Linoleic Acid

A Level

Linoleic acid is an unsaturated fatty acid that is found in some triglycerides and some phospholipids.

Phospholipids are components of cell membranes.

Figure 1 shows a molecule of linoleic acid.

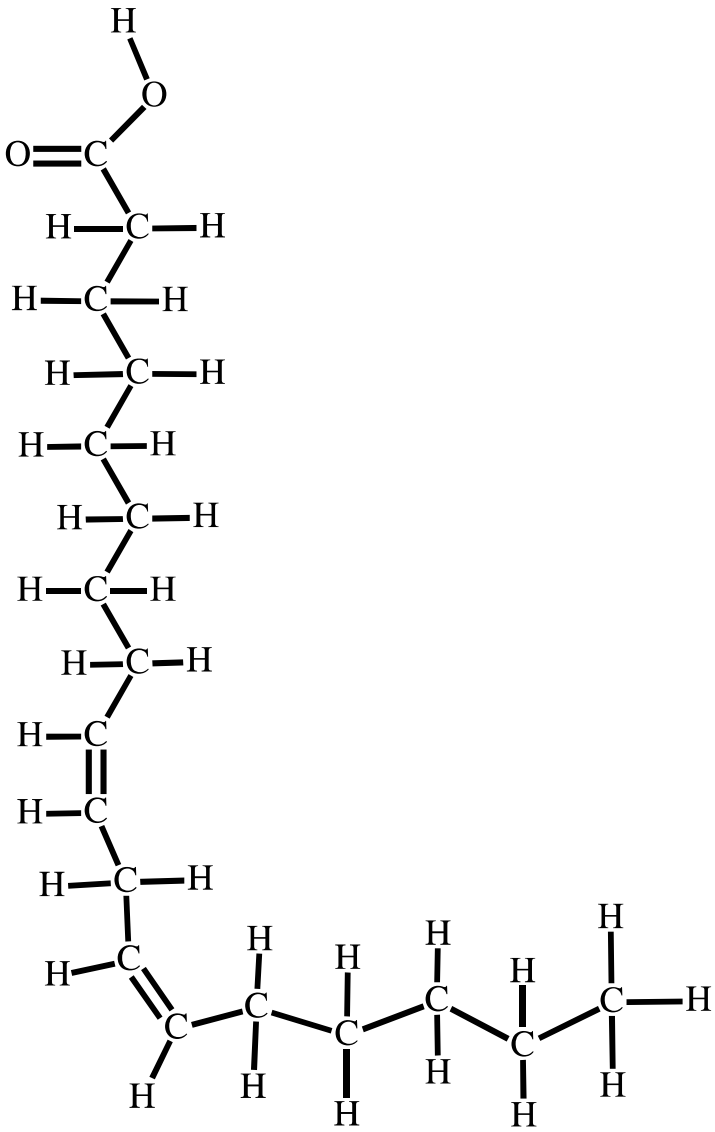

Figure 1: Linoleic acid structure.

Part A Hydrogen numbers

Linoleic acid contains 18 carbons and 32 hydrogens. How many hydrogens would an 18-carbon **saturated** fatty acid contain?

Part B Triglycerides vs phospholipids

Which of the following are structural differences between triglycerides and phospholipids? Select all that apply.

- [ ] phospholipids are lipids, whereas triglycerides are carbohydrates
- [ ] a triglyceride contains glycerol, whereas a phospholipid does not
- [ ] triglyceride fatty acids are all saturated, whereas phospholipid fatty acids may be saturated or unsaturated
- [ ] a triglyceride contains three fatty acids, whereas a phospholipid contains two fatty acids
- [ ] a phospholipid contains a phosphate group, whereas a triglyceride does not
- [ ] a triglyceride contains two fatty acids, whereas a phospholipid contains three fatty acids

Part C Phospholipid fatty acids

The composition of cell membranes of plants changes in response to changes in temperature.

At the start of the cold season there is an increase in the proportion of phospholipids with unsaturated fatty acids in the chickpea, *Cicer arietinum*. Chickpea plants that do not make this change do not survive.

Which of the following statements explain how the increase in the proportion of phospholipids with unsaturated fatty acids helps plants, such as chickpea, survive decreases in temperature? Select all that apply.

- [ ] unsaturated fatty acids have kinks in their chains which ensure that the phospholipids pack more tightly
- [ ] maintaining membrane fluidity maintains membrane permeability to molecules like O_2 and CO_2
- [ ] decreasing membrane fluidity increases membrane permeability to molecules like O_2 and CO_2
- [ ] unsaturated fatty acids have kinks in their chains which ensure that the phospholipids do not pack too tightly

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Adapted with permission from CIE AS Level Biology, June 2019, Paper 2, Question 2

Identical Twins and Genetic Relatedness

A Level

Identical twins are natural clones. They form when a fertilised egg cell divides by mitosis into two entirely separate groups of cells. Each group of cells develops into a baby.

Two brothers, who were identical twins, married two sisters, who were also identical twins. Each couple had one child.

Figure 1 shows the relationships between these six people.

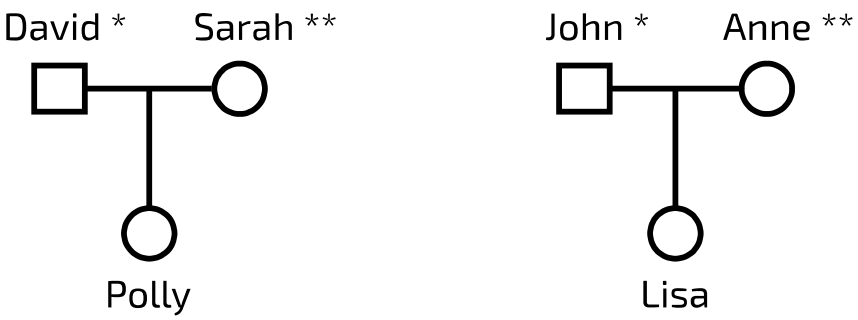


Figure 1: Two family trees. Males are represented by squares and females are represented by circles.

* David and John are identical twins

** Sarah and Anne are identical twins

Part A David and John

Estimate the percentage of alleles shared by David and John.

Part B Anne and Lisa

Estimate the percentage of alleles shared by Anne and Lisa.

Part C Sarah and Lisa

Estimate the percentage of alleles shared by Sarah and Lisa.

Part D Polly and Lisa

Estimate the percentage of alleles shared by Polly and Lisa.

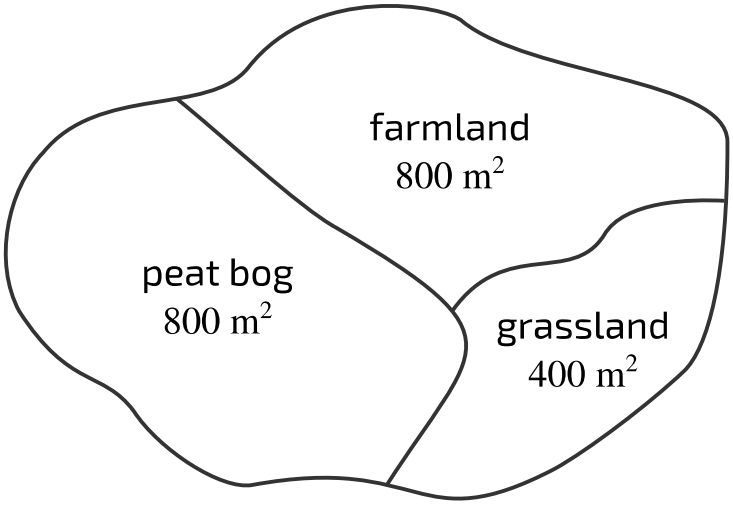
Adapted with permission from OCR A Level Biology A, June 2014, Control, Genomes and Environment, Question 1d

Gameboard:
STEM SMART Biology Week 50

Ecological Sampling and Population Estimates

A Level

Ecologists were studying an area that contained three different habitats. The area is shown in the diagram below.



Part A Sample type

The ecologists sampled the area to estimate insect biodiversity.

What type of sampling should they use to ensure that the sampling is representative?

Part B Sample numbers

The ecologists decide they only have the time and resources to take 10 samples of the whole area. How many samples should they take from each habitat? Fill in the blanks below.

- peat bog: ____
- farmland: ____
- grassland: ____

Items:

0 1 2 3 4 5 6 7 8 9 10

Part C Population estimates

Two of the insect species that were sampled were the large heath butterfly and the bog hoverfly.

The ecologists used the capture-mark-recapture technique and estimated population sizes using two different calculations: the Lincoln estimate and the Chapman estimate. The formulae are given below.

Lincoln estimate formula: $\text{population size} = \dfrac{n_1 \times n_2}{m}$

Chapman estimate formula: $\text{population size} = \dfrac{(n_1 + 1) \times (n_2 + 1)}{m + 1} - 1$

where

- n = number of individuals in a particular sample
- m = number of marked individuals in the second sample

Estimate the population sizes using the formulae above and the data below. Give your answers to the nearest whole number.

Species	Number captured and marked in sample 1	Total number in sample 2	Number of marked individuals in sample 2
large heath butterfly	77	73	4
bog hoverfly	5	6	1

large heath butterfly (Lincoln estimate):

large heath butterfly (Chapman estimate):

bog hoverfly (Lincoln estimate):

bog hoverfly (Chapman estimate):

Part D Lincoln vs Chapman estimation

Based on your answers in part C, which of the following statements comparing the Lincoln estimate to the Chapman estimate are correct? Select all that apply.

- [ ] the Lincoln estimate gives a **lower** estimate than the Chapman estimate
- [ ] the difference between the two estimates is proportionally greater for **smaller** populations
- [ ] the difference between the two estimates is proportionally greater for **larger** populations
- [ ] the Lincoln estimate gives a **higher** estimate than the Chapman estimate

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Adapted with permission from OCR A Level Biology A, October 2020, Unified Biology, Question 5

Gameboard:
STEM SMART Biology Week 50

Sensory Neurone Stimulation

A Level

Figure 1 shows a sensory neurone that receives input from three sensory receptor cells.

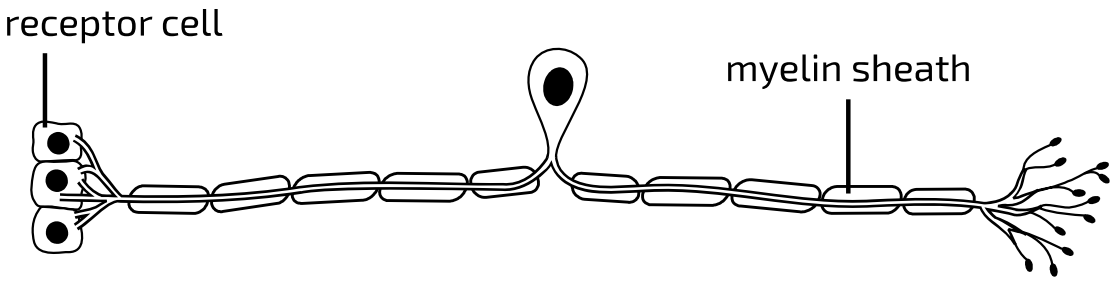

Figure 1: Diagram of a sensory neurone.

Part A Myelin sheath

Which of the following statements explain how the myelin sheath increases the speed of conduction of nerve impulses? Select all that apply.

- [ ] myelin acts as a conductor, allowing ion movement across the axon membrane
- [ ] myelin acts as an insulator, preventing ion movement across the axon membrane
- [ ] myelin acts as a neurotransmitter, transmitting the nerve impulse from one neurone to another
- [ ] ions can only move across the membrane at gaps in the myelin sheath, meaning nerve impulses "jump" from one gap to the next
- [ ] ions can only move across the membrane where there is myelin, meaning nerve impulses "jump" from one myelin bundle to the next

Part B Stimuli & action potentials

Figure 2 shows the changes in the membrane potential of a sensory neurone when the receptor cells are stimulated, as well as the strength of each stimulus.

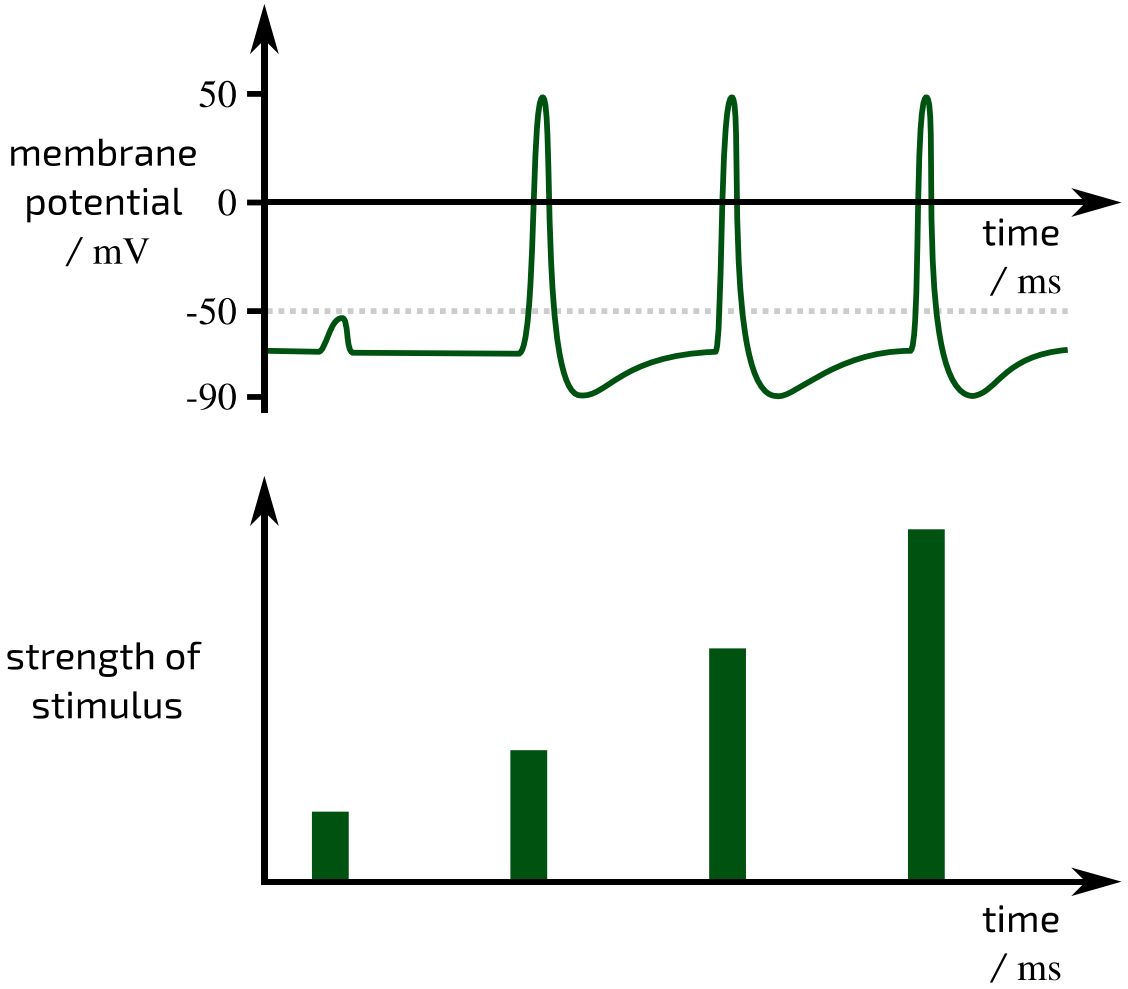

Figure 2: Changes in sensory neurone membrane potential over time in response to stimuli of different strengths being applied to sensory receptor cells.

Which of the following statements explain the relationship between the strength of the stimulus and the resulting action potential? Select all that apply.

- [ ] there is a directly proportional relationship between the strength of the stimulus and the strength of the action potential
- [ ] the action potentials produced by the neurone cause the strength of the stimulus to increase over time
- [ ] if the stimulus is **not** strong enough to increase the membrane potential above a certain threshold ($-50\,\mathrm{mV}$), then only a **weak** action potential is produced
- [ ] if the stimulus is **not** strong enough to increase the membrane potential above a certain threshold ($-50\,\mathrm{mV}$), then **no** action potential is produced
- [ ] if the stimulus is strong enough to increase the membrane potential above a certain threshold ($-50\,\mathrm{mV}$), then an action potential is produced
- [ ] if the stimulus is strong enough to increase the membrane potential above a certain threshold ($-50\,\mathrm{mV}$), then the resting membrane potential becomes positive rather than negative

Adapted with permission from CIE A Level Biology, June 2016, Paper 4, Question 8

Gameboard:
STEM SMART Biology Week 50

Mitochondrial Molecules and Numbers

A Level

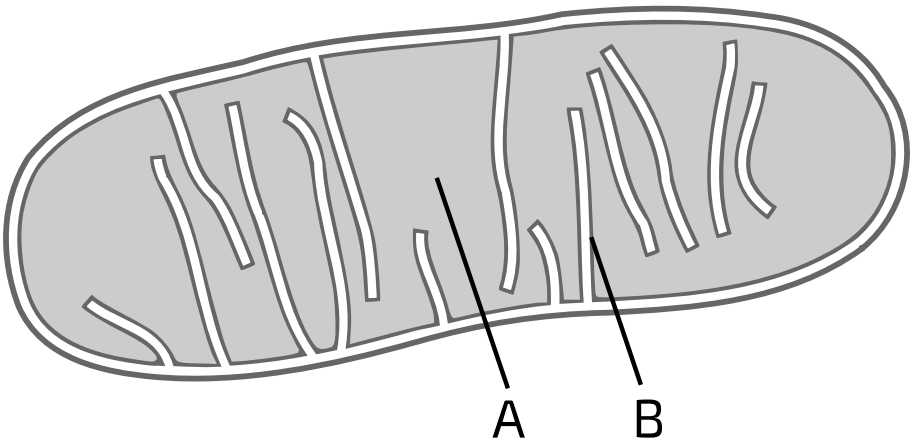

Figure 1: Simplified diagram of a transmission electron micrograph of a section through a mitochondrion.

Part A Aerobic respiration

The table below shows some structures and compounds involved in aerobic respiration.

Use letter **A** or **B** from **Figure 1** to show where each structure/compound is found/used.

Compound or structure	Location
ATP synthase	
acetyl CoA	
phospholipid bilayer	
oxaloacetate	

Items:

A B

Part B Cell types & mitochondrial numbers

The table below shows the mean number of mitochondria per cell and the mean cell volume for three types of mammalian cells.

Cell type	Mean number of mitochondria per cell	Mean cell volume / μm^3
fat cell	100	600 000
heart cell	2000	45 000
liver cell	2000	125 000

Calculate the mean number of mitochondria per μm^3 for each cell. Give your answers to 2 significant figures.

fat cell:

heart cell:

liver cell:

Part C Fat cell vs heart cell

Which of the following statements explain the difference in mean number of mitochondria per μm^3 between the fat cell and the heart cell in part B? Select all that apply.

- [ ] fat cells have a higher mean number of mitochondria per μm^3 than heart cells because they require more energy
- [ ] heart cells have a higher mean number of mitochondria per μm^3 than fat cells because they require more energy
- [ ] mitochondria produce ATP by aerobic respiration
- [ ] mitochondria produce ATP by photophosphorylation
- [ ] ATP is required for lipogenesis
- [ ] ATP is required for muscle contraction

Adapted with permission from CIE A Level Biology, June 2018, Paper 4, Question 6

Gameboard:
STEM SMART Biology Week 50

Budgie Genotypes

A Level

The Hardy-Weinberg principle, represented by the equations below, can be used to estimate the frequency of alleles and genotypes in a population.

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

$$p + q = 1$$

A breeder of birds keeps a population of 86 budgerigars in one enclosed area. Two distinct phenotypes are present, blue feathers and green feathers. Feather colour is controlled by one gene:

- **G** is the allele for green feathers
- **g** is the allele for blue feathers

Only 17 of the budgerigars have blue feathers.

Part A Heterozygous individuals

Estimate the number of **heterozygous** individuals in the population.

Part B Homozygous dominant individuals

Estimate the number of **homozygous dominant** individuals in the population.

Part C Hardy-Weinberg conditions

The Hardy-Weinberg principle does not apply to all populations.

Which of the following are conditions in which the Hardy-Weinberg principle does **not** apply?

- [ ] the population size is extremely small
- [ ] the population size is extremely large
- [ ] mating is random
- [ ] mating is non-random
- [ ] one allele is more common than the other
- [ ] one allele has a selective advantage over the other
- [ ] individuals are migrating into the population
- [ ] individuals are migrating out of the population

Adapted with permission from CIE A Level Biology, June 2018, Paper 4, Question 2c