BBO 2017 paper 1

Cell Biology

Which of the following correctly orders the cellular components by size from largest to smallest?

- Nucleus, protein, ribosome, amino acid
- Nucleus, ribosome, protein, amino acid
- Protein, nucleus, amino acid, ribosome
- Amino acid, protein, ribosome, nucleus
- Ribosome, nucleus, amino acid, protein

When DNA molecules are analysed by gel electrophoresis, they will migrate towards an electrode. Small DNA molecules will migrate at a different speed from large DNA.

Which of the following options about movement towards an electrode and speed of migration is correct?

- Moves towards positive electrode and small DNA molecules migrate at a slower rate than large DNA molecules
- Moves towards positive electrode and small DNA molecules migrate at a faster rate than large DNA molecules
- Moves towards negative electrode and small DNA molecules migrate at a slower rate than large DNA molecules
- Moves towards negative electrode and small DNA molecules migrate at a faster rate than large DNA molecules

Which of the following statements is correct about the synthesis of proteins in eukaryotes?

Protein synthesis only takes place by ribosomes bound to the endoplasmic reticulum
tRNA molecules transport amino acids to ribosomes during protein synthesis
A codon can code for more than one amino acid

- 1 only
- 2 only
- 3 only
- 1 and 2 only
- 2 and 3 only

Which of the following is the correct sequence of involvement in the process of protein synthesis?

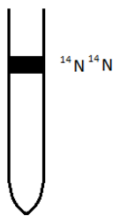
- Nucleus, mRNA, cytoplasm, ribosome,
- Ribosome, smooth endoplasmic reticulum, mitochondria, tRNA
- mRNA, tRNA, endoplasmic reticulum ,ribosome
- DNA, mRNA, golgi apparatus, nucleolus
- tRNA, endoplasmic reticulum, ribosome, nucleus

Which metabolic pathway is common to both animal respiration and yeast fermentation?

- Krebs cycle
- Electron transport chain
- Glycolysis
- Synthesis of acetyl CoA from pyruvate
- Reduction of pyruvate to lactate

DNA replication is a semi-conservative process. This was tested by Messelson and Stahl (1958), who grew *Escherichia coli* first on a medium of 'light nitrogen' (^{14}N) for one generation and then on a medium containing 'heavy nitrogen' (^{15}N).

After each generation they extracted DNA samples from the *E. coli* and centrifuged it at very high speeds, separating it out based on density. After growing *E.coli* on 'light nitrogen' they found the following DNA result after centrifugation.

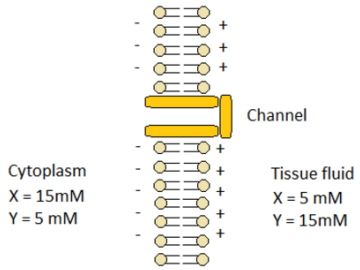


They then grew the *E.Coli* for two generations on 'heavy nitrogen'.

What would the centrifuged sample of DNA look like after the **second** generation grown on 'heavy nitrogen'?

In an enzyme-catalysed reaction, the addition of compound X results in a lowering of the activation energy. Compound X is likely to be which of the following?

- An inhibitor which structurally resembles the enzyme
- A molecule which denatures the enzyme
- An activator that binds to an allosteric site on the enzyme
- An inhibitor that binds irreversibly to the active site
- Another enzyme which reverses the reaction

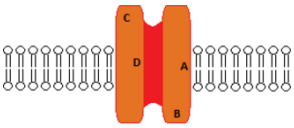


When open, the channel allows the positively charged ions X and Y through the plasma membrane. There is a potential difference across the membrane with the tissue fluid as indicated. Which of the following occur when the channel opens?

- There will be net movement of X out of the cell only.
- There will be net movement of Y into the cell only.
- The movement of Y into the cell will be greater than the movement of X out of the cell.
- The charge inside the cell will become more negative
- There will be no net change in the concentration of X or Y inside the cell as there will be no net change in the potential difference across the membrane.

The following schematic diagram shows a transmembrane ion channel. In which domain A-D would you expect an amino acid with an uncharged, non-polar side chain?

Outside



A cylinder is cut from an uncooked potato, measured and placed in a sugar solution. After two hours it is again measured and shows no change in length.

Which of the following explanations is most acceptable?

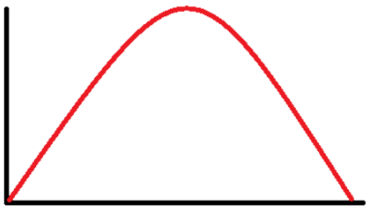
- The water potential on either side of the cell membrane is equal
- Placing the potato cylinders in the solution has prevented evaporation from the cut surface
- The sugar solution in which the potato is placed has a higher water potential than the cell sap
- The sugar solution in which the potato is placed has a lower water potential than the cell sap

The following stages were performed to make a dilution series of a solution.

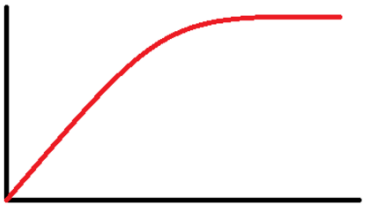
$5cm^3$ from $10cm^3$ of a stock 10% solution was transferred to $5cm^3$ of water in test tube 1. From this $1cm^3$ of solution was transferred to $9cm^3$ water in test tube 2. From this, $1cm^3$ of solution was transferred to $9cm^3$ water in test tube 3.

Which of the following ranges of solutions will result?

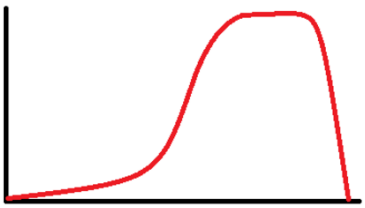
- 10%, 1%, 0.1%, 0.01%
- 10%, 0.5%, 0.1%, 0.01%
- 10%, 5%, 0.5%, 0.05%
- 10%, 0.1%, 0.5%, 0.01%



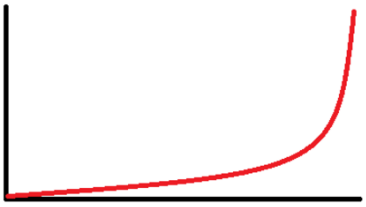
Graph 1



Graph 2



Graph 3



Graph 4

A student takes a beaker of water and stirs in some sucrose and a small number of yeast cells. They monitor the size of the yeast population over the next few weeks and plot their results as a line graph. Choose which of the graphs above you think most closely resembles their findings.

- Graph 1
- Graph 2
- Graph 3
- Graph 4

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2017 BBO Paper 1

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Genetics and evolution

Tay-Sachs disease which is lethal, results from having the homozygous recessive condition of the responsible gene.

Which ONE of the following statements is true?

- Only homozygous dominant individuals will be able to survive and reproduce
- Heterozygous individuals will survive and may pass the recessive allele on to their offspring
- In the heterozygous condition, the dominant allele will overcome the recessive allele and only the dominant allele will be passed on to offspring
- Homozygous dominant individuals will be more likely to reproduce than heterozygous individuals

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According to the Darwinian theory of evolution, which of the following is true?

- A father who has had his appendix removed will have children with no appendix
- Squids have longer arms because previous generations of squid stretched their tentacles to catch prey.
- Humans evolved from chimpanzees.
- An increasing proportion of Australian rabbits are immune to the myxomatosis virus because those that are resistant are able to breed, while those that are not die.
- Giraffes have long necks because each generation stretches their neck longer so that they can eat leaves higher on trees.

In a disputed paternity case, the following blood groups were identified.

Mother - Group A

Baby - Group O

Mr Richards - Group A

Mr Rigby - Group B

Which of the following statements is true?

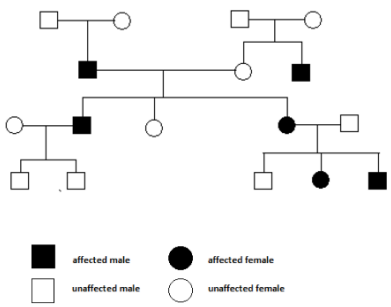
- Either man could be the father
- Mr Richards cannot be the father
- Mr Rigby cannot be the father
- Neither man could be the father

One thousand peppered moths, *Biston betularia*, were captured from a large isolated population. They were each marked with a spot of cellulose paint and then released. Later one hundred individuals were captured from the same population, and of these only ten moths had the paint spot on them.

Which of the following gives the most accurate estimate of the size of the population of moths of this species?

- 10^2
- 10^3
- 10^4
- 10^5
- 10^6

A rare condition is suspected to be inherited. The diagram below shows the pedigree of a family tree affected by the condition.



Which is the most likely explanation of the way the condition is inherited?

- Sex linkage on the X-chromosome
- Sex linkage on the Y-chromosome
- Autosomal recessive allele
- Autosomal dominant allele

In cattle, the allele for hornless condition is dominant. The alleles controlling colour show co-dominance, the heterozygote displaying the roan colour.

The most likely result from crosses between a red hornless bull and white horned cows would be offspring that are which of the following?

- Red hornless and roan hornless
- All roan horned
- Roan hornless and roan horned
- White hornless and roan hornless
- All red hornless

Which of the following is a true statement about Darwinian evolution?

- Bacteria are no longer evolving
- Dolphins are more highly evolved than fish
- An organism evolves throughout its lifespan
- Species that reproduce asexually do not evolve
- Predators are not the only selection pressure faced by most populations

In a population of 200 small mammals, there were 72 albinos. It can be assumed that the gene for albinism is recessive to the gene for brown hair, that there is random mating and that no mutation occurs.

How many mammals in the population were homozygous for brown hair?

- 16
- 28
- 32
- 64
- 128

2017 BBO Paper 1

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Animal anatomy and physiology

The main function(s) of the liver is/are which of the following?

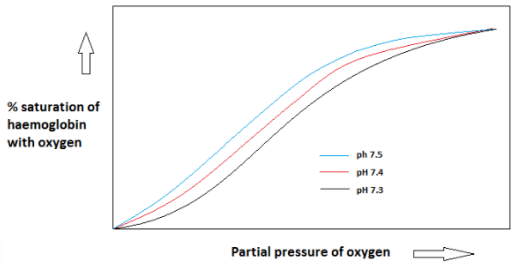
Secretion of insulin and glucagon
Production of bile
Uptake and release of glucose into the bloodstream
Excretion of nitrogenous wastes
Breakdown of toxic substances

- 1 only
- 2 only
- 2 and 3
- 1 , 3 and 4
- 2, 3 and 5

Which of the following initiates contraction in a muscle cell?

- An increase in the cytoplasmic Ca^{2+} concentration
- High concentrations of ATP
- An influx of H^{+} into the sarcoplasmic reticulum
- A decrease in the lactic acid concentration of the cell

The following graph shows the affinity of haemoglobin for oxygen at three different pH levels.



During periods of vigorous exercise, lactic acid is produced by the muscles.

What effect will this have on haemoglobin in the muscles compared to normal physiological conditions (pH7.4)?

- Haemoglobin will have a higher affinity for oxygen
- Haemoglobin will have a lower affinity for oxygen
- Haemoglobin will have the same affinity for oxygen
- Haemoglobin will have a higher affinity for oxygen at very low and very high oxygen concentrations only
- Haemoglobin will have a lower affinity for oxygen at very low and very high oxygen concentrations only

Impulses travel more rapidly along nerves from the leg muscles of a mammal than along nerves from the leg muscles of an insect.

Which of the following explains this?

- In the mammal there is a high concentration of sodium ions inside the axon
- In the mammal the nerves contain myelinated fibres
- In the mammal there is a potential difference across the axon membrane
- In the mammal the cell bodies of the fibres are contained within dorsal root ganglia
- In the mammal the area of a cross section of a fibre is greater

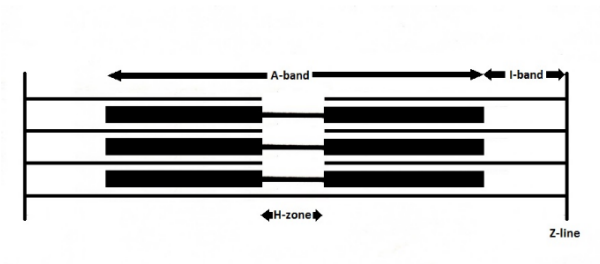
Which statement about human vision is **CORRECT**?

- The pigmented cornea gives the human eye its colour.
- In long-sightedness (hypermetropia), the lens is too close to the retina.
- The amount of light entering the eye is regulated by the lens
- Rod cells can distinguish colour in daylight.
- Cone cells are responsible for vision in dim light.

In the mammalian kidney, what causes water to be reabsorbed into the blood from the descending limb of the loop of Henle?

- Active transport of salt out of the descending tubule.
- A decrease in the water potential of the medullary tissue
- An increase in the water potential of the medullary tissue
- High blood pressure.
- The ascending loop being impermeable to water

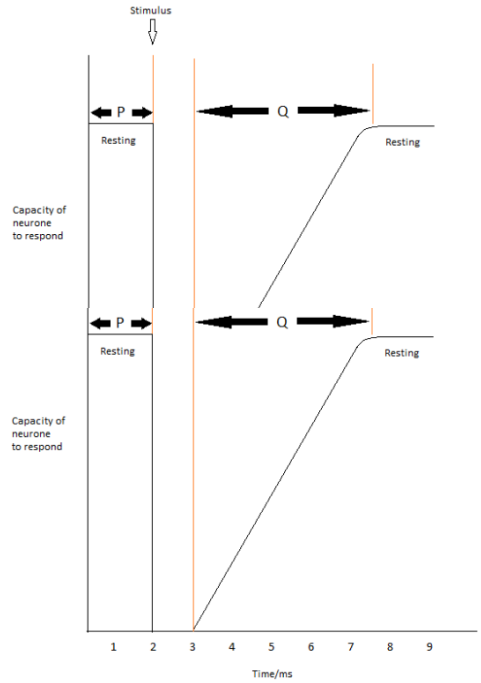
The diagram below shows the arrangement of protein filaments within one sarcomere of a myofibril in striated muscle.



According to the sliding filament hypothesis, which of the following would happen on contraction of this myofibril?

- The width of the A band would increase
- The width of the I band would decrease
- The width of the H zone would increase
- The tropomyosin heads would release ATP

The graph below records the capacity of a neurone to respond to a stimulus before, during and after the conduction of an impulse.



Which of the following statements is true about the time period marked Q compared with the period P?

- No impulses can be generated
- Impulses are conducted more slowly
- Impulses of smaller magnitude are conducted
- Larger stimuli are required to generate an impulse

A sample of human blood is taken, and it is found that all of the cells are alive.

- No impulses can be generated
- Impulses are conducted more slowly
- Impulses of smaller magnitude are conducted
- Larger stimuli are required to generate an impulse

A sample of human blood is taken, and it is found that all of the cells are alive.

The blood is then frozen at –20°C. One day later the blood is thawed and heated to 37°C and it is found that no cells in the blood are living.

Why have the cells died?

- The cold temperature inhibited important respiratory enzymes and therefore prevented the cells from releasing energy (ATP).
- As the water in the cells froze it expanded, fracturing the cells and hence killing them.
- As the serum cooled, ions such as sodium precipitated out, causing an osmotic imbalance between the cells and the serum.
- Human cells cannot be expected to survive longer than several hours outside the body, under any conditions.
- Cooling the cells down caused their cell membranes to solidify, thus preventing vital cellular processes and the exchange of compounds.

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Plant anatomy and physiology

In an experiment, wheat plants are exposed to carbon dioxide containing the ^{14}C carbon isotope ($^{14}CO_2$) for 1 hour in the presence of light.

Which of the following compounds would you expect to contain the highest amount of ^{14}C after the 1 hour exposure?

- Proteins
- Sugars
- Salts
- Lipids
- Nucleic acids

Which events occur during the light dependent reactions of photosynthesis?

- Fixation of carbon dioxide, reduction of NADPH, formation of ATP
- Oxidation of water, reduction of NADP, formation of ATP.
- Oxidation of water, reduction of NADP, hydrolysis of ATP.
- Fixation of carbon dioxide, release of oxygen, synthesis of glucose.
- Release of oxygen, fixation of carbon dioxide, hydrolysis of ATP.

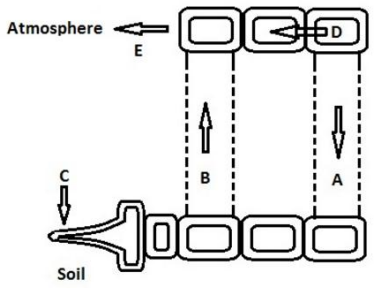
Most plants flower according to the number of hours of uninterrupted darkness they receive. Some plants known as 'short day' plants require more than 12 hours of uninterrupted darkness in order to flower. Other plants known as 'long day' plants require less than 12 hours of uninterrupted darkness in order to flower. If a 'short day' plant and a 'long day' plant are grown on a cycle of 10 hours light and then 7 hours darkness then 1 hour light then 6 hours darkness per day, which plant(s) will flower under these conditions?

- The 'short day' plant only
- The 'long day' plant only
- Both plants will flower
- Neither plant will flower
- Both plants will flower during the day but not at night

Which one of the following processes would not be stopped if the tissue concerned were poisoned?

- Development of turgor pressure by the cells of the cortex
- Transport in the phloem
- Uptake of salts by the root hair cells
- Transport in the xylem

The diagram below represents those parts of a plant associated with the transfer of materials during daylight.



Which one of the arrows A, B, C, D or E indicates mass-flow of organic solutes?

- A
- B
- C
- D

In photosynthesis, water is the source of which of the following?

- Oxygen for balancing its use in respiration
- Electrons for reducing oxidised chlorophyll
- Energy for reducing NADP
- Energy for producing ATP

Pea seedlings were grown in three culture solutions, X, Y and Z. After six weeks, the ones in solution X had yellow leaves and short internodes. The ones in solution Y were small with yellow leaves and had red patches on the stem. Those in solution Z had green leaves and stems.

Which of the following statements can be deduced?

- X lacked magnesium, Y lacked calcium, Z lacked iron
- X lacked calcium, Y lacked nitrogen, Z lacked chlorine
- X lacked calcium, Y lacked nitrogen, Z had all nutrients
- X lacked magnesium, Y lacked nitrogen, Z had all nutrients

In the root of a dicotyledon, Casparian strips are found in the which of the following?

- Exodermis
- Endodermis
- Xylem vessels
- Pericycle

In the root of a dicotyledon, Casparian strips are found in the which of the following?

- Exodermis
- Endodermis
- Xylem vessels
- Pericycle

Which of the following zones in the root provides the force needed to penetrate the soil?

- root cap zone
- zone of differentiation
- zone of vacuolation
- zone of cell division

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Ecology

Observations were repeated several times on the response to humidity of a group of beetles of the same age in a choice chamber.

While most of the beetles were found on the dry side, certain individuals were consistently on the moist side.

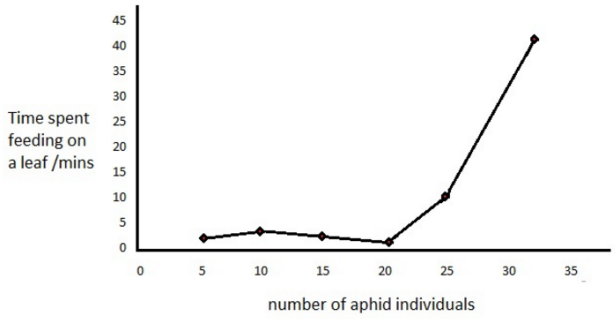
Which hypothesis below best accounts for this variation in behaviour?

- Certain beetles are unable to discriminate between relative humidity differences.
- Distribution of the beetles is the result of kinesis
- Beetles prefer surroundings of low humidity
- Some of the beetles had been previously exposed to a more humid environment than the others

Which of the following is a typical feature of the climax stage of an ecological succession?

- The ecosystem is relatively stable
- The increase in biomass is at its maximum
- The number of plant and animal species continues to increase
- The net production of the ecosystem has remarkable but regular differences from year to year.
- The climax stage is independent of abiotic factors

Aphids are common prey for ladybird beetles. The figure displays the number of individual aphids on a leaf against the amount of time spent feeding on a leaf by ladybird beetles.



What does the figure indicate?

Ladybird beetles become confused when stationary prey is abundant, and have to spend a longer time capturing an individual

The size of the ladybird population is dependent on the number of aphids available

Ladybirds do not waste time on a leaf when aphids are in short supply

Ladybirds have a better chance of spotting from afar a leaf with many aphid individuals compared with a leaf with few aphids

Ladybirds spend more time on leaves where there are more aphids, because their net energy gain is maximum due to fewer losses from searching

- only 1
- only 2
- only 3
- 3 & 5
- 2, 3 & 4

Which of the following factors would prevent estimation of the size of an insect population by the mark-release-recapture method?

- Random spreading after release
- A negligible amount of immigration
- A negligible amount of emigration
- A long adult life
- A short adult life

Which of the following will reduce the denitrifying activity of denitrifying bacteria?

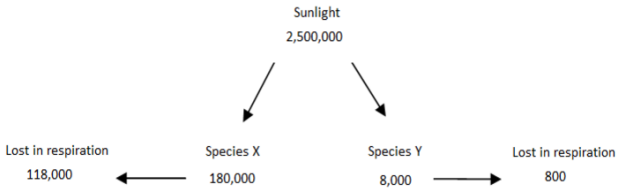
- An increase in soil moisture content
- An increase in soil nitrate concentration
- A decrease in nitrogen concentration
- A decrease in oxygen concentration
- An increase in oxygen concentration

Which of the following statements about eutrophication are TRUE?

1. It can be a naturally occurring process.
2. It is commonly found in standing rather than running water.
3. It can lead to oxygen depletion.
4. It is commonly associated with high levels of nitrates and sulphates.
5. It is commonly associated with high levels of phosphates and nitrates.

- all of them
- 1, 2, 3 & 4 only
- 2, 3, & 4 only
- 1, 2, 4 & 5 only
- 1, 2, 3, & 5 only

The data given show the energy flow in kJ m^{-2} $year^{-1}$ through a marsh, *Spartina* (cord grass) and algae being the principal autotrophs.



Which of the following statements is supported by these data?

- Spartina fixes approximately 2% of the sun's energy incident upon it
- The net productivity of Spartina is 144,898 kJ m^{-2} $year^{-1}$
- Algae are more efficient than Spartina at turning their photosynthetic product into plant matter
- Algae have a higher gross primary production than does Spartina

Energy is transferred between trophic levels in a food chain. Which of the following stages represents the **LEAST** efficient transfer of energy?

- Sun to the primary producer
- Primary producer to the primary consumer
- Primary consumer to the secondary consumer
- Secondary consumer to the tertiary consumer
- Tertiary consumer to decomposer

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