their stomach, which means almost everything they consume is metabolised by microorganisms. Cows then digest these microorganisms when they pass into their intestines.



Which of the following is correct?

A. Cows absorb a large amount of carbohydrate from their diet.
B. Cows eat small amounts of highly nutritious grass rather than large amounts of tough grass.
C. Cows convert microorganism proteins into carbohydrate.
D. Cows convert microorganism fats into carbohydrate.
E. Cows have long and large intestines relative to their size.

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17. Kwashiorkor is a severe form of malnutrition which occurs when people eat insufficient protein. The levels of proteins in the blood plasma become very low.

Which of the following are features of Kwashiorkor?

A. The blood has higher water potential
B. Water is absorbed from the blood into tissues
C. High sugar supplements are a treatment
D. The amount of urea producing enzymes is increased

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18. Several diseases can lead to someone producing large amounts of dilute urine.

What could cause one of them?

A. Absence of antidiuretic hormone (ADH / vasopressin)
B. Blood loss (haemorrhage)
C. Low blood glucose levels
D. Damage to the large intestine
E. Excessive salt consumption

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19. A dye remains trapped in the blood plasma until it is filtered by the kidneys into the urine. If the dye is infused into a person's vein at 0.2 mol/min it reaches a steady concentration of 1.6 mol/L in the plasma.

Calculate how much plasma the kidneys filter every minute.

A. 25 ml/min
B. 50 ml/min
C. 75 ml/min
D. 100 ml/min
E. 125 ml/min

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20. The speed at which an action potential travels down a neuronal axon depends on the following:

For myelinated neurons, the speed is directly proportional to the axon radius.

For unmyelinated neurons, the speed is directly proportional to the square root of the axon radius.

Which of these axons conducts action potentials at the highest speed?

A. A myelinated axon of radius: r
B. An unmyelinated axon of radius: r/2
C. An unmyelinated axon of radius: r^2
D. A myelinated axon of radius: $r\sqrt{2}$

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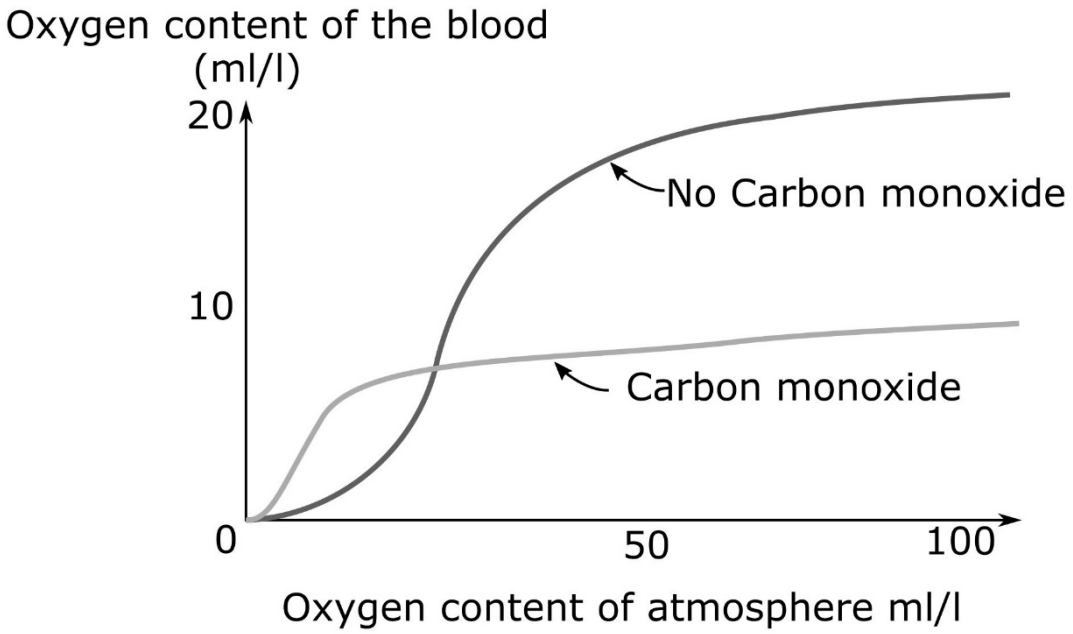
21. Carbon monoxide is a poisonous gas which can be released by poorly burning fuels.

It enters the blood and binds haemoglobin very tightly.

The amount of oxygen in blood has been plotted against the concentration of oxygen in the atmosphere, with and without the presence of carbon monoxide.



Which of the following is true?

A. Carbon monoxide increases the tightness of binding (affinity) of haemoglobin for oxygen.
B. Carbon monoxide increases the solubility of oxygen in the blood plasma.
C. Carbon monoxide increases the amount of functional haemoglobin in the blood.
D. Carbon monoxide is a competitive inhibitor of oxygen binding to haemoglobin.
E. Carbon monoxide can be used in respiration instead of oxygen.

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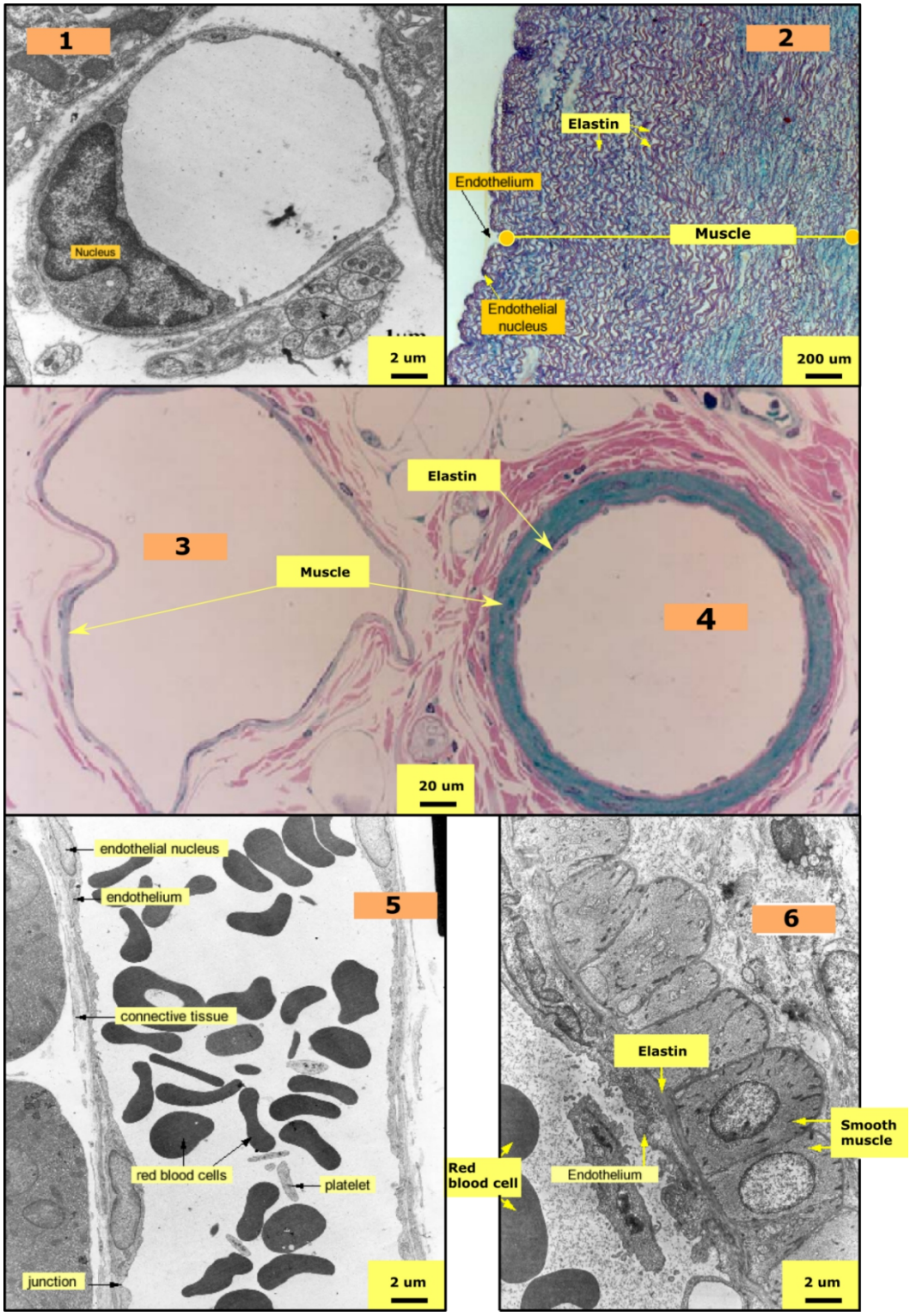
22. **Microscope images were taken of different blood vessels.**

Black and white images were taken with an electron microscope. Colour images are from samples where muscle has been stained blue and elastin has been stained pink. Elastin is a strong, elastic protein.



Match type of blood vessel to the number. Put the vessels in order from 1 to 6.

A. Aorta
B. Arteriole
C. Capillary
D. Vein
E. Venule
F. Artery

Section 4: Anatomy & Ecology

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23. Complete the following sentence:

An action potential occurs because...

A. Voltage sensitive channels open allowing sodium to enter the cell.
B. Calcium sensitive channels open allowing sodium to enter the cell.
C. A pump pushes more sodium into the cell than potassium out of the cell.
D. Voltage sensitive channels open allowing calcium to enter the cell.
E. Electrons flow along the cell.

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24. Which of the following is LEAST likely to cause an immune response?

A. Proteins from the nucleus released into tissue fluids by damage
B. Blood taken from a baby and injected into the mother
C. An artificial small protein
D. An artificial small non-protein
E. Mutated proteins present on the surface of cancer cells

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25. Cancer cells often contain many genetic mutations in their DNA.

Which of the following does NOT contribute to this observation?

A. Cancer tends to occur in older people after many cell divisions
B. Most DNA mutations cause cells to divide more often rather than less often
C. Genes must be mutated to allow uncontrolled cell division
D. Cancer can be caused by toxins and radiation which damage DNA
E. DNA repair mechanisms are often damaged in cancer cells

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26. Animals and plants have very different developmental genetics. This can be related to the way plants and animals function.

Order the features so as they match up with the list of evolutionary consequences:

1) Cannot move
2) Susceptible to herbivory
3) Primary producer
4) Fast movement
5) Complex anatomy

A. Variable body plan
B. Nervous system
C. Large part of genome regulates transcription factors
D. Large part of genome encodes enzymes
E. Any cell can re-grow any body part

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27. Plants use starch to store glucose, whilst animals store glycogen. Starch and glycogen stores have different properties which reflect the different ways plants and animals function.

Which of the following is NOT a correct explanation of the difference between plant and animal stores?

A. Animals need to release glucose quicker than plants to contract muscles
B. Animals store most of their energy as fat
C. Animals need to store their glucose in a denser form than plants
D. Animals need to control the concentration of glucose in their fluids more than plants
E. Animals often synthesise glucose from amino acids

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28. Lichens are organisms formed by the symbiosis of several kingdoms of life. They often include filamentous fungi, yeasts, algae and cyanobacteria (photosynthetic bacteria) living together.



Order the symbionts by their role in the organism.

1) Fixes nitrogen
2) Makes multicellular structure
3) Primary producer
4) Has chloroplasts
5) Reproduces sexually

A. Fungi
B. Cyanobacteria
C. Algae
D. Cyanobacteria & algae
E. Fungi & algae

29. Many species of plants are epiphytes, which means they grow on the branches of trees, to get brighter sunlight. Epiphytes collect their own water and nutrients so do not steal from the tree.

Which of the following correctly describes the epiphyte niche?

A. Growing on branches reduces competition
B. Epiphytes are parasites of trees
C. Trees and epiphytes are in a mutualistic symbiosis
D. Epiphytes increase the fitness of trees
E. Epiphytes only colonise living branches

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30. Monocots and dicots are the two major groups of flowering plants.

Which of the following are features of monocots? *Choose from the options below:*

i. Two seed leaves (cotyledons)
ii. Long narrow leaves
iii. Radial veins
iv. Taproot
v. Stem vessels in a ring

A. i
B. ii
C. iii
D. iv
E. v
F. ii and iv
G. ii and v
H. iii, iv, v
I. i, iii, iv, v

Section 5: Genetics & Analysis

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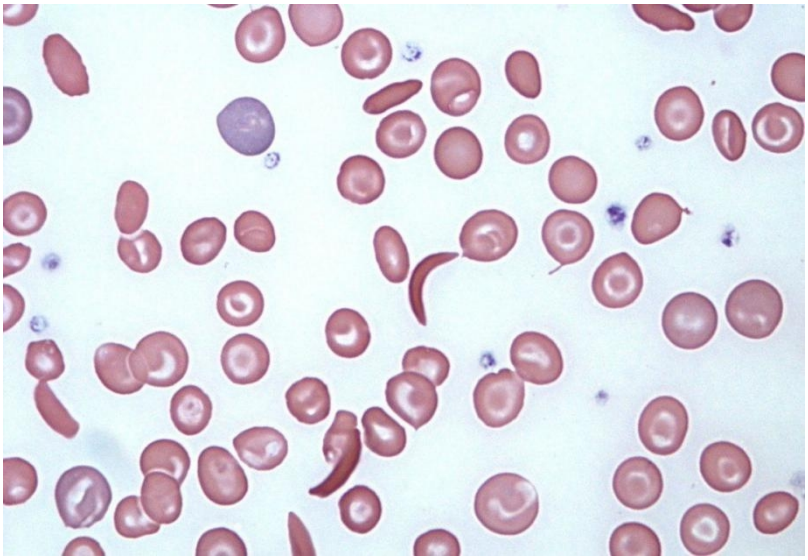
31. In a small village, 5% of people suffer Sickle Cell disease, caused by a recessive haemoglobin allele.



Calculate the frequency of the sickle cell allele in the village population.

A. 5.0%
B. 7.4%
C. 13.1%
D. 22.4%
E. 39.7%

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32. Fruit flies are the best organism for studying genetics. Wild type flies have a yellow body, whereas a mutant has an ebony body.



A yellow male and an ebony female were crossed. Their progeny had a roughly equal number of yellow and ebony flies of both sexes.

Which of the following is true?

A. Inheritance of body colour is NOT mendelian.
B. The mutation is X-linked.
C. One parent was homozygous and one parent was heterozygous.
D. Both parents were homozygous.
E. Both parents were heterozygous.

33.



The colour of snapdragon flowers is genetically controlled as shown:

Genotype	Phenotype
rr	White
Rr	Pink
RR	Red

Parent plants are crossed to produce many offspring. None of these first-generation offspring have white flowers. However, when these offspring are crossed, some of the second generation have white flowers.

What colour could each of the parent flowers be? *Choose from options in the table:*

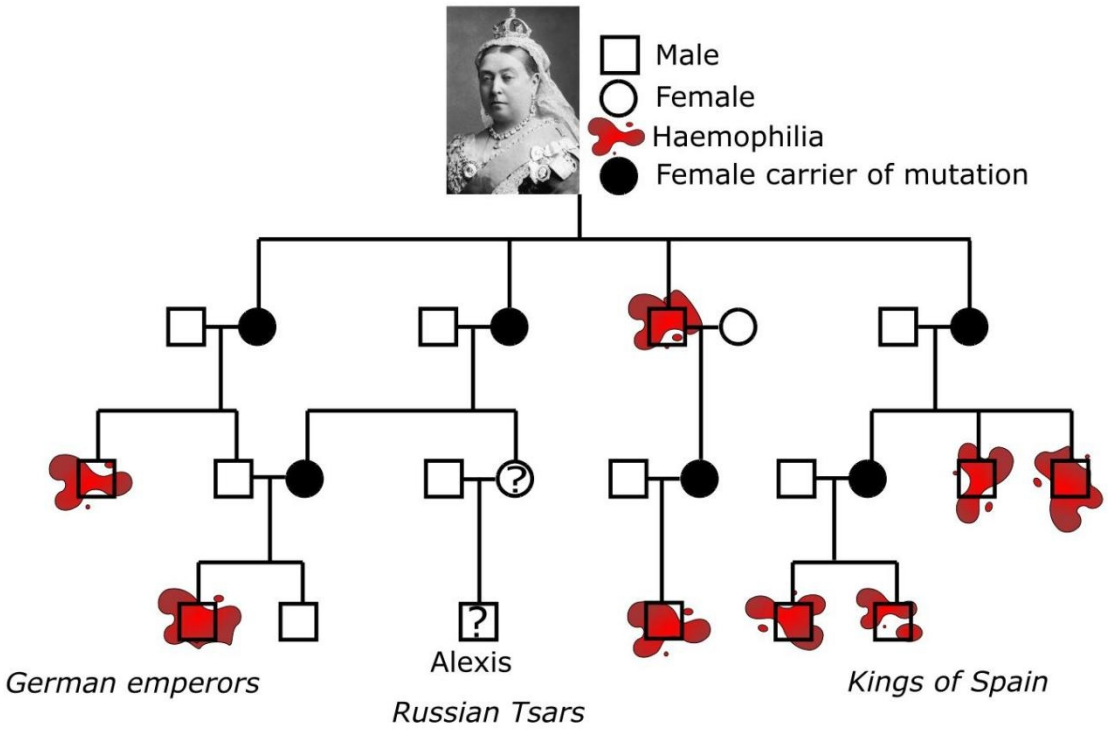
Cross	Parent 1	Parent 2
i	White	Red
ii	Pink	Pink
iii	Pink	Red
iv	Pink	White

A. i only
B. ii only
C. iii only
D. iv only
E. i and ii
F. i and iii
G. i and iv
H. ii and iii
I. ii and iv
J. iii and iv

34. **A genetic mutation occurred within Queen Victoria which caused many of her descendants to die from Haemophilia.**

The mutation is carried on the X chromosome, and is recessive.

Using this family tree, calculate the probability Alexis had Haemophilia.



A. 0%
B. 12%
C. 25%
D. 50%
E. 100%

35. Scottish wildcats are an endangered species.

In a modern version of a mark recapture experiment, hundreds of motion sensitive cameras were used to take pictures of wildcats. Volunteers used the patterns of their fur to distinguish individual cats. In one year, they found 10 different wildcats. In the next year they found 9 different wildcats, one of which had the same markings as a cat found the year before.

Calculate how many wildcats are left in Scotland.

A. 9
B. 90
C. 900
D. 1111
E. 9000

36. The resolving power of a microscope is the minimum distance apart two features have to be before the microscope can distinguish them.

The objective lenses of microscopes have two numbers engraved on them which are 'magnification / numerical aperture'. For example, a 40/0.65 lens has 40x magnification and a numerical aperture (NA) of 0.65.

λ is the wavelength of light in μm used to see the sample.



The resolving power of a microscope, in μm, is 0.61λ/NA.

Which of the following is true?

A. Zooming in on the image produced by an objective lens allows more detail to be seen.
B. Structures which glow red can be seen in more detail than structures glowing blue.
C. The example microscope can resolve organelles 1 μm apart using light of wavelength 1 μm.
D. A lens of NA = 0.2 is better than a lens of NA = 20.
E. Electrons in an electron microscope are accelerated to increase their wavelength.

Section 6: Quickfire II

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37. Some hormones have receptors in the cytosol (cytoplasm) and other have receptors on the plasma membrane.

What could NOT explain this difference?

A. Some hormones have trans-membrane transporters.
B. Some hormones are hydrophobic and can pass through the plasma membrane.
C. Some hormones can interact with their receptor from the other side of the membrane.
D. Some signals move from one cell into another through tunnels between them.

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38. Which of the following is an example of passive immunity?

A. Antibodies passed from mother to foetus.
B. Antibodies produced from B cells.
C. Cell death by killer T cells.
D. Vaccination with a weakened form of a virus.

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39. Water travels from plant roots to plant shoots.

How is this achieved?

A. Water is actively transported up the phloem.
B. Water is actively transported up the xylem.
C. Water is pulled by transpiration up the phloem.
D. Water is pulled by transpiration up the xylem.

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40. What colour of sunlight does chlorophyll NOT absorb?

A. Ultraviolet
B. Blue
C. Green
D. Orange
E. Red

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41. Genetic drift is a mechanism of evolution.

Which of the following is true?

A. Drift is a random process.
B. Drift results in adaptations.
C. Drift is driven by competition.
D. Drift occurs more in larger populations.
E. Drift only occurs in sexually reproducing organisms.

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42. War horses are trained not to be frightened by the sounds of war.



What type of behaviour is this?

A. Reflex
B. Instinct
C. Habituation
D. Imprinting
E. Conditioning
F. Insight

Section 7: Ecology II

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43. Flowers can use different strategies to spread their pollen.

Match the anatomy of the flower to the predicted pollination strategy it uses.

Put the strategies in the same order as the list below

1) Very fine, loosely attached pollen
2) Sturdy flowers with lots of nectar
3) Large pale flowers
4) Brightly coloured flowers with lots of pollen
5) Foul smelling flowers

A. Bird pollination
B. Bee pollination
C. Moth pollination
D. Fly pollination
E. Wind pollination

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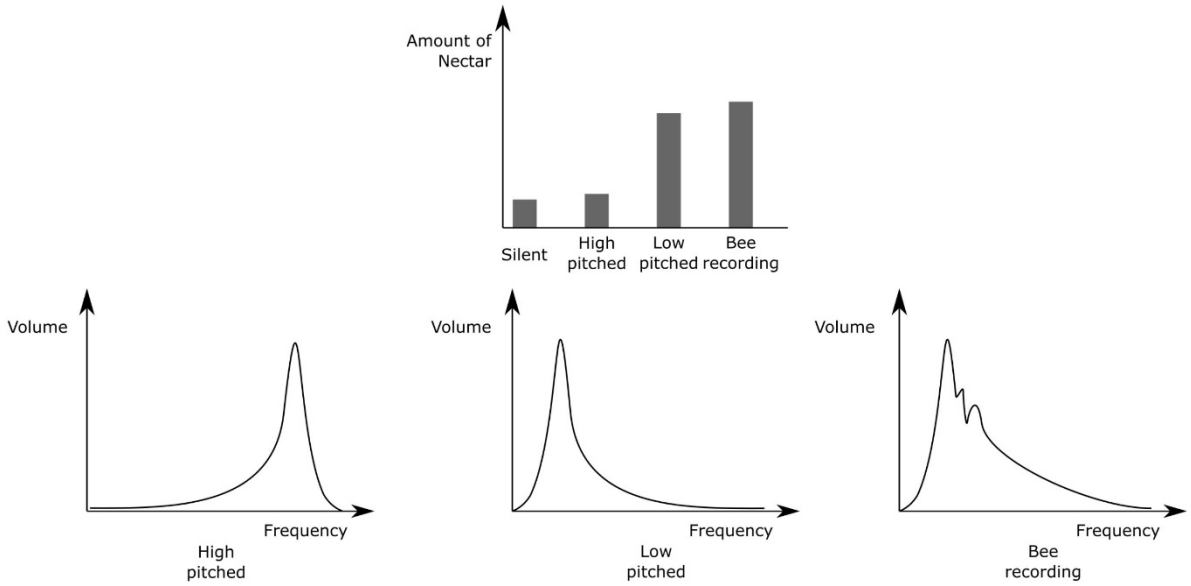
44. Scientists carried out an experiment to see whether plants could sense and respond to sounds. Specifically, they wanted to see if flowers changed their nectar production due to the sound of bees.

They played three sounds to flowers, at the same volume, and measured the amount of nectar produced after three minutes.



Which of the following is true?

A. The amount of nectar is always the same, irrespective of sound played.
B. Flowers only responded to the sound of bees.
C. Frequency of sound is important for flower perception.
D. The results are an artefact as a high pitch sound contains more energy than a low pitch one at the same volume.
E. Flowers can sense high pitched sounds.

45. Male and female bees visit distinct species of flower.

Males only need nectar for energy, but females need both nectar and pollen for nesting.

Which of the following is true?

A. Male and female bees are different species.
B. Male and female bees have identical adaptations.
C. Male bees visit fewer types of flower than females.
D. Male and female bees equally prefer the same colour patterns.
E. This behaviour increases intraspecific competition.

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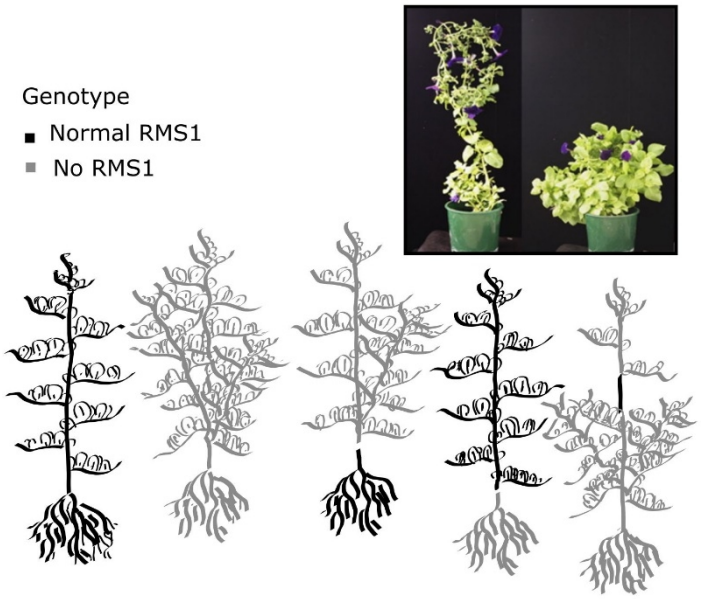
46. The gene *RMS1* controls how branched plants become, and it was altered in modern crops as part of the 'green revolution'.

Parts of seedlings with normal *RMS1* were grafted onto seedlings which have no *RMS1* to study how the gene works.



Which of the following is true?

A. *RMS1* increases shoot branching.
B. The signal produced by *RMS1* travels towards the shoot tip, rather than towards the roots.
C. *RMS1* in the roots alone is enough to give normal shoot branching.
D. Shoots cannot branch normally unless *RMS1* is in the roots.
E. The signal produced by *RMS1* only travels a short distance.

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47. You are familiar with food chains showing the flow of energy from primary producers to consumers, which mainly follows the flow of carbon.

Construct a food chain based on the flow of nitrogen.

Put the organism which consumes nitrogen gas from the air first, and the one which uses the nitrogen last at the end.

A. Plants
B. Anaerobically respiring gut bacteria
C. Saprotrophic bacteria (saprobionts)
D. Nitrogen fixing bacteria
E. Animals

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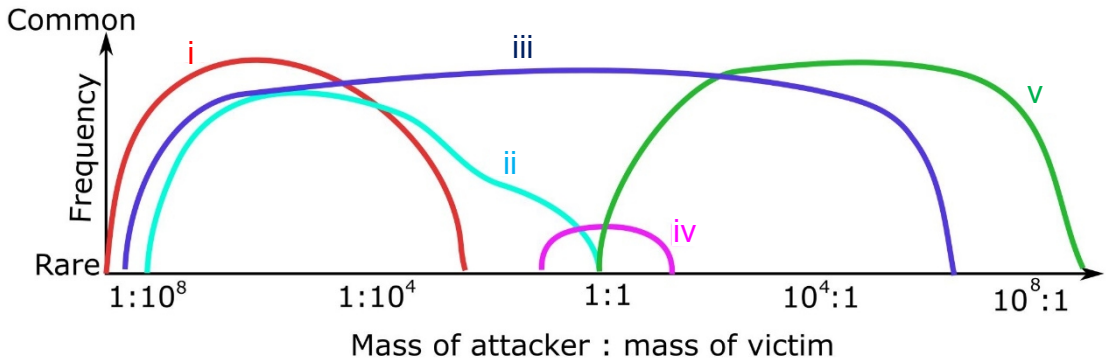
48. Some ecologists categorise species into a continuum containing pathogens to predators based on their niche and anatomy.

Below, the size of the attacker compared to the size of the victim is plotted.



Match the classification to the line letter.

Put the name corresponding to i first, then ii, iii, iv then v at the end.

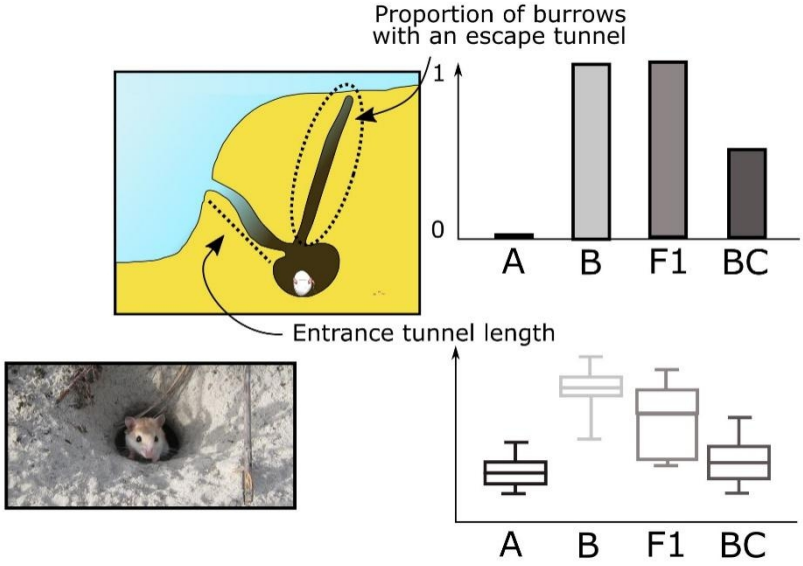
A. Parasite
B. Predator
C. Pathogen
D. Herbivore
E. Mimic

Section 8: Genetics II

49. Behaviour can be genetically controlled.

Burrowing mouse *species A* digs burrows without an escape tunnel and a short entrance tunnel. Burrowing mouse *species B* digs burrows with an escape tunnel and a long entrance tunnel.

Species A and B were cross-bred, and the burrows of the hybrid offspring (known as F1) were studied. The F1 mice were then cross-bred with species A, and the burrows of these back-cross (BC) mice were studied.



Which of the following is true?

A. Entrance tunnel length is influenced by many genes.
B. Absence of an escape tunnel is dominant to presence of an escape tunnel.
C. A mix of F1 hybrids and species B can be separated accurately by looking at their burrows.
D. Genes influencing entrance tunnel length and presence of an escape tunnel are close to each other (genetically linked).
E. Environmental factors influenced escape tunnel digging.

50. Sexual orientation in fruit fly matings can be controlled by the gene *fruitless*. *Fruitless* can make protein A and/or protein B, depending on circumstances. Mutations can disrupt which fruitless proteins are made.

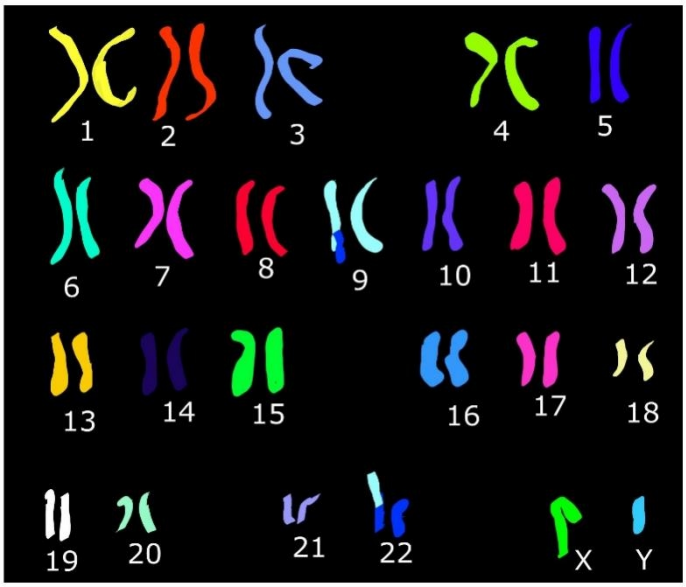
	Male		**Female**	
Genotype	Appearance of fly	Mates with	Appearance of fly	Mates with
Normal flies	Male	Females	Female	Males
No fruitless proteins	Male	Males & Females	Female	Males
Fruitless protein A only	Male	Females	Female	Females
Fruitless protein B only	Male	Males	Female	Males

Which of the following is true?

A. Fruitless controls which sex organs flies grow.
B. Fruitless protein B influences the sexual orientation of female flies.
C. Fruitless protein A causes flies to court with females.
D. Fruitless protein A and B have the same role in male and female flies.
E. Normal male flies only produce fruitless protein B.

51. A certain kind of blood cancer (leukaemia) is always caused when pieces of two chromosomes are swapped, which causes two genes to be stuck together. This new fusion gene produces a protein which forces cells to divide.

DNA from different chromosomes can be stained different colours, and seen down a microscope. Chromosomes from a person with this blood cancer are shown.



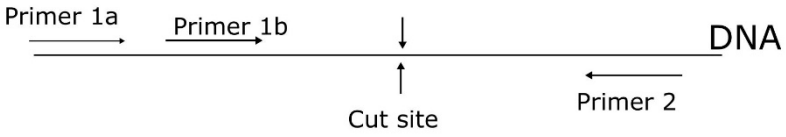
Which of the following is true?

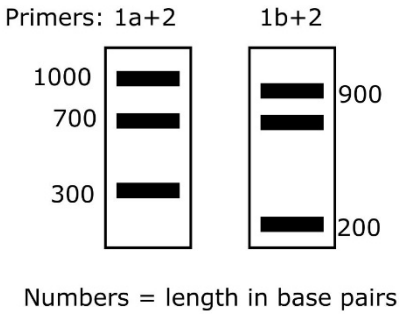
A. This mutation is recessive.
B. Pieces of chromosome 8 and 3 are swapped.
C. This person is female.
D. This person has Down syndrome (an extra copy of chromosome 21).
E. This person is heterozygous for the mutation.

52. The process of DNA fingerprinting involves using two primers to copy the bit of someone's DNA between them. These copies are then cut with enzymes that only bind specific DNA sequences. The length of the fragments of the copies can then be measured by gel electrophoresis.

DNA fingerprinting was carried out on one person using the primers shown.

The person had one allele that did not contain the cut site, and one allele which did contain the cut site.





Numbers = length in base pairs

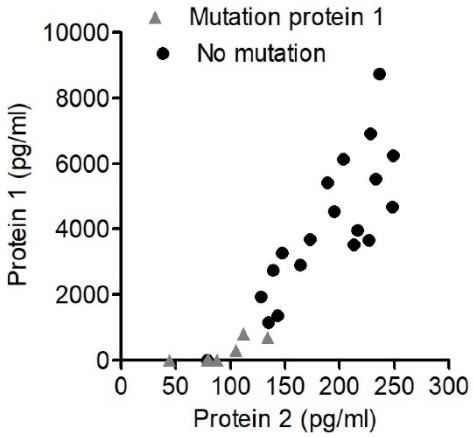
Calculate how far apart the primer and enzyme binding sites are away from one another. Which of the following is FALSE?

A. The primer 1b binding site is 100 bp from the Primer 1a binding site.
B. The enzyme cut site is 300 bp from the primer 1a binding site.
C. The primer 2 binding site is 1000 bp from the primer 1a binding site.
D. The primer 2 binding site is 700 bp from the cut site.
E. The primer 1b binding site is 300 bp from the cut site.

53. The concentration of two proteins in the blood vary between people.

Some people also carry mutations in the gene for one of these proteins.

The concentration of each protein in different people is plotted.

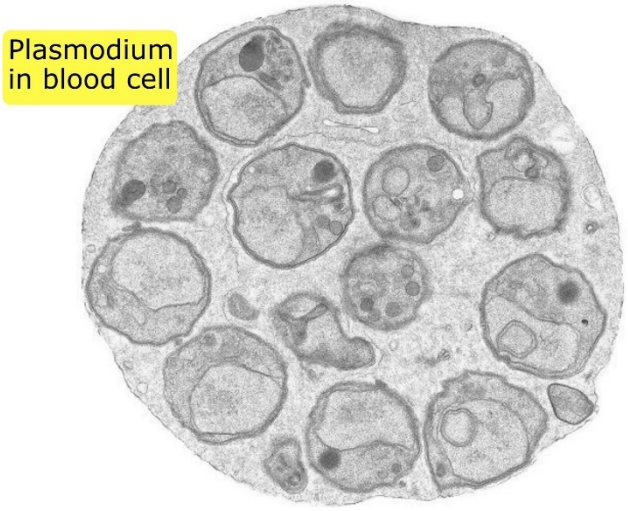


Which of the following hypothesis is NOT supported by this data?

A. Protein 1 and protein 2 are two halves of the same hormone.
B. The same transcription factor could regulate the genes for protein 1 and protein 2.
C. Environmental factors influence the concentration of protein 1.
D. Genetic factors influence the concentration of protein 1.
E. Protein 1 is required for the production of protein 2.

Section 9: Anatomy II

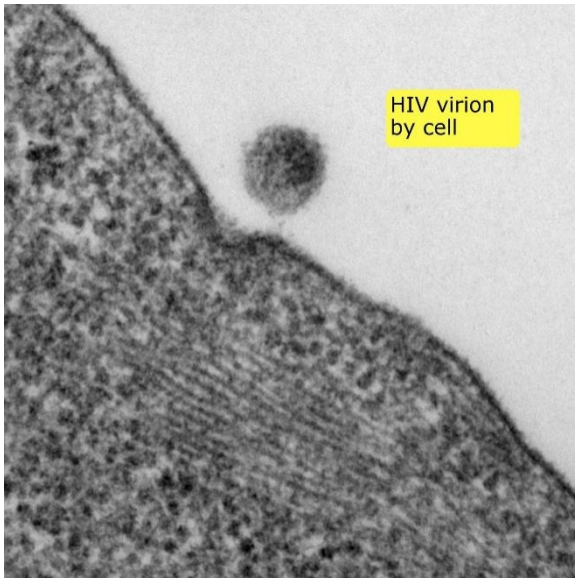
54. The organism which causes malaria, Plasmodium, has an organelle which is descended from chloroplasts.



Which of the following is true?

A. Plasmodium is a plant.
B. Plasmodium is a virus.
C. Plasmodium is a prokaryote.
D. Plasmodium can be killed by some herbicides.
E. Plasmodium does NOT have mitochondria.

55. HIV virus has a single stranded RNA genome which becomes incorporated into the human genome and then produces new virus.

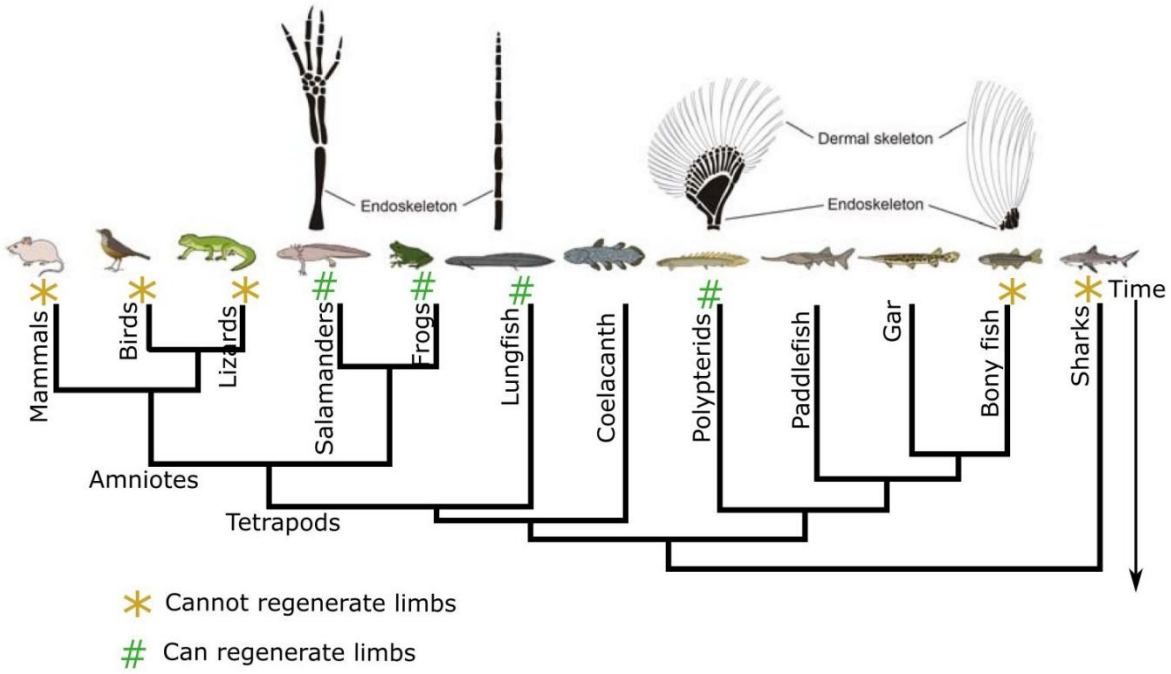


Put the following processes of the HIV life-cycle in order. *Assume the HIV genome has just entered the cell.*

A. DNA-dependent RNA polymerisation (transcription)
B. RNA-dependent DNA polymerisation (reverse transcription)
C. Release of new virus
D. DNA-dependent DNA polymerisation (DNA replication)

56. Some animals are able to regenerate their limbs if they are injured.

A phylogenetic tree of animals, and their regenerating ability is shown.



Which of the following is true?

A. Birds are more closely related to mammals than birds are to lizards.
B. Frogs are more closely related to lungfish than frogs are to birds.
C. The Amniota common ancestor could regenerate its limbs.
D. The coelacanth can regenerate its limbs.
E. Mammalian limbs cannot regenerate because the arrangement of bones is too complicated.

57. The heart can be stimulated to contract with either more or less force by nerves and hormones.

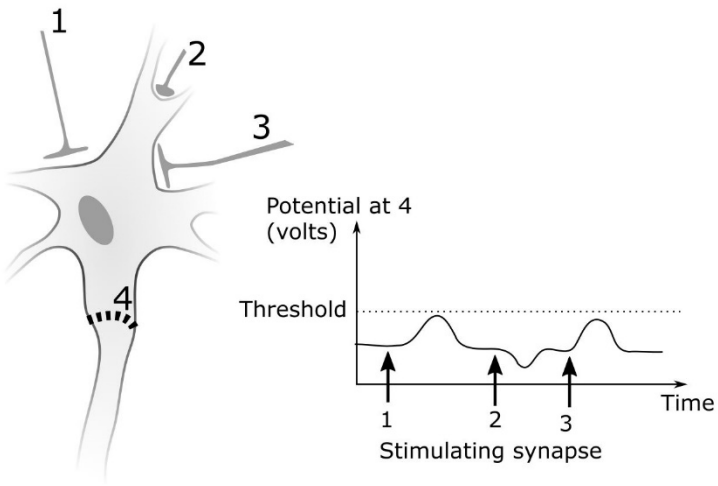
The heart can be stimulated to contract either more or less frequently by nerves.

Which of the following is true?

A. If pressure receptors of the arteries are over-stimulated, heart force and speed will increase.
B. Hearts rely more on the changing of frequency than force after they are transplanted into a new person.
C. The right-side of the heart contracts with more force than the left-side of the heart.
D. Blockage of the arteries requires the heart to contract more frequently.
E. Blockage of the arteries requires the heart to contract with more force.

58. Synapses transmit signals from one neuron to another, allowing them to process information like a computer. Different kinds of synapses have different effects on the neurons they signal to.

The effect of stimulation from synapses 1, 2 and 3 on the electrical potential of neuron 4 was measured.



Put the following events in order of the size of the potential that they cause at 4. *Put the event which causes the highest potential first, and the one that causes the most negative potential last.*

A. Stimulation from synapse 1, 2 and 3 simultaneously.
B. Stimulation from synapse 2 twice in quick succession.
C. Stimulation from synapse 1 and 3 simultaneously.
D. Stimulation from synapse 1 three times in quick succession.

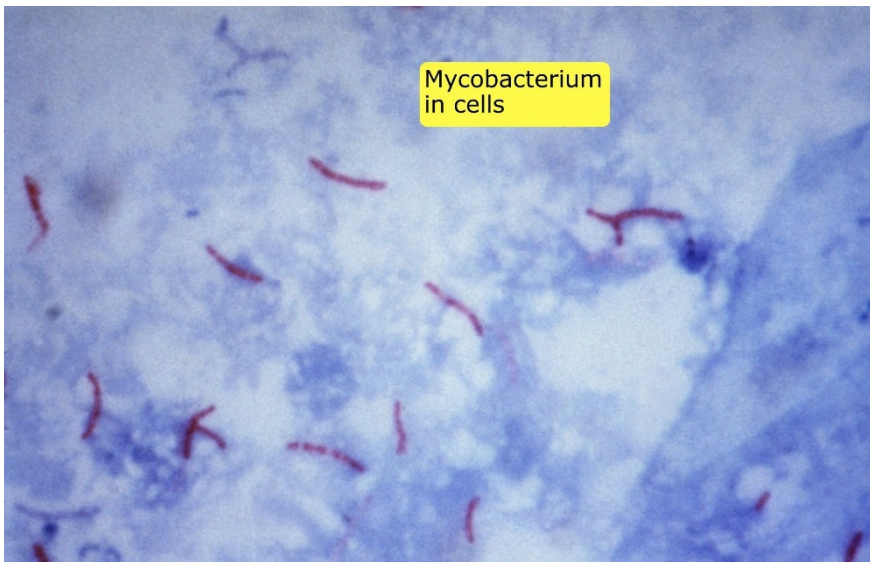
59. Insect and plant respiratory systems are similar. In both, openings (called spiracles in insects and stomata in plants) spread across their surface allow gasses to diffuse into air spaces within their bodies.

The facts listed below are true of both plants and insects, except one which is not true of both - which is it?

A. Spiracles and stomata shut in hot, dry conditions to conserve water.
B. Cells must be very close to the airspaces for diffusion.
C. Insects and plants are coated in a waxy layer to conserve water.
D. When spiracles and stomata are shut, carbon dioxide builds up within the organism.
E. Small hairs are used to trap humid air within plants and insects to conserve water.

Section 10: Biochemistry II

60. *Mycobacterium tuberculosis* causes TB, one of the oldest and most feared diseases.



Most antibiotics do not work against TB, the vaccine is moderately ineffective, and some strains are untreatable.

Listed below are special features of *M. tuberculosis*. Which does NOT make developing treatments difficult?

A. *M. tuberculosis* grows extremely slowly
B. *M. tuberculosis* only lives within human cells
C. *M. tuberculosis* has a very thick fatty cell wall
D. *M. tuberculosis* does not exchange genes horizontally with other bacteria
E. *M. tuberculosis* can go dormant within humans for decades

61. An agar plate was set up with 5 regions containing antibiotic at increasing concentrations as shown.

0 nM	1 nM	10 nM	100 nM	1000 nM

Bacteria were introduced at the left-hand side of the plate.

They quickly covered the whole of the first section then paused for a few days, before quickly spreading across the next section.

This behaviour repeated until, after 2 weeks, a uniform covering of bacteria was present across the whole plate.



Which of the following contributes to this observation?

A. Some of the bacteria put on the plate already had mutations which made them less susceptible to the antibiotic.
B. The bacteria spread out as far as possible to reduce competition for nutrients.
C. After 2 weeks, all the bacteria on the agar plate are resistant to the antibiotic.
D. The bacteria found on the right hand side are those which can swim the fastest.
E. The antibiotic was destroyed by chemicals in the agar over time.

62. Rigor mortis occurs after death because muscles stiffen.

Which of the following does NOT contribute to the onset of rigor mortis?

A. Myosin must bind ATP before it releases actin.
B. Damage to cell membranes leads to calcium accumulation within the cytoplasm.
C. Anaerobic glycolysis stops when cytoplasmic glucose runs out.
D. Damage to cell membranes leads to proteases degrading muscle proteins.
E. Oxygen is no longer delivered to muscles.

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63. RuBisCO is the enzyme which photosynthesising organisms use to fix carbon dioxide (CO2) from the air to carbohydrates. However, RuBisCO can bind oxygen (O2) instead of CO2, which forces the organism to consume energy.

Which of the following is true?

A. Plants do not need O_2 to grow.
B. If RuBisCO were modified to prevent oxygen binding, crops would grow better.
C. When RuBisCO first evolved, oxygen binding was as common as today.
D. Increased atmospheric carbon dioxide levels are increasing the rate of oxygen binding to RuBisCO.
E. Increasing the amount of RuBisCO in crops will help them grow better.

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64. Proteins fold into a shape based on non-covalent forces between atoms and the formation of covalent disulphide bonds between the side-chains of amino acids.

Urea is used to disrupt the non-covalent interactions, and DTT is used to reduce disulphide bonds.

The activity of an enzyme was measured after the addition and removal of DTT or urea to see how the denatured protein re-folds.

Added to begin with	Removed first	Removed second	Enzyme activity at end
None	None	None	100%
DTT & Urea	None	None	0%
DTT & Urea	Urea	None	0%
DTT & Urea	Urea	DTT	95%
DTT & Urea	DTT	Urea	2%

Which of the following is true?

A. The presence of the correct amino-acids alone is sufficient to give this enzyme activity.
B. Disulphide bonds always form between the same parts of this enzyme.
C. Disulphide bonds are necessary for this enzyme to function.
D. Non-covalent interactions are needed for disulphide bonds to form.
E. Non-covalent interactions contribute minimally to the activity of this enzyme.

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65. Many biological substances are polymers of simpler subunits. Condensation reactions join two molecules and water is produced as a product.

Which polymer is NOT produced in a condensation reaction?

A. Glycogen
B. Protein
C. Cellulose
D. Triglycerides
E. DNA

Section 11: Analysis II

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66. ***This is part one of two questions about protein translation.***

During translation, the triplet code of mRNA is complementary to specific tRNAs. Each type of tRNA is bound only to one of twenty different amino acids. Three triplets of mRNA instead bind factors which STOP translation.

ARS enzymes join particular amino acids to particular tRNAs.

Match the number to the correct statement.

1) The number of different mRNA triplets is...
2) The minimum number of different tRNAs needed is...
3) The minimum number of different ARS enzymes needed is...
4) The maximum number of different amino acids which an mRNA doublet code could specify is...

A. 20
B. 15
C. 64
D. 61

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67. ***This is part two of two questions about protein translation.***

ARS enzymes attach the wrong amino acid to a tRNA once in every 10 000 reactions.

Ribosomes pair the wrong tRNA with a mRNA once in every 10 000 reactions.

RNA polymerase includes the wrong nucleotide once in every 10 000 reactions.

DNA replication includes the wrong nucleotide once in every 1000 000 000 reactions.

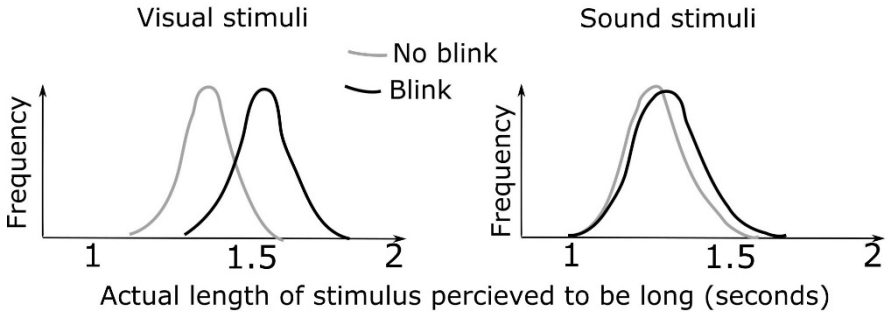
List the processes in order of the number of incorrect proteins they result in. ***Put the least important contributor to incorrect protein production first, and the most important contributor last.***

A. Replication
B. Transcription
C. Translation

68. Your brain manipulates your experience of the world in many ways.

One study asked if blinking eyes alters the perception of time. Specifically, they measured perceptions of the duration of a visual or a sound stimulus. Firstly, people were trained to get used to the duration of a long versus a short visual stimulus, or a long versus a short sound stimulus.

Next, people were given a random visual or sound stimulus, and were asked if they thought it had gone on for a long time. Sometimes, people happened to blink while they were experiencing the stimulus.



Which of the following is true about these results?

A. Blinking has the same effect on visual and sound perceptions of time.
B. Blinking makes visual stimuli appear slower.
C. The brain has a central clock which it uses to time stimuli.
D. The vision processing areas of the brain assess how much stimulus they received.
E. Blinking temporarily stops processing of sounds by the brain.

END