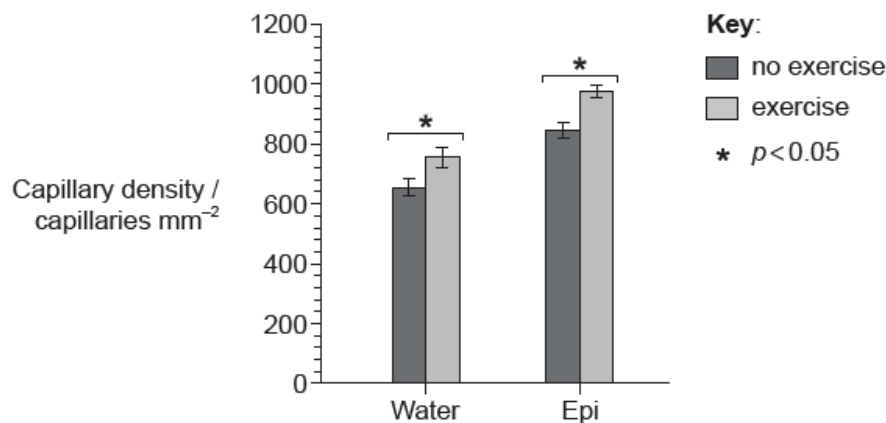


Exam Prep various command terms 2 [72 marks]

Consumption of dark chocolate has been shown to have health benefits. A study was undertaken to see the effects of epicatechin (Epi), a substance in dark chocolate, on the aerobic capacity of leg muscles of mice.

A group of adult mice was used to measure the effects of a low dose of Epi given over 15 days. The mice were divided into four groups and given either water or Epi and were either kept idle (no exercise) or made to exercise on a treadmill.

After 15 days, the results were analysed. The blood capillary density in leg muscle was measured under the light microscope.



[Source: adapted from L Nogueira, et al., (2011), *The Journal of Physiology*, 589 (part 18), Wiley, pages 4615–4631]

1a. State the significance of the statement: $p < 0.05$.

[1 mark]

Markscheme

there is a significant «statistical» difference between two experimental values

OR

there is a less than 5 % chance that the difference is random

OR

95 % or more probability that results are due to the experiment «IV» and not random/can reject the null hypothesis

OR

there is a relationship/correlation between doing exercise and capillary density

OWTTE

1b. Outline the trends in capillary density in the results of this experiment. [2 marks]

Markscheme

- a. exercise «significantly» increased the density with both water and Epi
“both” or OWTTE must be mentioned
- b. Epi «significantly» increased the density with and without exercise
- c. Epi-exercise had the greatest increase in the density
OR
Epi increases the density more than exercise alone

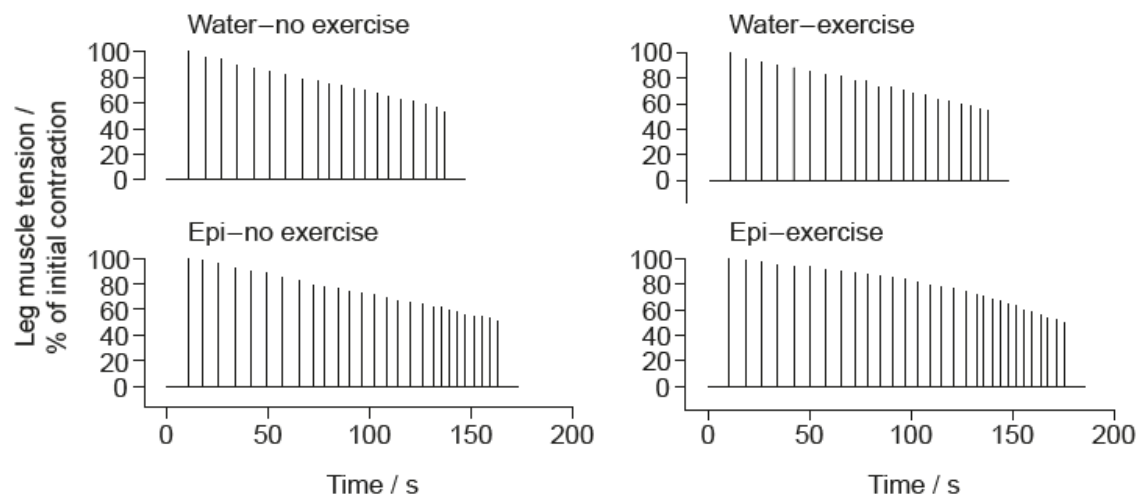
- 1c. Describe how increased capillary density could affect the aerobic capacity of muscle.

[2 marks]

Markscheme

- a. increases amount of blood taken to the muscle
- b. increases the delivery of oxygen/glucose/nutrients for aerobic respiration
- c. increases the removal of carbon dioxide/wastes
OR
increased gas exchange

Leg muscle tension was measured over time during a treadmill exercise in all four groups. The muscle is considered to reach a point of fatigue when there is a decrease in tension to 50 % of the initial tension.



[Source: adapted from L Nogueira, et al., (2011), *The Journal of Physiology*, **589** (part 18), Wiley, pages 4615–4631]

- 1d. State the time when the point of fatigue occurred in the Epi-exercise group. [1 mark]

Markscheme

175 «seconds»

Accept 170 to 180 «seconds».

- 1e. Compare and contrast the results for the water-no exercise group and the Epi-no exercise group. [3 marks]

Markscheme

- in both cases the tension decreased over time
- Epi-no exercise lasts longer/more time until «onset of» fatigue «than water-no exercise»
- the rate of decrease in tension is the same/similar in both
- Epi-no exercise has more contractions per second before fatigue point «than water-no exercise»

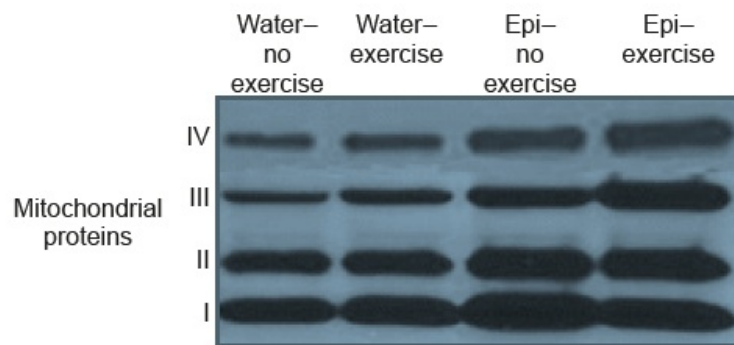
Do not accept numerical comparisons without justification.

- 1f. Discuss the effect of exercise on the results of the experiment. [2 marks]

Markscheme

- a. «exercise with» water has no impact
- b. «exercise with» Epi promotes higher levels of tension for more time
- c. «exercise with» Epi increases the time to fatigue

The scientists tested the expression of four different mitochondrial proteins. The protein samples were taken from leg muscles. The technique that was used to quantify the amount of protein expressed was Western blotting. In this procedure the thickness of the band is an indicator of the amount of protein.



[Source: adapted from L Nogueira, *et al.*, (2011), *The Journal of Physiology*, **589** (part 18), Wiley, pages 4615–4631]

- 1g. Analyse the effect of exercise on the presence of the mitochondrial proteins in the leg muscle.

[2 marks]

Markscheme

- a. exercise has no/very little effect with water
- b. exercise with Epi increased III/IV
- c. «it appears that» exercise with Epi has no/very little effect on II
OR
Epi relative to water increases all 4
OR
exercise has little/no effect on protein I/II
- d. exercise with Epi «appears to» decrease I

- 1h. Mitochondria are essential for aerobic respiration. Suggest **one** possible role of the proteins that were studied.

[1 mark]

Markscheme

a. protein channels

OR

pumps in membranes of mitochondria

OR

hormone binding sites

b. structural/integral/peripheral/glyco/surface proteins

c. enzymes/catalysts

Accept verifiable names of specific membrane enzymes.

d. electron transport chain proteins

- 1i. The scientists concluded that Epi significantly increased aerobic capacity [3 marks] in leg muscle.

Evaluate the strength of the evidence provided by all of the data for dark chocolate improving the aerobic capacity of athletes.

Markscheme

Limitations:

a. study done on mice and may not apply to humans

b. levels of Epi administered in experiment may exceed levels in a sample of dark chocolate

OR

levels of Epi administered in experiment may have different levels in a sample of dark chocolate

OR

chocolate may have other components with unknown effects on aerobic capacity

c. mitochondrial proteins may not improve aerobic capacity

Strengths:

d. data supports as dark chocolate contains EPI

e Epi improves capillary density and would therefore increase aerobic capacity

f. Epi improves fatigue resistance

g. Epi in combination with exercise improves it further

h. Epi increases mitochondrial proteins therefore/presumably increasing aerobic capacity

OWTTE

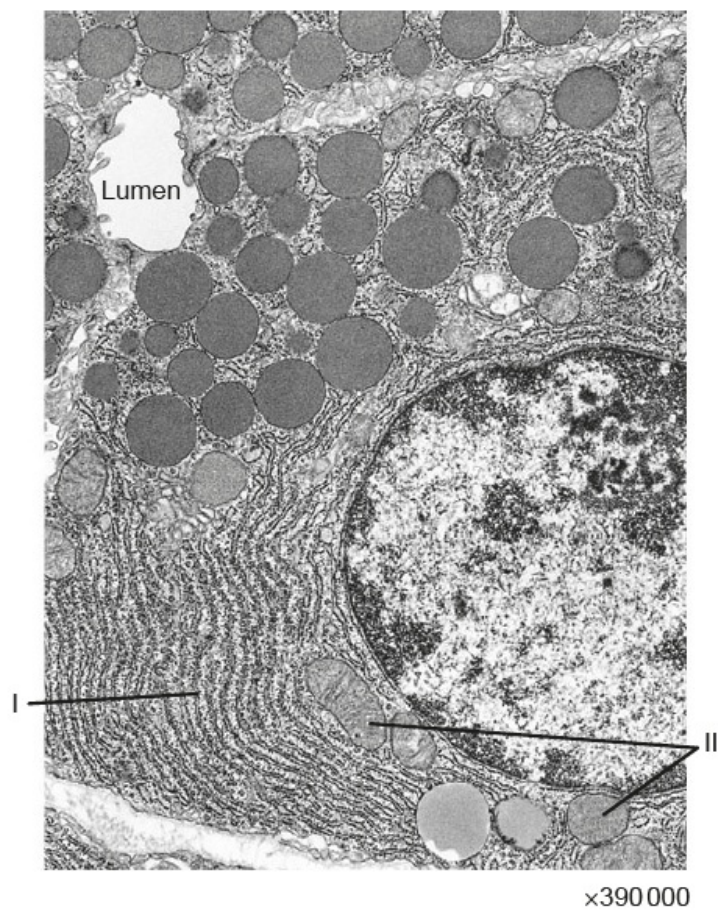
2a. Glands are organs that secrete and release particular chemical substances. Melatonin is an important hormone secreted in the pineal gland in the brain. Describe its role in mammals.

[2 marks]

Markscheme

- a. controls circadian rhythms/biological clocks «in mammals»
- b. production is controlled by amount of light detected by the retina
- c. high production/secretion in the dark
OR
no production/secretion in the day
OR
production/secretion is directly proportional to night time duration
- d. affects «seasonal» reproduction/sleep-wake cycles/jet lag

The electron micrograph shows the structures in an exocrine gland cell of the pancreas.



[Source: Meschner AL, *Junqueira's Basic Histology: Text and Atlas*, 12th edition. Copyright McGrawHill Education.]

2b. State the principal product of this cell. [1 mark]

Markscheme

«digestive» enzymes

2c. Using the table, identify the organelles labelled I and II on the electron micrograph with their principal role. [2 marks]

Organelle	Name	Principal role
I		
II		

Markscheme

<i>organelle</i>	<i>name</i>	<i>principal role</i>
I	rough endoplasmic reticulum OR ribosome	protein production/synthesis «for excretion»
II	mitochondrion/mitochondria	<u>aerobic</u> «cell» respiration OR ATP/energy production

3a. Draw a molecular diagram of an amino acid to show its general structure.

[3 marks]

Markscheme

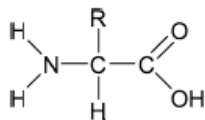
a. COO- **or** COOH group at one end

b. NH₂ **or** NH₃⁺ at the other

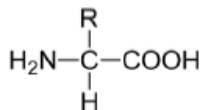
c. CH in middle with H or R group attached

If shown expanded, then carbonyl oxygen must attach to C
If shown non-expanded, N of amine group must attach to C

eg:



OR



3b. Outline the role of ribosomes in translation.

[4 marks]

Markscheme

- a. translation is the production of polypeptides/proteins
- b. mRNA binds to the ribosome
- c. tRNA binds to the ribosome
- d. at the site where its anti-codon corresponds to the codon on the mRNA

OWTTE

e. amino acids of «consecutive tRNAs» bind by a peptide link «in the ribosomes»

f. the ribosome moves along the mRNA

OR

continues with elongation of polypeptide chain

Accept annotated diagrams of the process.

-
- 3c. Some blood proteins are involved in defence against infectious disease. *[8 marks]*
Explain the roles of **named** types of blood proteins in different defence mechanisms.

Markscheme

a. clotting factors «are proteins» that initiate the clotting cascade/process

b. fibrin «is a protein that» permits blood clotting

OR

allows the formation of a clot

c. «the protease» thrombin converts fibrinogen to fibrin

OWTTE

d. fibrin forms a mesh/clot that prevents the entry of pathogen/antigen into the blood

e. antibodies are «specific» proteins that lymphocytes make

f. each antibody corresponds to a specific pathogen/antigen

OR

antibodies are specific «to certain pathogens/antigens»

g. antibodies create specific immunity

h. plasma cells produce large amounts of «specific» antibodies

OR

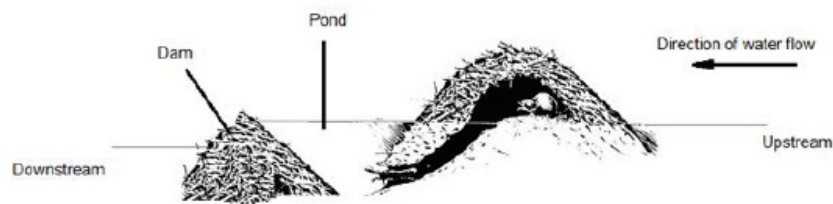
memory cells retain the ability to produce «specific» antibodies

i. immunoglobulins are antibodies against pathogens

j. enzymes in phagocytic white blood cells may digest pathogens

Accept annotated diagrams of the process.

Beavers are large rodents that live in waterways throughout the northern hemisphere. Dams made by beavers change the temperature of the streams and affect the mayfly, *Baetis bicaudatus*. In the summer of 2008, beaver ponds in West Brush Creek and Cement Creek, Colorado, were studied to evaluate their impacts on mayflies. The study sites included streams flowing into (upstream) and out of (downstream) each beaver pond.



[Source: adapted from https://upload.wikimedia.org/wikipedia/commons/thumb/d/d4/Beaver_lodge.jpg/330px-Beaver_lodge.jpg]

Mayflies, including the species *B. bicaudatus*, are aquatic insects that hatch and spend their larval stages in water emerging from the water as adults. Larger females produce an increased number of better quality eggs.

The table shows the mean temperature differences (downstream – upstream) and mean dry mass for female and male mayflies.

	Beaver pond	Relative height of dam	Mean temperature differences / °C	Mean dry mass / mg					
				Female			Male		
				Up-stream	Down-stream	Difference	Up-stream	Down-stream	Difference
West Brush Creek	1	low	+0.1	1.97	1.83	–0.14	1.39	1.37	–0.02
	2	high	–0.3	1.43	1.51	+0.08	1.15	1.18	+0.03
	3	high	–0.2	1.55	1.67	+0.12	1.19	1.23	+0.04
	4	low	+0.4	2.27	2.15	–0.12	1.53	1.51	–0.02
Cement Creek	5	low	0.0	2.12	2.07	–0.05	1.39	1.33	–0.06
	6	high	–0.1	1.79	1.76	–0.03	1.34	1.31	–0.03
	7	high	–0.2	2.10	2.14	+0.04	1.53	1.49	–0.04
	8	low	+0.2	2.14	2.10	–0.04	1.49	1.53	+0.04
	9	high	–0.3	2.05	2.09	... I ...	1.57	1.45	... II ...

[Source: Fuller, M. R. and Peckarsky, B. L. (2011), Ecosystem engineering by beavers affects mayfly life histories. *Freshwater Biology*, 56: 969–979. doi:10.1111/j.1365-2427.2010.02548.x
© 2011 Blackwell Publishing Ltd]

- 4a. Calculate the difference in the mean dry mass of mayflies upstream and downstream of Cement Creek pond 9 for female and male mayflies. [1 mark]

I.	Female: mg
II.	Male: mg

Markscheme

I. female: «+» 0.04 «mg»

AND

II. male: «-» 0.12 «mg»

Both needed.

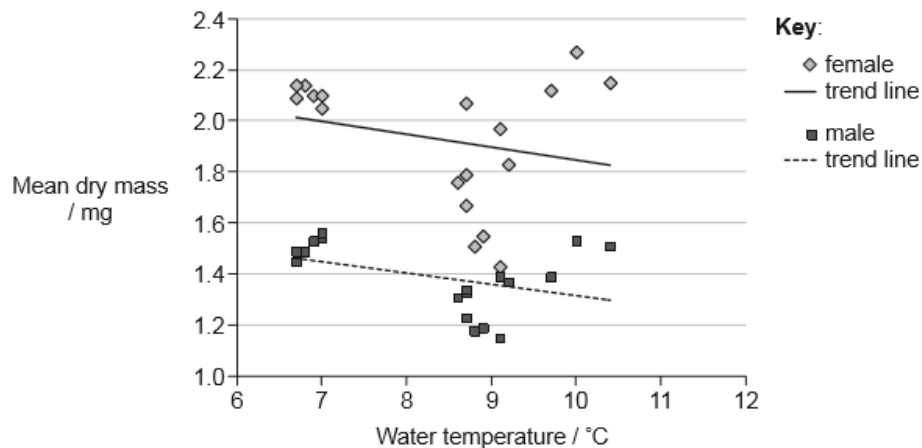
4b. Describe the effect dams have on water temperature.

[2 marks]

Markscheme

- a. height of dam affects the temperature
- b. high dams tend to cool the water
- c. low dams tend to warm the water
- d. pond 5/one pond shows no change/stays the same

4c. The graph shows the mean dry mass of mayflies relative to the water temperature in their habitats. [2 marks]



[Source: Fuller, M. R. and Peckarsky, B. L. (2011), Ecosystem engineering by beavers affects mayfly life histories. *Freshwater Biology*, 56: 969–979. doi:10.1111/j.1365-2427.2010.02548.x
© 2011 Blackwell Publishing Ltd]

Using the graph, discuss evidence for the hypothesis that mayflies grow to greater dry mass in cooler water.

Markscheme

a. trend lines support «the hypothesis»

OR

trend shows a negative correlation shown «between increased temperature and size»

Do not credit answers with just numbers.

Accept “line of best fit” wtte.

b. the trend line is shallow / small slope

OR

there is a large amount of scatter at higher temperatures (reducing the certainty)

OR

wide/overlapping ranges so no significant difference «(at» 9°C)

Note that it is only the trend line that indicates support.

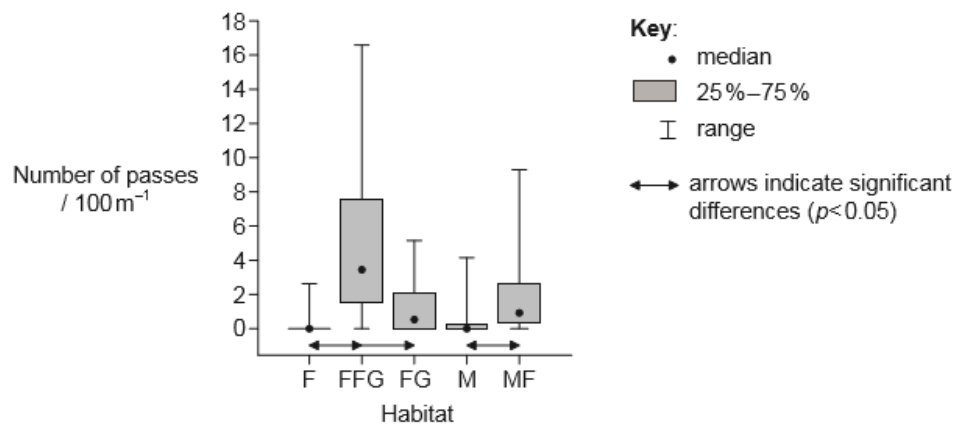
c. (hypothesis not supported because) females in water over 10°C have the highest «mean dry» mass

Words other than “hypothesis not supported” may be used: “as opposed to”, “whereas”, to express deviation from support.

The bat, *Pipistrellus nathusii*, feeds on insects including mayflies. A study was undertaken in Poland to see the effect of European beavers (*Castor fiber*) on the activity of bats. Beaver activity can affect forests that are covered by trees and meadows that are covered by grasses and have no trees. The following habitats were studied:

- forest (F)
- flooded forest with canopy gaps created by beavers and flooding due to the presence of beaver dams (FFG)
- forest with canopy gaps created by beavers but no flooding (FG)
- meadow (M)
- meadow with flooding due to the presence of beaver dams (MF).

As bats feed they fly through the air catching insects. The number of feeding passes made by bats was counted. The graph shows differences in the bat activity between particular habitats.



[Source: adapted from Ciechanowski, M., Kubic, W., Rynkiewicz, A. et al. (2011), "Reintroduction of beavers *Castor fiber* may improve habitat quality for vespertilionid bats foraging in small river valleys". *European Journal of Wildlife Research*, Volume 57, Number 4, Page 737.]

4d. Analyse the data to find the effect of flooding and tree felling by beavers [2 marks] on the activity of bats.

Markscheme

a. both flooding and tree felling increases bat passes/activity / WTTE

b. flooding has greater/increase on bat passes/activity / WTTE

OR

flooding has the greater impact than tree felling on bat passes

c. supporting argument from the data

4e. The trout, *Oncorhynchus mykiss*, that live in West Brush Creek and Cement Creek also feed on the mayflies. Fishermen come to Colorado to catch and eat trout. Draw a diagram of part of a food web for the creeks in Colorado, including mayflies, humans, trout and bats. [2 marks]

Markscheme

- a. arrow pointing from trout to human
- b. arrows pointing from mayflies to trout and bats

Award [1 max] if answer does NOT show all 4 organisms.

4f. Identify an example of competition between organisms in this food web. [1 mark]

Markscheme

bats and trout compete for mayflies

4g. The North American beaver (*Castor canadensis*) was introduced to islands adjacent to Argentina and Chile where they have become an invasive species. Discuss **one** ecological criterion (a basis for deciding) whether beavers are harmful **or** helpful to the ecosystems there. [2 marks]

Markscheme

- a. criterion
- b. reason that beavers damage
- c. reason that beavers help

eg,

- a. biodiversity
- b. if indigenous species are eliminated biodiversity is reduced, then the beavers would be seen as damaging
- c. if biodiversity increases (due to the engineering of waterways), then beavers could be a benefit

Consider criteria something that may be dealt with from a range of perspectives.

Other possible criteria: abiotic disturbance changes to food webs diversity

5a. Define metabolism.

[1 mark]

Markscheme

(the web of all) the enzyme-catalyzed reactions in a cell/organism

OR

the totality of an organism's chemical reactions (consisting of catabolic and anabolic pathways which manage the material and energy resources of the cell)

- 5b. Identify the following processes as **either** anabolism **or** catabolism by placing a tick (✓) in the correct box. [2 marks]

Process	Anabolism	Catabolism
Photosynthesis	<input type="checkbox"/>	<input type="checkbox"/>
Glycolysis	<input type="checkbox"/>	<input type="checkbox"/>

Markscheme

process	anabolism	catabolism
photosynthesis	<input checked="" type="checkbox"/>	<input type="checkbox"/>
glycolysis	<input type="checkbox"/>	<input checked="" type="checkbox"/>

- 5c. Describe cell respiration in terms of metabolism. [2 marks]

Markscheme

a. «cell respiration is metabolism because» enzymes control the reactions

b. energy is released from complex molecules «to make ATP»

c. respiration is catabolic (metabolism)

OR

complex molecules become simpler

OR

$C_6H_{12}O_6$ to $CO_2 + H_2O$

The diploid number of chromosomes in horses (*Equus ferus*) is 64 and the diploid number in donkeys (*Equus africanus*) is 62. When a male donkey and a female horse are mated, the result is a mule which has 63 chromosomes.

6a. State the haploid number for horses.

[1 mark]

Markscheme

32

6b. Explain reasons that mules cannot reproduce.

[2 marks]

Markscheme

- a. because the chromosome number is not an even number/63
- b. (so) cannot divide by two during meiosis/cannot perform meiosis/chromosomes cannot pair up during meiosis
- c. one chromosome has no homologue/WTTE
- d. because unlikely to/cannot produce viable gametes/sperm/egg cells

6c. Discuss whether or not horses and donkeys should be placed in the same species.

[2 marks]

Markscheme

- a. to be in same species two organisms must have the same genes arranged on the same chromosomes
OR
must have the same number of chromosomes
- b. members of same species produce fertile offspring and a mule is not fertile

6d. A mule was born at the University of Idaho in the USA with 64 chromosomes. Suggest a mechanism by which this could happen.

[1 mark]

Markscheme

non-disjunction

Accept description of non-disjunction.

- 7a. Living organisms have been placed in three domains: archaea, eubacteria and eukaryote. Distinguish archaea from eubacteria.

[3 marks]

Archaea	Eubacteria

Markscheme

<i>archaea</i>	<i>eubacteria</i>
DNA with proteins/histones	DNA with no proteins/histones
usually have introns	seldom have introns
cell walls lack peptidoglycan/glycoprotein	cell walls with peptidoglycan/glycoprotein
lipids different/cell membrane with glycerol-ether	lipids different/cell membrane with glycerol-esters
found in extreme environments	not in extreme environments
ribosomes are different (than eubacteria)	ribosomes are different (than archaea)

Award [1] for each correct row.

Award reasonable distinctions even if not strictly contrasted.

- 7b. List **two** types of evidence used to determine which species belong in the same clade.

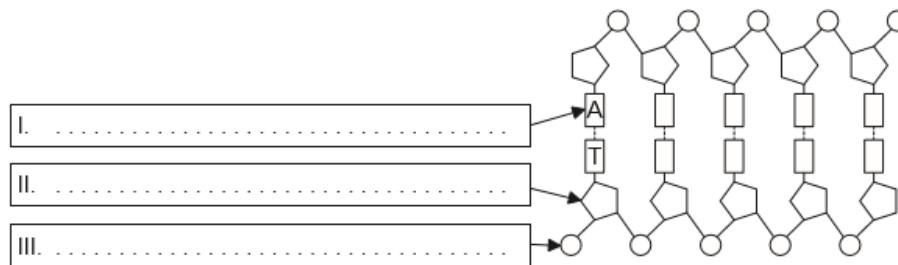
[2 marks]

Markscheme

- a. DNA/base sequences (of a gene/genes)
- b. amino acid sequences (in a protein/proteins)

Do not credit references to morphology.

8a. Label the parts of two paired nucleotides in the polynucleotide of DNA. [3 marks]



Markscheme

/: nitrogenous base

OR

adenine

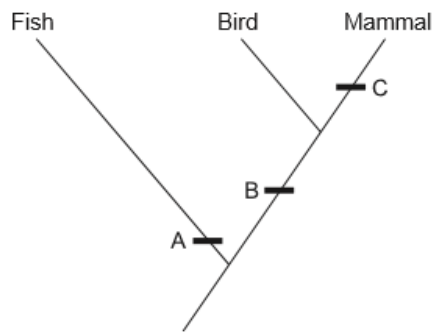
OR

purine base

//: deoxyribose

///: phosphate

The image shows part of a cladogram.



8b. Using the cladogram, identify **one** diagnostic feature that characterizes the given groups of vertebrates at A, B and C. [3 marks]

A:
B:
C:

Markscheme

A: gills **or** fins **or** scales **or** no limbs **or** external fertilization

B: homeothermic **or** endothermic **or** warm-blooded **or** lungs **or** tetrapod **or** four limbs **or** pentadactyl limbs **or** internal fertilization

C: hair **or** fur **or** mammary glands **or** milk

8c. State the name of the domain to which these organisms belong.

[1 mark]

Markscheme

Eukaryotes