

Practice Multiple choice questions: Enzymes

Which type of bonds link carboxyl and amino groups outside of peptide bonds and are relatively weak to changes in pH?

- A. Hydrogen bonds ☐
- B. Disulfide bridges ☐
- C. Ionic bonds ☐
- D. Hydrophobic interactions ☐

What level of a protein's structure is two or more large molecular subunits joined together to make one protein?

- A. Primary structure ☐
- B. Secondary structure ☐
- C. Tertiary structure ☐
- D. Quaternary structure ☐

Which model of enzyme activity suggests that the substrate slightly changes the shape of the enzyme, making it more effective?

- A. Lock and key model ☐
- B. Activation model ☐
- C. Induced-fit model ☐
- D. Complementary model ☐

Which term correctly describes a molecule that fits into a secondary site on an enzyme, and changes the enzyme's shape so it cannot bond with its substrate?

- A. Permanent inhibitor ☐
- B. Non-competitive inhibitor ☐
- C. Competitive inhibitor ☐
- D. Active inhibitor ☐

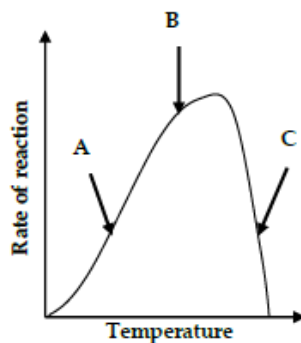
What is the optimum pH of a digestive enzyme that is most active in the stomach likely to be close to?

- A. 3 ☐
- B. 5 ☐
- C. 7 ☐
- D. 12 ☐

Which of the effects described below would *consistently* increase the rate of different enzyme-controlled reactions?

- A. Decreasing the temperature ☐
- B. Reducing the enzyme concentration ☐
- C. Introducing a non-competitive inhibitor ☐
- D. Increasing the substrate concentration ☐

At which point on the graph below is temperature most likely to be the limiting factor on the rate of the enzyme-controlled reaction?



- A. Point A ☐
- B. Point B ☐
- C. Point C ☐
- D. It is equally likely to be the limiting factor at both point A and point C. ☐

Set 2:

What effect do enzymes have on the energy levels of a reaction?

- A. They decrease the energy level of the products, so more energy is released overall. ☐
- B. They increase the energy level of the substrate, so less energy is needed to start. ☐
- C. They lower the activation energy of a reaction, making it easier to start. ☐
- D. They increase the activation energy of a reaction, so more energy is released overall. ☐

Enzymes are described as having specificity. What does this mean?

- A. Enzymes have a defined 3D shape which is not easily modified by changes in temperature or pH. ☐
- B. Each enzyme has an exact amino acid sequence, which does not vary between individuals in a species. ☐
- C. Enzymes only function under a specific set of climatic conditions. ☐
- D. Each enzyme only catalyses one specific reaction, or a few similar reactions. ☐

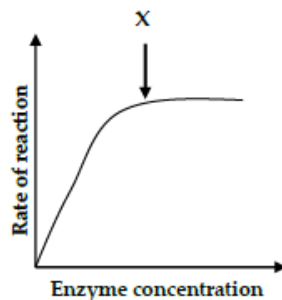
Malonic acid interacts with the active site of succinate dehydrogenase, blocking its substrate from accessing the active site. Which term best describes this effect?

- A. Competitive inhibition ☐
- B. Non-competitive inhibition ☐
- C. Reversible inhibition ☐
- D. Non-reversible inhibition ☐

Which of the effects described below would *consistently* decrease the rate of different enzyme-controlled reactions?

- A. Increasing the temperature ☐
- B. Reducing the pH ☐
- C. Introducing a non-competitive inhibitor ☐
- D. Increasing the substrate concentration ☐

What is most likely to be the limiting factor on the rate at point X in the enzyme-controlled reaction below?



- A. Enzyme concentration ☐
- B. pH ☐
- C. Substrate concentration ☐
- D. Temperature ☐

Mitosis and Meiosis:

1. Which part of the cell disintegrates in the early stages of mitosis?

- A. Spindle fibres ☐
- B. Nuclear envelope ☐
- C. Golgi apparatus ☐
- D. Cell membrane ☐

2. Which of these is *not* a function of mitosis?

- A. Enabling the zygote to divide into many cells ☐
- B. To increase genetic diversity ☐
- C. To allow the body to grow ☐
- D. To repair tissue damage ☐

3. Which stage of mitosis is shown in the picture/diagram below?



- A. Prophase ☐
- B. Metaphase ☐
- C. Anaphase ☐
- D. Telophase ☐

4. What happens during cytokinesis?

- A. The nucleus divides. ☐
- B. The cytoplasm divides. ☐
- C. Spindle fibres develop. ☐
- D. Chromatids are pulled to opposite ends of the cell. ☐

Which of these sentences correctly describes a *difference* between mitosis and meiosis?

- A. Mitosis creates cells in the adult body while meiosis only occurs in the embryo. ☐
- B. Mitosis creates diploid daughter cells, while meiosis creates haploid cells. ☐
- C. Mitosis creates four daughter cells, while meiosis only creates two. ☐
- D. Mitosis occurs at a specific point in the life cycle, while meiosis happens throughout ☐

Which of these processes does *not* describe a way in which genetic variation increases during meiosis?

- A. Random segregation of homologous chromosomes during the first metaphase/anaphase ☐
- B. Random mutation of the genetic code during DNA replication ☐
- C. Random segregation of chromatids during the second metaphase/anaphase ☐
- D. Crossing-over of homologous chromosomes, to exchange parts of their arms ☐

Set 2:

Which event does *not* occur during interphase?

- A. The cell grows in size and carries out normal metabolic functions. ☐
- B. Chromosomes line up across the equator of the cell. ☐
- C. Checkpoints assess any damage to DNA and can 'pause' the cell cycle. ☐
- D. DNA is replicated with the aid of DNA polymerase. ☐

During which stage of meiosis do the nuclear envelopes reform around separated chromatids?

- A. Anaphase ☐
- B. Prophase ☐
- C. Metaphase ☐
- D. Telophase ☐

Which of the events below causes genetic variation during mitosis?

- A. Crossing over of homologous chromosomes ☐
- B. Random mutation ☐
- C. Independent assortment ☐
- D. Random fertilisation ☐

Which stage of mitosis is shown in the picture/diagram below?



- A. Prophase ☐
- B. Metaphase ☐
- C. Anaphase ☐
- D. Telophase ☐

Biodiversity

Which of these methods alone would *not* provide information about biodiversity in an ecosystem?

- A. Counting the number of species present in five randomly located 1 m × 1 m quadrats ☐
- B. Counting percentage cover of plants in quadrats, to estimate relative species dominance ☐
- C. Marking, releasing and recapturing individuals from a species to estimate its population size ☐
- D. Sequencing the genes of endemic species to find out how many loci are polymorphic ☐

For a mountain goat, identify the abiotic factor from the list below.

- A. Competition for food from other herbivorous mammals. ☐
- B. Risk of predation from wolves. ☐
- C. Competition for space on thin mountain ledges. ☐
- D. Temperature extremes at high altitude. ☐

Male lions on the African savannah compete for mates, territory and food, often killing younger or less able males. What form of competition is this?

- A. Interspecific competition ☐
- B. Exclusionary competition ☐
- C. Interference competition ☐
- D. Intraspecific competition ☐

A population of small mammals is accidentally introduced by humans into a region where the species did not previously exist. Which factor below would *not* limit the carrying capacity of the population?

- A. Availability of water ☐
- B. Competition from other species ☐
- C. Rate of population growth ☐
- D. Risk of predation ☐

Which type of sampling is achieved using a belt transect?

- A. Random sampling ☐
- B. Systematic sampling ☐
- C. Opportunistic sampling ☐
- D. Stratified sampling ☐

A research team wants to know the size of a population of rabbits. They capture 60 rabbits, marking them with UV paint before releasing them. Three days later, they capture a second sample of 60 rabbits; of the second sample group, 9 are marked with UV paint.

Estimate the size of the rabbit population.

- A. 400 ☐
- B. 540 ☐
- C. 3600 ☐
- D. More information needed. ☐

Set 2:

Which sentence describes the difference between species evenness and species richness?

- A. Species richness describes the number of species present, while species evenness shows how abundant each species is. ☐
- B. Species evenness describes the number of species present, while species richness shows how abundant each species is. ☐
- C. Species richness is a measure of biodiversity, while species evenness is a measure of genetic diversity. ☐
- D. Species evenness is a measure of biodiversity, while species richness is a measure of genetic diversity. ☐

An area of subtropical forest in central Africa has an Index of Diversity value of 0.83. Suggest which sentence is likely to be true.

- A. The forest has one dominant tree species which crowds out competitors. ☐
- B. A small change to the environment is likely to have catastrophic effects. ☐
- C. A forest species chosen at random has a high genetic diversity. ☐
- D. The ecosystem is resilient to the introduction of predators or new pathogens. ☐

Which of the following practices has had the most *positive* impact on biodiversity?

- A. Growing monocultures ☐
- B. Reintroducing hedgerows at field margins ☐
- C. Use of inorganic fertilisers ☐
- D. Draining marshland ☐

What is a community?

- A. A group of individuals of the same species living in the same place at the same time. ☐
- B. A group of individuals of different species living in the same region at the same time. ☐
- C. A group of individuals of different species and the non-living parts of an environment. ☐
- D. A subgroup of individuals of the same species that are closely related. ☐

For a growing dogwood tree, identify the biotic factor from the list below.

- A. Light intensity varying throughout the year. ☐
- B. Small particle size in the deciduous forest's soil. ☐
- C. Competition for nitrate ions in the soil. ☐
- D. Unexpected low temperatures during the spring. ☐

Palm trees, grasses and other desert plants compete for water around a Saharan oasis. What form of competition is this?

- A. Interspecific competition ☐
- B. Exclusionary competition ☐
- C. Interference competition ☐
- D. Intraspecific competition ☐

Which term describes the maximum sustainable size of a population within an ecosystem?

- A. Carrying capacity ☐
- B. Pareto limit ☐
- C. Density dependence ☐
- D. Metapopulation ☐

Which sampling technique would be most appropriate for measuring changes in biodiversity across a succession ecosystem?

- A. Mark-release recapture ☐
- B. Random quadrat sampling ☐
- C. Relevé sampling ☐
- D. Belt transect ☐

A team of ecologists is trying to estimate the size of a flightless bird population. They capture 38 birds, marking them with UV paint before releasing them. Three days later, they capture a second sample of 38 birds; of the second sample group, seven are marked with UV paint.

Estimate the size of the bird population.

- A. 206 ☐
- B. 266 ☐
- C. 326 ☐
- D. More information needed. ☐

Photosynthesis:

Where do the light-dependent stage of photosynthesis and the light-independent stage of photosynthesis happen?

- A. The light-dependent stage happens in the stroma, and the light-independent stage happens in the thylakoid membrane. ☐
- B. The light-dependent stage happens in the thylakoid membrane, and the light-independent stage happens in the stroma. ☐
- C. The light-dependent stage happens in the chloroplast membrane, and the light-independent stage happens in the thylakoid membrane. ☐
- D. The light-dependent stage happens in the chloroplast membrane, and the light-independent stage happens in the matrix. ☐

'Water is split by energy from sunlight, forming four H^+ ions, four electrons and one molecule of O_2 from each pair of water molecules.'

Which process does the sentence above describe?

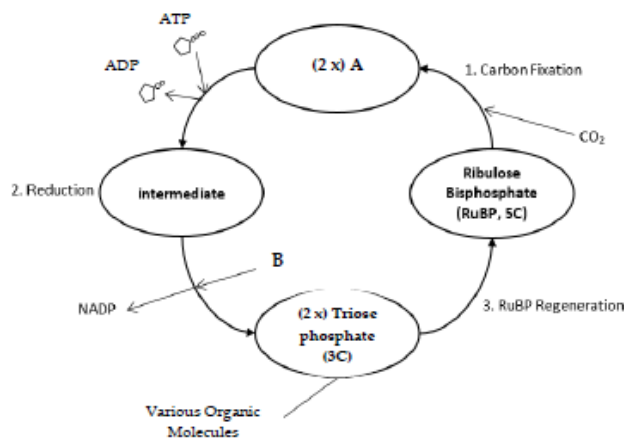
- A. Non-cyclic photophosphorylation ☐
- B. Cyclic photophosphorylation ☐
- C. Hydrolysis ☐
- D. Photolysis ☐

'Electrons pass through a series of electron carriers before being accepted by NADP. The energy generated is used to pump H^+ ions into the thylakoid space.'

Which process does the sentence above describe?

- A. Non-cyclic photophosphorylation ☐
- B. Cyclic photophosphorylation ☐
- C. Hydrolysis ☐
- D. Photolysis ☐

Identify the correct names of molecule A and molecule B in the schematic diagram of the Calvin cycle shown below.



- A. A: pyruvate 3-phosphate; B: NAD ☐
- B. A: glycerate 3-phosphate; B: NAD ☐
- C. A: pyruvate 3-phosphate; B: reduced NADP ☐
- D. A: glycerate 3-phosphate; B: reduced NADP ☐

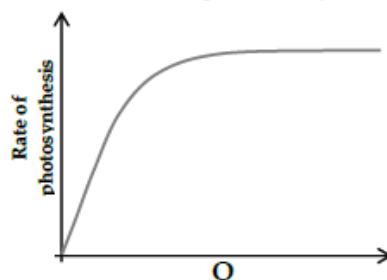
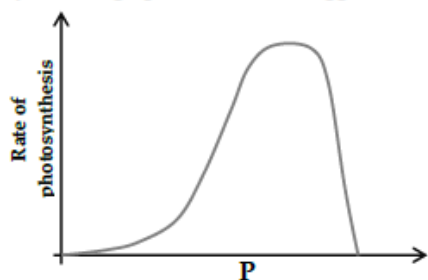
What role does the enzyme ATP synthase carry out in the light-dependent reaction?

- A. It uses triose phosphate sugars to regenerate ribulose biphosphate. ☐
- B. It uses the passage of protons across chloroplast membranes to catalyse the addition of inorganic phosphate to ADP. ☐
- C. It uses the splitting of water into protons, electrons and oxygen to catalyse the reduction of NADP. ☐
- D. It joins two triose phosphate molecules together to form hexose biphosphate, so they are easier to transport. ☐

Pea plants are being grown in a greenhouse. The sun has just set. Over the next hour, which change would you expect to see in the leaves of the plants?

- A. An increase in the concentration of triose phosphate. ☐
- B. A decrease in the concentration of glycerate 3-phosphate. ☐
- C. A decrease in the concentration of RuBP. ☐
- D. An increase in the concentration of CO_2 . ☐

Study the two graphs below, and suggest which variable could be represented by P and Q.



- A. P – light intensity, Q – CO₂ concentration
 B. P – temperature, Q – light intensity
 C. P – wind speed, Q – CO₂ concentration
 D. P – temperature, Q – humidity

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Which of the following is not true of triose phosphate?

- A. It is oxidised to reduce NADP, and in the process it forms pyruvate.
 B. Some triose phosphate is converted to useful organic substances, such as starch and glucose.
 C. It is reduced to generate ATP.
 D. Most of it is used to regenerate RuBP for the Calvin cycle.

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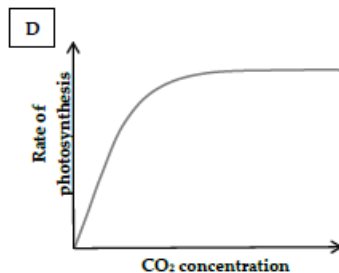
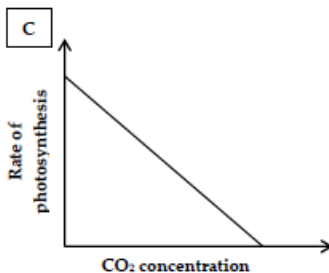
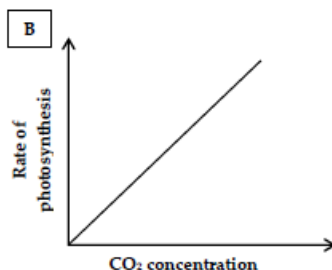
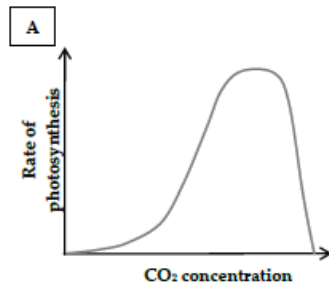
Set 2:

What role does the enzyme rubisco carry out in the Calvin cycle?

- A. It uses triose phosphate sugars to regenerate ribulose biphosphate, so that the Calvin cycle reactions can continue.
 B. It is part of the cascade of enzymes that converts glycerate 3-phosphate to triose phosphate.
 C. It adds CO₂ to ribulose biphosphate, forming an unstable six-carbon compound that breaks down into two glycerate 3-phosphate molecules.
 D. It joins two triose phosphate molecules together to form hexose biphosphate, so they are easier to transport.

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Choose the graph below which correctly describes the relationship between CO₂ concentration and rate of photosynthesis on a cloudy day.



- A. Graph A
 B. Graph B
 C. Graph C
 D. Graph D

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A data logger is used to measure oxygen levels in the water of a sealed bottle, which contains water, nutrients and a small aquatic plant. The oxygen levels are taken to represent the rate of photosynthesis.

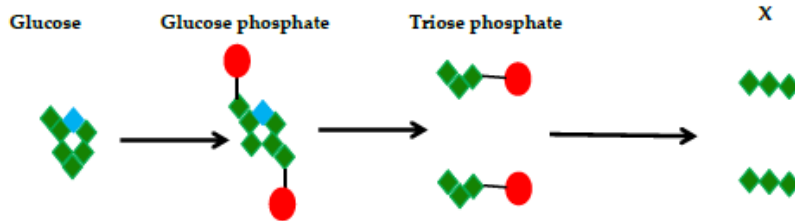
Suggest one limitation to this method.

- A. The temperature of the laboratory may limit the rate of photosynthesis.
 B. Data loggers are not able to distinguish between small differences in oxygen levels.
 C. The plant may be storing oxygen, and not using it for photosynthesis.
 D. This method doesn't take into account how much oxygen is being used in respiration.

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Respiration

In the schematic diagram below, which shows only the products of glycolysis, name the substance at point X.



- A. Acetyl ☐
- B. Pyruvate ☐
- C. Glycerol ☐
- D. Bisphosphate ☐

Which sentence below does *not* describe glycolysis?

- A. The main product of glycolysis is further modified by the link reaction. ☐
- B. Glucose is phosphorylated, using energy from ATP. ☐
- C. A net gain of four ATP molecules per glucose molecule is produced. ☐
- D. Nicotinamide adenine dinucleotide (NAD) is reduced, forming reduced NAD. ☐

What happens to lactate in mammals when oxygen levels are very low?

- A. It is converted into acetyl by the link reaction. ☐
- B. It is converted to glucose and then glycogen by the liver. ☐
- C. It is stored in the muscles, although excess lactate may be released into the blood. ☐
- D. It is stored in the liver, although excess lactate may build up in the muscles. ☐

What is the first stage of the link reaction?

- A. Glucose is phosphorylated using two molecules of ATP. ☐
- B. Phosphorylated glucose is split into two molecules of triose phosphate. ☐
- C. Acetate and coenzyme A combine to form acetyl coenzyme A. ☐
- D. Pyruvate is oxidised to acetate, which produces carbon dioxide and reduces two molecules of NAD. ☐

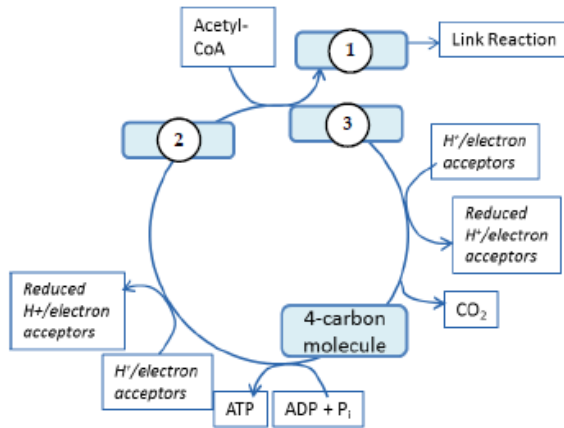
What happens to pyruvate in the absence of sufficient oxygen during glycolysis in yeast?

- A. It is converted to lactate. ☐
- B. It is converted to ethanol and carbon dioxide. ☐
- C. It is converted to acetate and carbon dioxide. ☐
- D. It is phosphorylated to produce triose phosphate. ☐

Which two enzyme groups are essential to the link reaction?

- A. Hydrogenase, carboxylase ☐
- B. Decarboxylase, dehydrogenase ☐
- C. Protease, decarboxylase ☐
- D. Hydrogenase, protease ☐

7. Identify the substances 1-3 in the diagram of the Krebs cycle, below.



- A. 1 – coenzyme A, 2 – citrate, 3 – oxaloacetate
- B. 1 – acetyl, 2 – oxaloacetate, 3 – citrate
- C. 1 – acetyl, 2 – citrate, 3 – oxaloacetate
- D. 1 – coenzyme A, 2 – oxaloacetate, 3 – citrate

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8. A student is designing a poster to explain the Krebs cycle. He writes the following statement:

The Krebs cycle produces carbon dioxide, six molecules of reduced NAD and two molecules of reduced FAD for each molecule of glucose used in respiration. The Krebs cycle also produces the majority of ATP used by the cell.

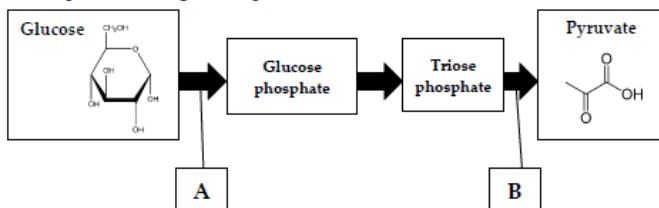
What mistake has the student made?

- A. The vast majority of ATP is actually produced by oxidative phosphorylation.
- B. FAD is not used to accept electrons in respiration, only in photosynthesis.
- C. The Krebs cycle reactions do not produce carbon dioxide; this is produced during the link reaction.
- D. FAD is not reduced by the Krebs cycle reactions; it is oxidised.

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Set 2:

The schematic diagram below shows only the main products of glycolysis. How is ATP energy used or produced throughout the process?



- A. Two molecules of ATP are used at A, and four are produced at B.
- B. Two molecules of ATP are produced at A, and four are produced at B.
- C. Two molecules of ATP are used at A, and two are produced at B.
- D. No molecules of ATP are produced at A, but two are produced at B.

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Which sentence below correctly describes glycolysis?

- A. It is the largest ATP-producing stage of respiration.
- B. It is an anaerobic reaction (does not require oxygen).
- C. It occurs in the intermembrane space of mitochondria.
- D. It produces reduced NADP, which is used in oxidative phosphorylation.

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Escherichia coli (*E. coli*) is a facultative anaerobe. Which sentence is correct?

- A. *E. coli* cannot produce energy in a high oxygen environment, and will die.
- B. *E. coli* prefers to respire glucose in the presence of oxygen, but also can produce enough energy to survive through fermentation.
- C. *E. coli* cannot produce energy in a low oxygen environment, and will die.
- D. *E. coli* prefers to produce energy using fermentation, but can generate some energy through aerobic respiration of glucose.

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What is the primary product of the link reaction?

- A. Pyruvate
- B. Glycerate-CoA
- C. Oxaloacetate
- D. Acetyl-CoA

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Inheritance:

Choose the correct word to describe the physical, biochemical and behavioural characteristics of an individual, caused by how their genes interact with the environment?

- A. Morphology ☐
- B. Genotype ☐
- C. Physiology ☐
- D. Phenotype ☐

Two individuals who are heterozygous for gene Y have a child. What is the probability that their child will be heterozygous for the gene?

- A. 25 % ☐
- B. 50 % ☐
- C. 75 % ☐
- D. 100 % ☐

The Punnett square below shows a cross between two doubly heterozygote nasturtiums (a type of flowering plant).

	F _B R	F _B r	F _O R	F _O r
F _B R	F _B F _B RR	F _B F _B Rr	F _B F _O RR	F _B F _O Rr
F _B r	F _B F _B Rr	F _B F _B rr	F _B F _O Rr	F _B F _O rr
F _O R	F _O F _B RR	F _O F _B Rr	F _O F _O RR	F _O F _O Rr
F _O r	F _O F _B Rr	F _O F _B rr	F _O F _O Rr	F _O F _O rr

- The gene for flower colour has two alleles – plants which are homozygous for F_B have indigo flowers, heterozygotes have light blue flowers, and plants which are homozygous for F_O have white flowers.
- The gene R controls petal shape – plants with the dominant (R) allele have short, round petals, and plants with two recessive (r) alleles have elongated petals.

What proportion of the offspring should have light blue flowers and short, round petals?

- A. 6/16 (38 %) ☐
- B. 8/16 (50 %) ☐
- C. 9/16 (56 %) ☐
- D. 12/16 (75 %) ☐

A gene for flower colour has two alleles – plants which are homozygous for F_B have indigo flowers, heterozygotes have light blue flowers, and plants which are homozygous for F_O have white flowers. Which term correctly describes alleles F_B and F_O?

- A. Epistatic ☐
- B. Dihybrid ☐
- C. Co-dominant ☐
- D. Recessive ☐

A gene, H, has a recessive allele (X_h) which causes haemophilia. It is found on the X-chromosome. A mother who is a carrier for the haemophilia allele has a son. What is the probability that her son will have haemophilia?

- A. 25 % ☐
- B. 50 % ☐
- C. 75 % ☐
- D. More information needed. ☐

Two individuals are heterozygous for both characteristic A and characteristic B. These characteristics show autosomal linkage. If the two individuals are crossed, what is the expected ratio of genotypes in their offspring?

- A. 9 AABb : 3 AAbb : 3 aaBB : 1 aabb ☐
- B. 1 AABb : 1 aabb ☐
- C. 1 AABb : 1 AAbb : 2 AABb : 2 AaBB : 4 AaBb : 2 Aabb : 2 aaBb : 1 aaBB : 1 aabb ☐
- D. 1 AABb : 2 AaBb : 1 aabb ☐

Choose the correct definition of 'epistasis'.

- A. A gene is modified by methylation or phosphorylation, affecting whether or not it is transcribed. ☐
- B. Two alleles of the same gene each contribute to the overall phenotype of the individual. ☐
- C. A gene produces a protein which in turn inhibits the transcription of the gene. ☐
- D. The genotype of one gene controls whether another gene is able to be expressed. ☐

The results below show observed versus expected results of a dihybrid cross between two rabbits. Carry out a chi-squared test on the results. Which value is the outcome of the chi-squared test?

	Expected results	Observed results
Long, black fur	27	18
Short, black fur	9	14
Long, agouti fur	9	15
Short, agouti fur	3	1

Chi-squared equation:

$$X^2 = \sum \frac{(O - E)^2}{E}$$

- A. 1.74 ☐
- B. 3.33 ☐
- C. 11.1 ☐
- D. 12.1 ☐

What is the most accurate definition of a population?

- A. A group of individuals of different species occupying the same habitat at the same time. ☐
- B. A group of individuals of different species in a habitat and the non-living elements of their environment. ☐
- C. A group of individuals of a species in a habitat and the non-living elements of their environment. ☐
- D. A group of individuals of a species occupying the same habitat at the same time that are capable of interbreeding. ☐

A gene, *K*, controls the production of the enzyme phenylalanine hydroxylase. It has two alleles:

- *K* – the dominant allele, creates a normal enzyme.
- *k* – the recessive allele, creates a dysfunctional enzyme which causes the disease phenylketonuria (PKU).

In an isolated island population, the proportion of people with PKU is 0.04 (4%). What proportion of the population has at least one copy of the recessive *k* allele?

Hardy-Weinberg equation:

$$p^2 + 2pq + q^2 = 1$$

- A. 0.04 ☐
- B. 0.32 ☐
- C. 0.36 ☐
- D. 0.64 ☐

What is the main source of variation within a population?

- A. Environmental influence ☐
- B. Mutation ☐
- C. Meiosis ☐
- D. Random fertilisation of gametes ☐

Set 2:

When the chickens are actually crossed, it emerges that birds with long feathers (*jj*) always have a cream coat, no matter what their genotype is for gene *C*. Describe the relationship between the two genes.

- A. *J* is dominant over *C*. ☐
- B. *J* is recessive to *C*. ☐
- C. *J* is epistatic to *C*. ☐
- D. *J* and *C* are co-dominant. ☐

The gene for blood type in humans has three alleles: *I_A*, *I_B* and *I_O*. *I_A* and *I_B* are co-dominant, and both are dominant over *I_O*. List the blood types of the three people below.

Person 1 – *I_OI_B*
Person 2 – *I_BI_A*
Person 3 – *I_AI_O*

- A. 1 – type BO, 2 – type AB, 3 – type AO ☐
- B. 1 – type B, 2 – type AB, 3 – type A ☐
- C. 1 – type B, 2 – type A, 3 – type A ☐
- D. 1 – type O, 2 – type AB, 3 – type O ☐

A gene, *H*, has a recessive allele (*X_h*) which causes red-green colour blindness. It is found on the X chromosome. Describe the probability that a mother who carries the recessive allele will have a daughter with red-green colour blindness.

- A. 0 % ☐
- B. 25 % ☐
- C. 50 % ☐
- D. More information needed. ☐

Which sentence describing gene linkage is correct?

- A. Genes are said to be linked if they have the same promoter and operator. ☐
- B. Gene linkage only occurs on the sex chromosomes, not on the autosomes. ☐
- C. If genes *A* and *B* are linked, the dominant alleles *A* and *B* are likely to be passed on together. ☐
- D. For genes which are linked, alleles don't assort independently during meiosis. ☐

Receptors:

Which of the following best describes kinesis?

- A. The distribution of hormones in an organism changes in response to a stimulus. ☐
- B. An organism's speed changes in response to a stimulus. ☐
- C. An organism's direction changes in response to a stimulus. ☐
- D. The distribution of enzymes in an organism changes in response to a stimulus. ☐

Which statements below about the central nervous system are correct?

Statement 1 – it only coordinates responses which are under conscious control.
Statement 2 – reflex arcs avoid passing through it altogether.
Statement 3 – it includes some receptors, such as those which detect changes in core body temperature.

- A. Statement 1 only ☐
- B. Statements 1 and 2 ☐
- C. Statements 2 and 3 ☐
- D. Statement 3 only ☐

Which of the following is not a feature of a reflex that acts to protect an organism from harm?

- A. Reflexes are rapid. ☐
- B. Reflexes involve the brain. ☐
- C. Reflexes are innate from birth. ☐
- D. Reflexes are involuntary. ☐

Which stimulus would a Pacinian corpuscle detect?

- A. Someone shining a torch into your pupil. ☐
- B. Someone brushing against your hair as they walk past. ☐
- C. Someone pressing their thumb against your wrist. ☐
- D. Someone shouting to you across a busy room. ☐

What is the change in the relative electrical potential inside an axon when a stimulus is strong enough to create a generator potential in a sense receptor?

- A. From -70 mV to +30 mV ☐
- B. From -70 mV to 0 mV ☐
- C. From +70 mV to -30 mV ☐
- D. From +70 mV to 0 mV ☐

Which statement below about rod cells is true?

- A. Rods cells allow the eye to distinguish between different colours. ☐
- B. Rod cells can respond to low-intensity light because rhodopsin is easily broken down. ☐
- C. Rod cells provide high visual acuity because they link to a single bipolar cell. ☐
- D. There are fewer rod cells than cone cells in the eye. ☐

Which sentence describes the role of the Purkyne tissue in the cardiac cycle?

- A. It sets the heart rate and stimulates atrial contraction. ☐
- B. It prevents the ventricles from contracting at the same time as the atria. ☐
- C. It contracts to pull the semilunar valves closed. ☐
- D. It conducts a wave of excitation which causes the ventricles to contract. ☐

What is the role of the sinoatrial node (SAN)?

- A. It receives and transmits a wave of electrical excitation from the atrioventricular node (AVN). ☐
- B. It is a region of the brain which controls the heart rate. ☐
- C. It is a collection of Purkyne tissue which conveys waves of electrical excitation. ☐
- D. It acts as the pacemaker of the heart, generating a wave of electrical excitation. ☐

Which sentence describing the autonomic nervous system is true?

- A. It is part of the central nervous system. ☐
- B. It is under conscious control. ☐
- C. It can be divided into the sympathetic and the parasympathetic system. ☐
- D. It functions by causing skeletal muscles to contract or relax. ☐

Answers:

Enzymes:

- C. **Ionic bonds.** Ionic bonds are the attraction between oppositely charged ions, i.e. the negative COO^- group and the positive NH_3^+ group. Hydrogen bonds occur between the slightly positive hydrogen of an $-\text{NH}$ group and the slightly negative oxygen of a $-\text{C}=\text{O}$ group. Disulfide bridges link two sulfurs. Hydrophobic interactions occur when non-polar molecules group together in water.
- D. **Quaternary structure.** The primary structure of a polypeptide is its amino acid sequence, while the secondary structure is the shape that amino acid chain makes, due to interactions between its radical groups (usually a helix or a flat sheet). The tertiary structure is how that chain is folded into a complex three-dimensional shape, and the quaternary structure is made when multiple polypeptide folded chains are combined to form a larger protein.
- C. **Induced-fit model.** The lock and key model suggests that enzymes have an active site with a specific shape, and are activated by a specific substrate 'key' which fits perfectly into the active site. The induced-fit model is a refinement of this theory – it recognises that the substrate can change the shape of the molecule.
- B. **Non-competitive inhibitor.** The inhibitor is called non-competitive because it doesn't compete with the substrate for access to the enzyme's active site, and its effect on the enzyme does not depend on how much substrate is present.
- A. 3. The stomach is acidic and therefore has a low pH, usually between 1.5 and 3.5. The enzymes that are active in the stomach are ones which can work effectively in these conditions.
- D. **Increasing the substrate concentration.** The frequency of enzyme–substrate collisions would increase with a greater concentration of substrate. Decreasing the temperature would lower the kinetic energy of particles. Reducing the enzyme concentration would decrease the frequency of enzyme–substrate collisions. Introducing a non-competitive inhibitor would decrease the functionality of the enzyme.
- D. **It is equally likely to be the limiting factor at both point A and point C.** The rate of reaction at A and C is the same, and in both cases a change in temperature (an increase for A and a decrease for C) could greatly increase the rate. Temperature is unlikely to be the limiting factor at B as the graph at this point is almost at its maximum, which suggests that another factor, e.g. enzyme concentration, is probably the limiting factor at this point.

Set 2:

C D A C C

Mitosis and Meiosis:

- B. **Nuclear envelope.** The envelope usually keeps the genetic material separate from the cytoplasm, although mRNA molecules can pass through it.
- B. **To increase genetic diversity.** Meiosis increases genetic diversity, but mitosis does not. This is because the cells of the body need to have the same instructions if they are to work effectively together.
- D. **Telophase.** The nucleus is separating into two nuclei (and the nuclear envelope is reforming around each); however, the cell is yet to divide fully into two.
- B. **The cytoplasm divides.** Cytokinesis divides the remainder of the cell's contents into two after the genetic material has been replicated. Spindle fibres develop in prophase, and chromatids move during anaphase.
- B. **Mitosis creates diploid daughter cells, while meiosis creates haploid cells.** The haploid cells created by meiosis (gametes) are then able to fuse during reproduction to make a diploid zygote. Meiosis is actually the process which creates four daughter cells and occurs at a specific point in the life cycle, i.e. during sperm and egg production.
- B. **Random mutation of the genetic code during DNA replication.** DNA replication occurs in full before meiosis starts, and, therefore, any mutations that happen during DNA replication are not part of meiosis.

Set 2:

B D B C

Biodiversity:

- C. **Marking, releasing and recapturing individuals from a species to estimate its population size.** In the absence of other information, the size of one population won't tell you anything about biodiversity – this species could dominate the landscape, or could be one of diverse range of related organisms. A) or B) would give you information about species diversity, and D) would give you information about genetic diversity.
- D. **Temperature extremes at high altitude.** All of the other factors are biotic factors, because they relate to how the goat's environment is shaped by other living things. Temperature extremes are an abiotic factor, because they are not caused by living things but by the sun and the altitude.
- D. **Intraspecific competition.** This is competition between members of the same species, often to establish dominance. Interspecific competition occurs between members of different species.
- C. **Rate of population growth.** The rate of population growth will affect how long the population takes to reach carrying capacity, but it shouldn't affect the size of the carrying capacity. This is determined by other factors such as overcrowding and disease, competition for scarce resources and weather conditions.
- B. **Systematic sampling.** Systematic sampling occurs when you study a variable at regular predetermined intervals, such as investigating biodiversity every 5 m along a line. Opportunistic sampling involves choosing the data which you are most able to collect, while stratified sampling involves breaking down a population into subgroups (such as age ranges) and sampling from each group.
- A. 400.
$$\frac{\text{Number marked in 2nd population}}{\text{Number marked in 1st population}} = \frac{\text{Number marked in 1st population}}{\text{Total}}$$
 Therefore, $9/60 = 60/x$, where x is the estimated total size of the population. Flipping the fractions, $60/9 = x/60$, which means $x = (60/9) \times 60$. So $x = 400$.

Set 2:

A D B B C A A D A

Photosynthesis:

- B. The light-dependent stage happens in the thylakoid membrane, and the light-independent stage happens in the stroma. The light-dependent reaction involves a series of electron carriers, which are lined up in the thylakoid membrane, allowing efficient transfer of electrons and energy. The outer chloroplast membrane protects and compartmentalises the organelle, but isn't directly involved in photosynthesis.
- D. Photolysis. The two photophosphorylation processes create ATP by moving excited electrons between electron carriers. Hydrolysis is the process of breaking down a large molecule into a smaller one using water.
- A. Non-cyclic photophosphorylation. The process is called photophosphorylation because it involves using light (photo-) to phosphorylate (i.e. add phosphate to) ADP, creating ATP. It is non-cyclic because the electrons do not return to the chlorophyll pigment.
- D. A: glycerate 3-phosphate; B: reduced NADP. Pyruvate is the product of glycolysis in respiration, and is not used in the Calvin cycle. Reduced NADP donates hydrogen ions to a three-carbon molecule in the Calvin cycle, and becomes oxidised.
- B. It uses the passage of protons across chloroplast membranes to catalyse the addition of inorganic phosphate to ADP. A concentration gradient of protons is set up using proton pumps, and the protons can only cross the thylakoid membrane of the chloroplasts via ATP synthase.
- C. A decrease in the concentration of RuBP. Low light intensity reduces the rate at which glycerate 3-phosphate is converted to triose phosphate in the Calvin cycle, because this stage requires energy from light-dependent photosynthesis. As a result, glycerate 3-phosphate builds up, very little triose phosphate is formed, and RuBP is not regenerated.
- B. P – temperature, Q – light intensity. As the temperature increases, the rate of photosynthesis increases up to an optimum temperature; above this temperature, enzymes start to denature and the rate rapidly decreases. As light intensity (or CO₂ concentration) increases, rate of photosynthesis increases until it is no longer a limiting factor, and some other factor is limiting the maximum rate of respiration.
- C. It is reduced to generate ATP. Triose phosphate is involved in the generation of ATP; however, it is oxidised, not reduced. The removal of a phosphate group converts it to pyruvate, and the phosphate is added to an ADP molecule to generate ATP.

Set 2:

C D D

Respiration:

- B. **Pyruvate.** Pyruvate is then converted into an acetyl group via the link reaction. Glycerol is a different three-carbon molecule, which forms the backbone of triglycerides. Bisphosphate is a general word for a molecule with two phosphate (PO_4^{3-}) ion groups.
- C. **A net gain of four ATP molecules per glucose molecule is produced.** Although four ATP molecules are produced when triose phosphate is converted to pyruvate, two are also used to phosphorylate glucose, creating hexose biphosphate. So the net gain from glycolysis is just two ATP molecules.
- D. **It is stored in the liver, although excess lactate may build up in the muscles.** Lactate can be converted into pyruvate and then acetyl for use in the Krebs cycle, and it can be converted to glucose, but both of these stages can only occur when oxygen levels increase. Lactate build-up in the blood could be very dangerous, because this would lower the blood pH and disrupt enzyme-controlled reactions.
- D. **Pyruvate is oxidised to acetate, which produces carbon dioxide and reduces two molecules of NAD.** Pyruvate is a three-carbon molecule; therefore, upon losing two hydrogens (which reduce one NAD each) and one carbon as carbon dioxide, it becomes the two-carbon molecule pyruvate.
- B. **It is converted to ethanol and carbon dioxide.** During anaerobic respiration in animals, pyruvate accepts hydrogen from reduced NAD, converting it to lactate. It is instead converted to ethanol and carbon dioxide in plants and some microorganisms.
- B. **Decarboxylase, dehydrogenase.** The decarboxylase removes CO_2 from pyruvate, creating a two-carbon molecule, and the dehydrogenase removes hydrogen ions, which are accepted by reduced NAD.
- D. **1 – coenzyme A, 2 – oxaloacetate, 3 – citrate.** Oxaloacetate is a four-carbon molecule, which is combined with the two-carbon acetyl group to form the six-carbon molecule citrate. Coenzyme A is released from acetyl and can be reused.
- A. **The vast majority of ATP is actually produced by oxidative phosphorylation.** Although the Krebs cycle does produce a little ATP, its main purpose is to generate hydrogen ions and electrons which reduce NAD and can be used in oxidative phosphorylation. Although NAD is the main electron/hydrogen acceptor, FAD is also used. Both the link reaction and the Krebs cycle produce carbon dioxide.

Set 2:

A B B D

Inheritance:

- D. **Phenotype.** Genotype is the genetic code of an individual, while phenotype is how that genetic code interacts with the environment. Physiology is the study of how an organism carries out its metabolic processes, while morphology is the study of its physical shape.
- B. **50 %.** The parents each have the genotype Yy (heterozygous). Each parent can pass on either allele to a child with equal likelihood. This means that a child is equally likely to have the genotype YY (homozygous), Yy (heterozygous), yY (heterozygous) or yy (homozygous).
- A. **6/16 (38 %).** Only the offspring who have the genotype F_1F_1 (or F_1F_1 heterozygotes) and the genotype RR or Rr (homozygous or heterozygous) will have light blue flowers and short, round petals. The allele R is dominant, so it will express itself fully as long as at least one copy is present. $\frac{1}{2}$ of individuals have the genotype F_1F_1 , and $\frac{3}{4}$ of these have the genotype RR or Rr. $\frac{1}{2} \times \frac{3}{4} = \frac{6}{16}$.
- C. **Co-dominant.** Alleles are co-dominant when both alleles affect the phenotype of an organism which is heterozygous. For example, plants with the genotype F_1F_1 don't have white flowers or indigo flowers, but light blue flowers (a mix).
- A. **50 %.** The mother has a 50 % chance of passing on the recessive allele (X_{re}) to her son, since she is equally likely to pass on either of her X chromosomes. The genotype of the father doesn't matter in this case, because he must pass on a Y chromosome to his son – the Y chromosome determines male sexual development.
- D. **1 AAbb : 2 AaBb : 1 aabb.** As the characteristics show autosomal linkage, each individual has the possibility of producing only AB or ab gametes. Using a Punnett square to cross these gametes produces the possible genotypes AAbb, AaBb, aAbB, aabb.
- D. **The genotype of one gene controls whether another gene is able to be expressed.** For example, if a cat has a recessive allele that causes it to be albino (white fur all over), other genes that affect coat colour patterns may have no effect. Answer A) describes epigenetic effects, while answer B) describes co-dominance – C) is a form of end-product inhibition.
- C. **11.1.** The formula for the chi-squared test is $\chi^2 = \sum \frac{(O-E)^2}{E}$, where O is the observed result for a specific phenotype, and E is the expected result for that phenotype.
- D. **A group of individuals of a species occupying the same habitat at the same time that are capable of interbreeding.** A population contains only members of a single species which can interbreed. A) describes a community of different species, and B) describes an ecosystem.
- C. **0.36.** The Hardy-Weinberg equation is as follows: $p^2 + 2pq + q^2 = 1$, where p is the dominant allele's frequency and q is the recessive allele's frequency. q^2 is the frequency of recessive homozygotes, i.e. people with the disease phenylketonuria. If $q^2 = 0.04$, then $q = \sqrt{0.04} = 0.2$. Since there are only two alleles, all the alleles that are not q must be p, so $p = 1 - 0.2 = 0.8$. $2pq$ is the number of heterozygotes, and is equal to $2 \times 0.2 \times 0.8 = 0.32$. However, the question asks for the number of people with at least one recessive allele, which is equal to $2pq + q^2$, or $0.32 + 0.04 = 0.36$.
- B. **Mutation.** Most mutations have no effect on phenotype, but some have the power to create marked changes to the genotype, which then affect the phenotype. Meiosis and random fertilisation create new combinations of alleles but do not change the genotype. Environmental influences affect how genes are expressed but have comparatively less of an effect than mutations.

Set2:

C B D A

Receptors:

- B. **When an organism's speed changes in response to a stimulus.** Kinesis often acts to slow down an organism in a favourable environment to increase the time it spends there, and speed up an organism so that it is more likely to leave an unfavourable environment.
- D. **Statement 3 only.** The hypothalamus is part of the brain, but also contains temperature receptor cells. As well as the brain, the central nervous system (CNS) also includes the spinal cord, which reflex arcs pass through. The CNS coordinates lots of actions which aren't under conscious control, such as increasing the heart rate in response to adrenaline.
- B. **Reflexes involve the brain.** Reflexes are processed by the spinal cord, which bypasses the brain and the need for a conscious decision. This also reduces the distance that impulses have to travel, increasing reaction times.
- C. **Someone pressing their thumb against your wrist.** Pacinian corpuscles are relatively deep in the skin and detect heavy pressure. Hair follicle cells detect slight changes in pressure as the hairs move, while cone cells would respond to a light shined into the pupil. Auditory hair cells detect sound in the inner ear.
- A. **From -70 mV to +30 mV.** This effect is known as depolarisation, and is caused by sodium channels opening and allowing positive Na^+ ions to flood into the cell. The rapid opening of channels causes the inside of the axon to become slightly positively charged before the sodium channels are triggered to close.
- B. **Rod cells can respond to low-intensity light because rhodopsin is easily broken down.** Rod cells, unlike cone cells, are unable to distinguish between different wavelengths of light, and hence different colours. Because rod cells link to a single bipolar cell and only generate a single impulse, they provide low visual acuity. There are around 20 times more rod cells in each eye than there are cone cells.
- D. **It conducts a wave of excitation which causes the ventricles to contract.** The sinoatrial node causes the wave of excitation that starts a heartbeat, making the atria contract. The signal is stopped by the septum and there is a gap between atrial and ventricular contraction, to allow the ventricles to fill with blood completely. The atrioventricular node is stimulated by the wave of excitation, and sends its own wave through the Purkyne tissue, which conducts the wave of excitation to the base of the heart and causes the ventricles to contract from the base.
- D. **It acts as the pacemaker of the heart, generating a wave of electrical excitation.** This wave then travels to the AVN, and along Purkyne fibres in the bundle of His. The heart rate is controlled by a region of the brain called the medulla oblongata.
- C. **It can be divided into the sympathetic and the parasympathetic system.** The autonomic nervous system is involuntary and is not controlled consciously; it mostly works by stimulating smooth and cardiac muscle in the internal organs, unlike the somatic nervous system which works through skeletal muscles. Both the somatic and autonomic nervous systems are part of the peripheral nervous system.