

Exam Prep various command terms *[218 marks]*

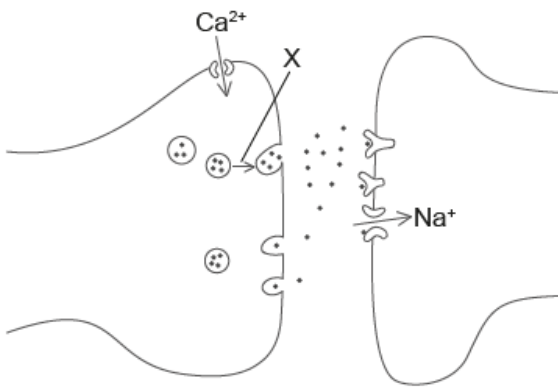
- 1a. Outline how the amphipathic properties of phospholipids play a role in membrane structure. *[2 marks]*

Markscheme

- a. part hydrophobic/not attracted to water/non-polar **AND** part hydrophilic/attracted to water/polar; *Both needed.*
- b. bilayer formed (formed naturally by phospholipids in water);
- c. hydrophilic heads/parts face outwards **AND** hydrophobic tails/parts face inwards;

Do not allow water loving/hating in mpa or mpc.

The diagram shows part of two neurons.



[Source: © International Baccalaureate Organization 2020.]

- 1b. State the name of the structure shown. *[1 mark]*

Markscheme

synapse/synaptic

- 1c. X indicates the movement of a structure in the neuron. Explain what events trigger this movement and what happens next. [3 marks]

Markscheme

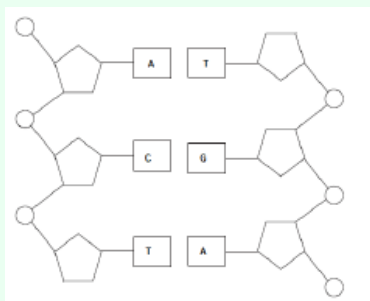
- depolarization of pre-synaptic membrane / action potential/nerve impulse arrives;
- uptake of calcium / calcium ions diffuse in / calcium channels open;
- structures containing neurotransmitter/vesicles move to/fuse with membrane;
- neurotransmitter/acetylcholine released by exocytosis into cleft/binds to postsynaptic membrane/receptors;

- 2a. Sketch the complementary strand to complete the section of a DNA diagram. [3 marks]



Markscheme

- correct base sequence: T, G, A;
- strand drawn anti-parallel;
- correct shapes used;



Award [2 max] if bonds are not from the correct carbon or if the nucleotides are not joined.

2b. Define mutation.

[1 mark]

Markscheme

change in genetic makeup/DNA/nucleotide/base sequence

2c. Explain how evolution by natural selection depends on mutations.

[4 marks]

Markscheme

- a. mutations cause variation among organisms of same species/population;
- b. some variations/mutations make individual more suited to its environment/way of life;
- c. individuals that are better adapted survive and produce offspring;
- d. individuals pass on genetic characteristics/mutation/variation to offspring;
- e. natural selection increases frequency of characteristics/alleles that make individuals better adapted;

A short base sequence of mRNA and a table of the genetic code are shown below.

Sequence of mRNA

AUGAGCCGAAGGUAGCUG

Table of the genetic code

		2nd letter					
		U	C	A	G		
1st letter	U	Phe	Ser	Tyr	Cys	U	3rd letter
		Phe	Ser	Tyr	Cys	C	
		Leu	Ser	STOP	STOP	A	
		Leu	Ser	STOP	Trp	G	
	C	Leu	Pro	His	Arg	U	
		Leu	Pro	His	Arg	C	
		Leu	Pro	Gln	Arg	A	
		Leu	Pro	Gln	Arg	G	
	A	Ile	Thr	Asn	Ser	U	
		Ile	Thr	Asn	Ser	C	
		Ile	Thr	Lys	Arg	A	
		Met/START	Thr	Lys	Arg	G	
	G	Val	Ala	Asp	Gly	U	
		Val	Ala	Asp	Gly	C	
		Val	Ala	Glu	Gly	A	
		Val	Ala	Glu	Gly	G	

3a. Outline the function of codons.

[1 mark]

Markscheme

«three bases on mRNA» coding for one amino acid «in a polypeptide» ✓

3b. Determine the sequence of amino acids that could be translated from the

[1 mark]

sequence of mRNA.

Markscheme

met-ser-arg-arg

OR

start-ser-arg-arg

OR

met-ser-arg-arg-stop

OR

start-ser-arg-arg-stop ✓

Do not accept peptides containing an amino acid/leu for the last codon.

- 3c. Determine the DNA base sequence transcribed to form this sequence of mRNA. [1 mark]

Markscheme

TAC TCG GCT TCC ATC GAC ✓

- 3d. Suggest a hypothesis that accounts for the slightly different meaning of some codons in a very limited number of organisms. [1 mark]

Markscheme

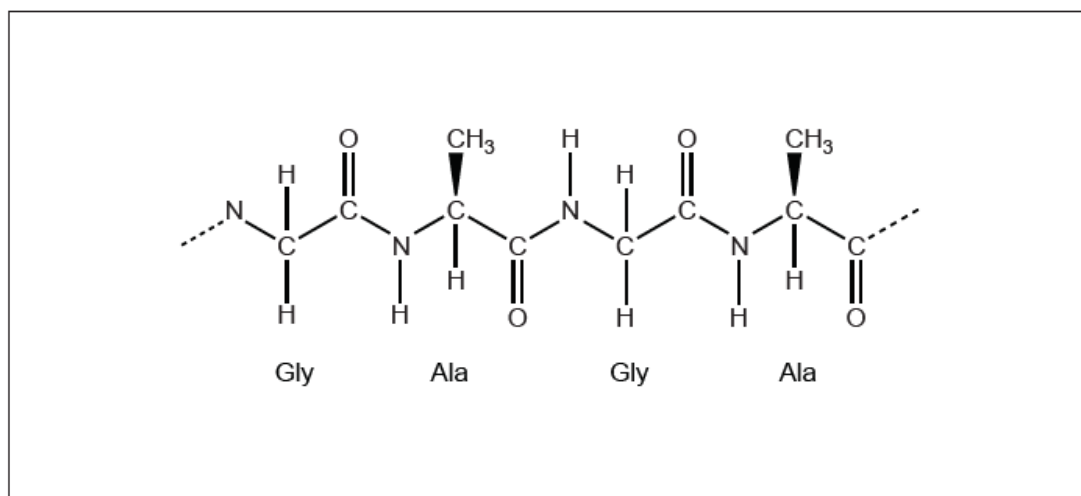
they occurred after the common origin of life *OWTTE*

OR

the genetic code is not «in fact» universal ✓

Look for alternatives.

The diagram shows a section of a polypeptide.

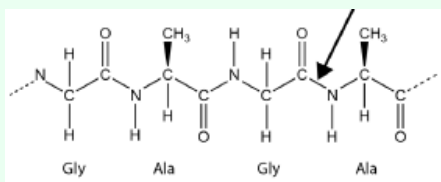


3e. Annotate the diagram to show a peptide bond between two amino acids. [1 mark]

Markscheme

any annotation between a C=O and the next NH ✓

e.g.



3f. State the type of reaction that removes water while linking amino acids together to form polypeptides. [1 mark]

Markscheme

condensation ✓

Do not accept anabolism alone.

3g. Outline the function of Rubisco and of spider silk in relation to their three-dimensional conformation. [2 marks]

	Function	Conformation
Rubisco		
Spider silk		

Markscheme

	c	d
	Function	Conformation
Rubisco	enzyme/catalyst / carbon fixation / <i>OWTTE</i>	globular ✓
Spider silk	absorb stretch/structural / <i>OWTTE</i>	fibrous/longitudinal /linear/«mainly»β-pleated ✓

Award **[1]** per correct row or correct column.

4a. Outline the cell theory. [2 marks]

Markscheme

- a. cells can only arise from preexisting cells ✓
- b. living organisms are composed of cells/smallest unit of life ✓
- c. organisms consisting of only one cell carry out all functions of life in that cell/cells perform life functions «at some point in their existence» ✓
- d. although most organisms conform to cell theory, there are exceptions ✓

4b. State **two** functions of life. [2 marks]

Markscheme

- a. nutrition ✓
- b. metabolism/respiration ✓
- c. growth ✓
- d. response/irritability ✓
- e. excretion ✓
- f. homeostasis ✓
- g. reproduction ✓

*Do not allow "feeding", plants do not "feed".
Mark the first two answers only.*

4c. List **three** characteristics of eukaryotic homologous chromosomes. [3 marks]

Markscheme

- a. linear DNA molecules
OR
DNA associated with histone «proteins» ✓
- b. carry the same sequence of genes ✓
- c. «but» not necessarily the same alleles «of those genes» ✓
- d. both are present when nucleus is in diploid state ✓
OR
occur in pairs ✓
- e. have same size/length/banding patterns ✓
- f. centromeres are in the same position ✓

- 4d. Using the following table, compare and contrast anaerobic cell respiration in yeasts and in humans. The first row has been completed as an example.

[3 marks]

	Yeasts	Humans
Small yield of ATP	yes	yes
Require oxygen		
Produce ethanol and CO ₂		
Produce lactate		

Markscheme

	Yeasts	Humans
<i>Small yield of ATP</i>	<i>yes</i>	<i>yes</i>
require oxygen	no	no ✓
produce ethanol and CO ₂	yes	no ✓
produce lactate	no	yes ✓

Award **[1]** per correct row.

- 5a. State the immediate consequence of a species producing more offspring than the environment can support. [1 mark]

Markscheme

competition/lack of resources/death/exceeding carrying capacity ✓

Allow a description of it.

Do not allow "overpopulation" or "natural selection".

- 5b. Explain the consequence of overpopulation on the survival and reproduction of better adapted individuals within a population.

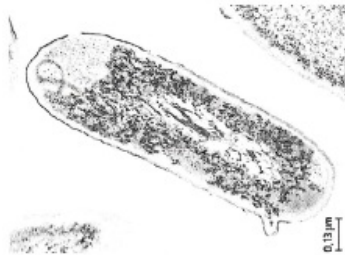
[3 marks]

Markscheme

- a. «better adapted» tend to survive more ✓
- b. «better adapted» reproduce/produce more offspring ✓
- c. pass on characteristics to their offspring «when they reproduce» ✓
- d. their frequency increases «within the population» due to natural selection ✓
- e. leading to evolution ✓

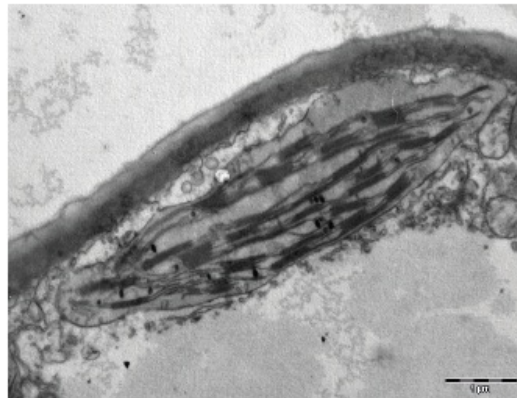
6a. Identify which electron micrograph shows a mitochondrion, providing **one** [1 mark] observation to support your choice.

A



[Source: Pradana Aumars, https://commons.wikimedia.org/wiki/Category:Bacteria#/media/File:Bacteria_cell_division.jpg]

B



[Source: and3k and caper437/ https://bs.wikipedia.org/wiki/Datoteka:Chloroplast_in_leaf_of_Anemone_sp_TEM_12000x.png]

C



[Source: republished with permission of McGraw-Hill Education, from *Harrison's Principles of Internal Medicine*, J L Jameson et al., 16th edition, 2004; permission conveyed through Copyright Clearance Center, Inc]

Markscheme

«micrograph» C cristae/double membrane is visible/«folds of» membranes inside ✓

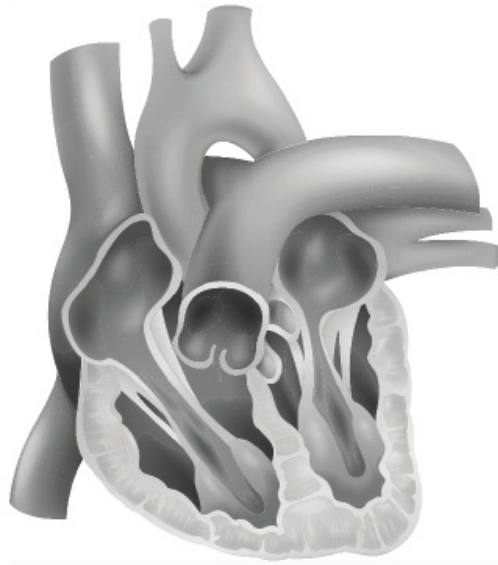
Must state observation

- 6b. Discuss the evidence for the theory that mitochondria may have evolved [3 marks] from free-living prokaryotes by endosymbiosis.

Markscheme

- a. «double» membrane may have formed when engulfed ✓
- b. replicate by binary fission like free-living prokaryotes
OR
reproduce separate from «host» cell replication ✓
- c. they have their own «circular» DNA **AND** reproduce on their own ✓
- d. they have «70s» ribosomes **AND** can manufacture «their own» proteins ✓
- e. have organelle«s» similar to free-living prokaryotes ✓
- f. similar in size to free-living prokaryotes ✓
- g. mitochondrial inner membranes manufacture ATP like bacterial membranes ✓
- h. currently there is no free-living prokaryote like a mitochondrion ✓

The diagram shows the human heart.



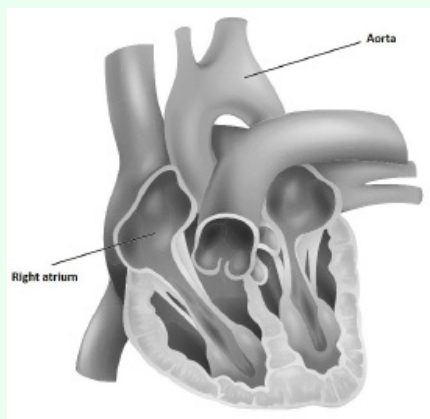
[Source: BlueRingMedia/Shutterstock]

7a. On the diagram, label the aorta.

[1 mark]

Markscheme

both labelled clearly as in diagram ✓



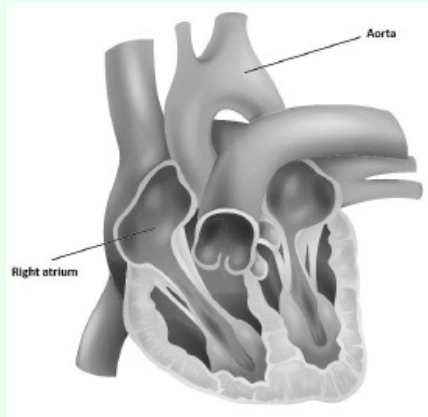
[Source: BlueRingMedia/Shutterstock]

7b. On the diagram, label the right atrium.

[1 mark]

Markscheme

both labelled clearly as in diagram ✓



[Source: BlueRingMedia/Shutterstock]

7c. Explain how valves control the flow of blood through the heart.

[2 marks]

Markscheme

- a. valves open and close in response to changes in blood pressure/heart contraction/pumping ✓
- b. valve prevents backflow/maintains direction of blood flow ✓
- c. valves allow heart chambers to fill/to empty ✓

7d. Outline the causes and consequences of blood clot formation in coronary arteries. [2 marks]

Markscheme

a. coronary heart disease/CHD/coronary artery disease/CAD occurs when there is reduction of oxygen to the heart muscle ✓

b. high ratio of LDL to HDL/fatty diet leads to plaque formation in arteries ✓

c. plaque breaks off causing damage that activates blood clot formation ✓

d. clots «in the bloodstream» may block a coronary artery/coronary thrombosis reducing blood flow/oxygen

OR

clots can cause heart attack/muscle death ✓

e. sickle cell anemia «crisis» produces blood clots «that can cause coronary/arterial blockage» ✓

7e. Outline the role of lymphocytes in defence against disease.

[2 marks]

Markscheme

a. produce antibodies ✓

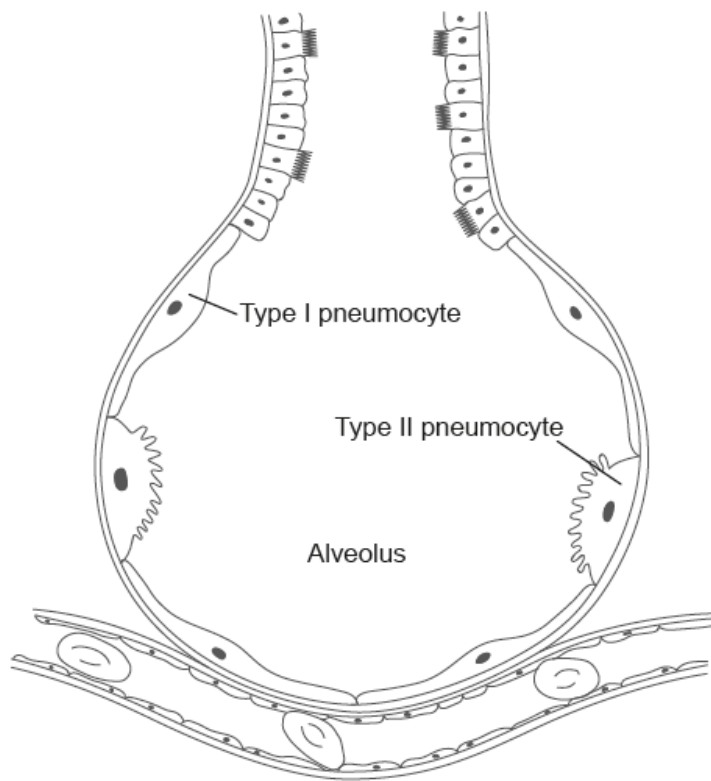
b. memory cells confer immunity ✓

c. specific immunity results from production of antibodies specific to a particular antigen ✓

d. recognize pathogens ✓

e. destroy foreign cells/cancer cells ✓

The diagram shows the structure of an alveolus and an adjacent capillary.



[Source: © International Baccalaureate Organization 2019]

8a. Outline the functions of type I and type II pneumocytes.

[2 marks]

Markscheme

type I:

a. carry out gas exchange

OR

diffusion of gases/ CO_2/O_2 ✓

type II:

b. secrete fluid/surfactant ✓

8b. Explain how gases are exchanged between the air in the alveolus and the blood in the capillaries.

[3 marks]

Markscheme

a. O₂ concentration in alveolar air greater than in capillary/blood «prior to gas exchange»

OR

hemoglobin in blood binds oxygen maintaining the concentration gradient ✓

b. O₂ gas dissolves in water lining the alveolus ✓

c. O₂ diffuses through wall of alveolus and capillary into blood ✓

d. CO₂ concentration in blood greater than in alveolar air «prior to gas exchange» ✓

e. CO₂ diffuses through wall of capillary and alveolus into alveolar airspace ✓

The table gives common names and binomial names for some mammals.

Common name	Binomial name
Golden bamboo lemur	<i>Hapalemur aureus</i>
Golden jackal	<i>Canis aureus</i>
Grey wolf	<i>Canis lupus</i>
Red fox	<i>Vulpes vulpes</i>

9a. State **one** feature that characterizes these species as mammals.

[1 mark]

Markscheme

fur/hair/mammary glands/feed young with milk/three inner-ear bones/lungs ventilated by diaphragm/lungs contain alveoli ✓

9b. Identify the **two** species most closely related.

[1 mark]

1.

2.

Markscheme

Canis aureus/golden jackal **AND** *Canis lupus*/grey wolf ✓
Both needed

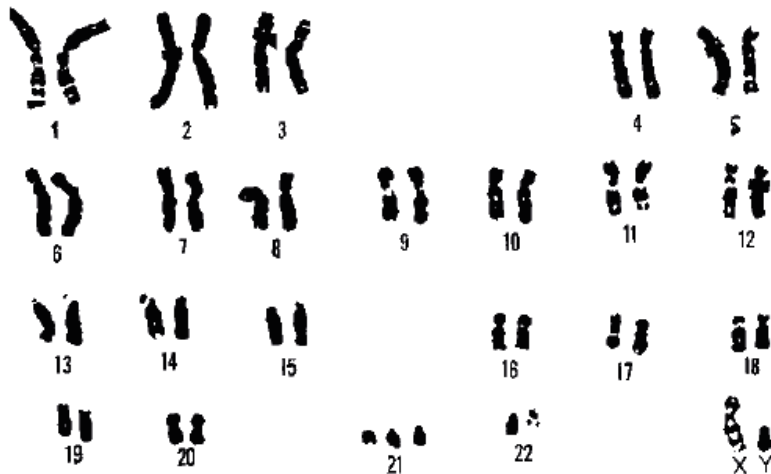
9c. Identify **two** species from the list that are classified in different genera. [1 mark]

- 1.
- 2.

Markscheme

Hapalemur aureus/Golden bamboo lemur **AND** *Canis aureus*/golden jackal/*Canis lupus*/grey wolf/*Vulpes vulpes*/red fox
OR
Vulpes vulpes/red fox **AND** *Canis aureus*/golden jackal/*Canis lupus*/grey wolf/*Hapalemur aureus*/golden bamboo lemur ✓

The image shows the chromosomes from a body cell of an adult human.



[Source:
http://www.ornl.gov/sci/techresources/Human_Genome/graphics/slides/elsikaryotype.
U.S. Department of Energy Human Genome Program.]

10a. Identify, with a reason, the sex of this individual. [1 mark]

Markscheme

male because Y chromosome present

OR

male because sex chromosomes/last two chromosomes/pair 23 are unpaired/different «from each other»/not homologous ✓

10b. Identify the chromosome that is affected by a trisomy in this individual, [1 mark]
naming the condition that this trisomy gives rise to.

Chromosome number:

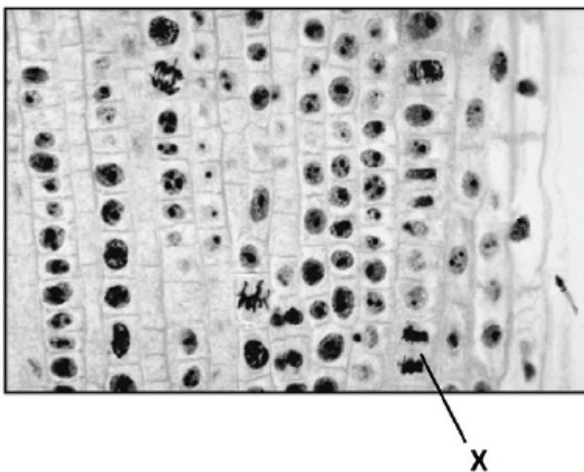
Name of condition:

Markscheme

21 **AND** Down syndrome/trisomy 21 ✓

Both needed

11a. Identify the stage of mitosis labelled X in the image, giving a reason. [1 mark]



[Source: Copyright 2002, The Trustees of Indiana University]

Markscheme

telophase because the chromosomes/chromatids have reached the poles

OR

«late» anaphase as some chromosomes/chromatids are still moving/tails visible ✓

OWTTE

11b. Outline the use of a karyogram during pregnancy.

[3 marks]

Markscheme

a. is a photograph/diagram of homologous pairs of chromosomes that can be analysed ✓

b. information may be used to determine other chromosome abnormalities/changes in chromosome numbers/possible birth defects ✓

c. Down syndrome/trisomy can be detected if there are three copies of a chromosome *Not just "Down syndrome"*.

OR

accept any other valid example ✓

d. other missing or extra pieces of chromosomes can be detected ✓

e. sex can be determined as the Y chromosome is shorter than the X ✓ *Or correct ref to X and Y.*

12a. State **two** causes of the decrease of biomass along food chains in terrestrial ecosystems.

[2 marks]

Markscheme

- a. «cell» respiration/loss of CO₂/biomass consumed to provide/as a source of energy ✓
- b. loss of energy «as heat» between trophic levels means less energy available for building biomass ✓
- c. waste products «other than CO₂»/loss of urea/feces/egesta ✓
- d. material used/CO₂ released by saprotrophs ✓
- e. undigested/uneaten material «teeth, bones, *etc*»/detritus buried/not consumed

OR

formation of peat/fossils/limestone ✓

12b. The table shows the global carbon budget over two decades; the years [3 marks]
1990 to 1999 and 2000 to 2009.

Carbon	Global carbon budget / $\times 10^{12}$ kg	
	1990 to 1999	2000 to 2009
Atmospheric carbon dioxide	3.0	4.0
Fossil fuel and cement	6.5	8.0
Land use change	1.5	1.0
Carbon storage in land	2.5	2.0
Carbon storage in oceans	2.0	2.5

[Source: © International Baccalaureate Organization 2019]

Using the table, explain causes of the changes in carbon flux over the two decades.

Markscheme

a. increased CO₂ flux to the atmosphere due to increased burning of fossil fuels by industry/transportation / cement production ✓

b. «land use change leading to» decreased rate of forest burning

OR

better fire suppression leading to decrease in CO₂ release

OR

example of land use changes that uses less fossil fuel

OR

increase in land covered by forests/plants / forests recovering from historical forestry

OR

any other reasonable explanation of land use change that would lead to decreased rate of carbon flow to atmosphere ✓

c. carbon storage in land decreased as less photosynthesis due to fewer forests/more construction

OR

release of methane due to «drying of» wetlands/sealing of land with concrete/buildings/roads ✓

d. carbon storage in ocean increased due to more photosynthesis/algae/greater concentration of CO₂ in the atmosphere

OR

increased diffusion/rate of dissolving of CO₂ into ocean from the atmosphere

OR

limestone/carbonate accumulation «more snails» ✓

12c. Suggest how climate change can influence the natural selection of organisms that live in the Arctic oceans.

[3 marks]

Markscheme

a. individuals in a population will show a variation of adaptations to climate change ✓

b. organisms that resist temperature changes

OR

current changes of the ocean/melting ice/more acidity/changes in food chains will survive better ✓

c. reproduce more and pass on their characteristics ✓

d. organisms with less adaptation will disappear with time ✓

e. example «*eg* polar bears have less ice to be able to catch prey/seals and are starving the ones that manage to find other food sources will survive»
OWTTE ✓

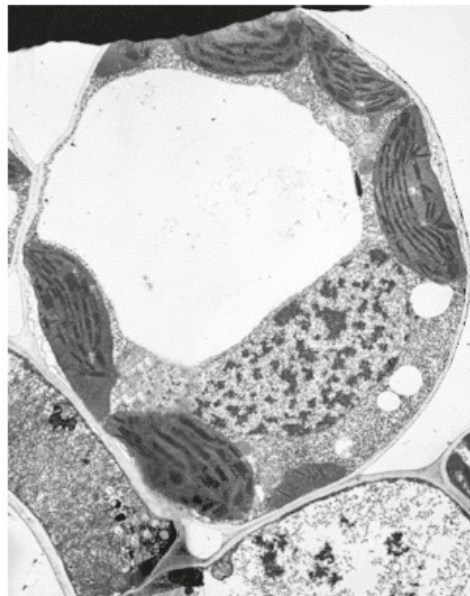
f. changes will occur within species

OR

new species may appear «over time» ✓

Accept any valid example of an Arctic ocean organism.

13a. Label the area where cellulose is found in the micrograph of a plant cell. [1 mark]



[Source: BIOPHOTO ASSOCIATES/Getty Images]

Markscheme

label placed anywhere along outside perimeter/cell wall of plant cell ✓

13b. Cellulose is the most abundant organic polymer on Earth. Describe the structure of cellulose. [3 marks]

Markscheme

a. unbranched/straight chain of glucose molecules

OR

unbranched/straight-chain polysaccharide ✓

b. formed of beta glucose;

c. formed by condensation reactions/glycosidic bonds

OR

1, 4 linkage ✓

d. hydrogen bonds form between cellulose chains

e. form microfibrils ✓

Award marks to an accurate annotated diagram

Do not allow carbohydrate

13c. Outline **one** reason for humans being unable to digest cellulose.

[1 mark]

Markscheme

humans lack cellulase/appropriate enzyme ✓

13d. Explain the advantages of having both lipid and carbohydrate as energy stores in the human body. [2 marks]

Markscheme

a. lipid is long-term energy storage

OR

carbohydrate is short-term energy storage/readily available ✓

b. lipids are insoluble, so easier to store

OR

carbohydrates/sugars are soluble, so easy to transport by blood ✓

c. lipids store more energy «per gram»

OR

lipids occupy less space «per energy/kJ» ✓

OWTTE

14a. The structure of prokaryotic cells has been investigated using electron [4 marks]
microscopy. Draw a labelled diagram to show prokaryotic cell structure.

Markscheme

a. cell wall — a uniformly thick wall ✓

b. pili — hair-like structures connected to cell wall

OR

flagellum — at one end only, longer than pili ✓

c. plasma/cell membrane — represented by a continuous single line ✓
May be labelled as the innermost wall line

d. «70S» ribosomes — drawn as small discrete dots not circles ✓

e. naked DNA/nucleoid — region with DNA not enclosed in membrane ✓

f. cytoplasm — the non-structural material within the cell ✓

Award [1] for each structure clearly drawn and correctly labelled

Award [2 max] if any eukaryotic structure is drawn and labelled

14b. Outline the reasons for differences between the proteomes of cells [4 marks]
within a multicellular organism.

Markscheme

- a. all the genome is the same in all the cells of an organism ✓
 - b. the genome/DNA/genes instructs the production/expression of proteins/proteome ✓
 - c. the proteome is all the proteins produced by a cell ✓
 - d. the proteome varies with the function/location/cell differentiation/environmental conditions of the cell ✓
 - e. specific genes are expressed/turned on/off in different cells ✓
 - f. «turning on/off» according to a required function ✓
- Accept a specific example (eg: insulin only produced in pancreas)*

14c. Discuss the cell theory and its limitations.

[7 marks]

Markscheme

cell theory:

- a. cell theory is the accepted explanation of life ✓
- b. organisms are composed of «one or more» cells ✓
- c. cells are the basic/fundamental/smallest units of life ✓
- d. cells can only come from pre-existing cells ✓
- e. spontaneous generation of life has been disproven ✓

limitations:

f. striated muscle cells contain many nuclei «while most eukaryotic cells have one nucleus»

OR

red blood cells have no nucleus «while most eukaryotic cells have one nucleus» ✓

g. giant algae have complex single cell structure

OR

organisms as large as giant algae would be expected to be multicellular, but they have only one cell with one nucleus ✓

h. aseptate fungal hyphae are tube-like structures that contain no cell membranes between the many nuclei

OR

slime molds contain many nuclei ✓

i. viruses have some characteristics of living organisms but are not cells ✓

j. if all cells come from pre-existing cells, where did the first one come from? ✓

Allow description of Pasteur's experiments

Do not accept a list of limitations without explanation

- 15a. Isolated communities in rural Finland, Hungary and some of the Scottish [3 marks]
islands have a high incidence of red-green colour blindness. Describe
the inheritance of red-green colour blindness.

Markscheme

- a. sex linked/gene is on the X chromosome ✓
- b. allele «for red-green colour blindness» is recessive/colour blindness is recessive trait/disorder ✓
- c. heterozygous females are unaffected/carriers ✓
- d. X^B denotes normal allele and X^b denotes colour blindness allele ✓
- e. more frequent in males because they only have one X chromosome ✓
- f. 50 % chance of colour blindness in sons whose mother who is heterozygote/ $X^B X^b$ ✓

Accept any other letter for the alleles.

Award mpb, mpc, mpd and mpf if these points are clearly made on a Punnett grid.

15b. The human hand is an example of adaptive radiation. Outline adaptive [5 marks] radiation.

Markscheme

- a. «happens in a group of species that» evolve from a common ancestor ✓
- b. evolution «of a structure» in different ways ✓
- c. for different functions ✓
- d. common features remain «despite the differences» ✓
- e. homologous structures are evidence «of adaptive radiation»

Must see "homologous" ✓

- f. an example of adaptive radiation ✓
- g. example of specific adaptation ✓
- h. second description of a specific adaptation ✓

example 1:

f. pentadactyl limb

g. human hand is adapted for grasping/climbing/manipulation

h. front limb of mole is adapted for digging»

example 2:

f. «Darwin's» finches'/birds' beaks

g. nectar feeding has a long/thin beak

h. seed feeding has a short/stout beak

15c. Explain how the human body defends itself against pathogens.

[7 marks]

Markscheme

- a. skin/mucous membranes primary/first defence against pathogens ✓
- b. tears/mucus contain enzymes/lysozymes which destroy pathogens ✓
- c. stomach/skin/some mucus produces acid which kills pathogens ✓
- d. phagocytic white blood cells/phagocytes/macrophages ingest pathogens
OR
lysosomes in phagocytes/macrophages release enzymes that digest pathogens ✓
- e. phagocytes/macrophages give non-specific immunity «to diseases» ✓
- f. specific immunity provided by lymphocytes ✓
- g. lymphocytes divide to produce clones «of plasma cells» ✓
- h. plasma cells/lymphocytes produce antibodies ✓
- i. antibodies are specific to a pathogen/antigen ✓
- j. memory cells provide immunity against future attacks by same pathogen ✓
- k. blood clotting/fibrin closes opening in the body so pathogens cannot enter ✓

Accept leukocytes instead of white blood cells

16a. Distinguish between the structure of amylose and the structure of amylopectin.

[1 mark]

Markscheme

amylose unbranched/helical while amylopectin branched / *vice versa*

16b. Suggest the reason for cellulose passing undigested through the human gut. [1 mark]

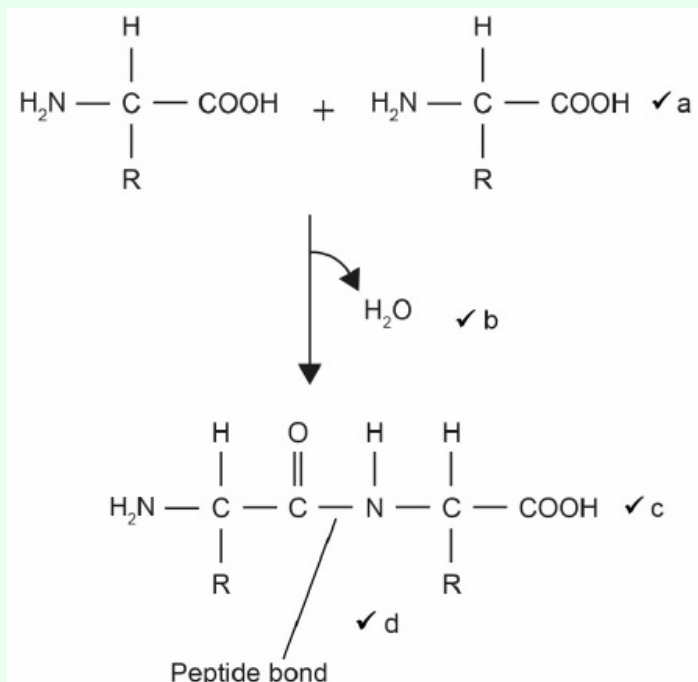
Markscheme

enzymes required to digest cellulose not present in the human gut **OWTTE**
OR
undigested cellulose provides bulk/fibre

16c. Draw an annotated diagram to show how a peptide bond is formed. [3 marks]

Markscheme

- a. correct structure of two amino acids
 - b. H_2O lost
 - c. C from COOH of one links to N of $\text{NH}_2/\text{NH}_3^+$ from the other
 - d. correct labelling of the peptide bond
- e.g.



16d. State **two** structural features that differ between RNA and DNA. [2 marks]

Markscheme

- a. number of strands
OR
(usually) only one strand in RNA/two strands in DNA
- b. base composition
OR
uracil only in RNA / thymine only in DNA
- c. type of pentose
OR
ribose only in RNA / deoxyribose only in DNA

17a. Using the Punnett grid, explain how two parents can have children with [3 marks]
any of the different ABO blood groups.

Markscheme

- a. correct gametes of one parent as I^A **AND** i in header line/column **AND**
correct gametes of other parent as I^B **AND** i in header column/line
- b. correct corresponding genotypes in inner squares as I^AI^B, I^Ai, I^Bi, ii
- c. corresponding phenotypes of children identified as AB, A, B and O
- d. ratio of phenotypes is 1:1:1:1 **OWTTE**

Allow ECF.

Gametes	I ^A	i
I ^B	I ^A I ^B	I ^B i
i	I ^A i	ii

17b. Distinguish between the structure of arteries and the structure of veins. [3 marks]

Markscheme

a. arteries have thicker (muscular) walls/layer/tunica (media)

OR

veins have thinner (muscular) walls/layer/tunica (media)

b. arteries have no valves

OR

veins have valves

c. arteries have thicker elastic layer

OR

veins have thinner elastic layer

d. arteries have a smaller lumen/bore

OR

veins have a larger lumen/bore

Accept answers presented in a table.

17c. Explain how cuts in the skin are sealed by blood clotting.

[2 marks]

Markscheme

a. clotting factors released from platelets

b. clotting process involves a cascade/series of reactions

c. produces thrombin

d. causes rapid conversion of fibrinogen into fibrin

e. fibrin makes a mesh to seal the wound **OWTTE**

18a. State **one** reason that viruses are not classified as living organisms.

[1 mark]

Markscheme

a. they do not have a metabolism/homeostasis/other specifically named life function

b. cannot reproduce by themselves

c. they are not cells/they need a host cell

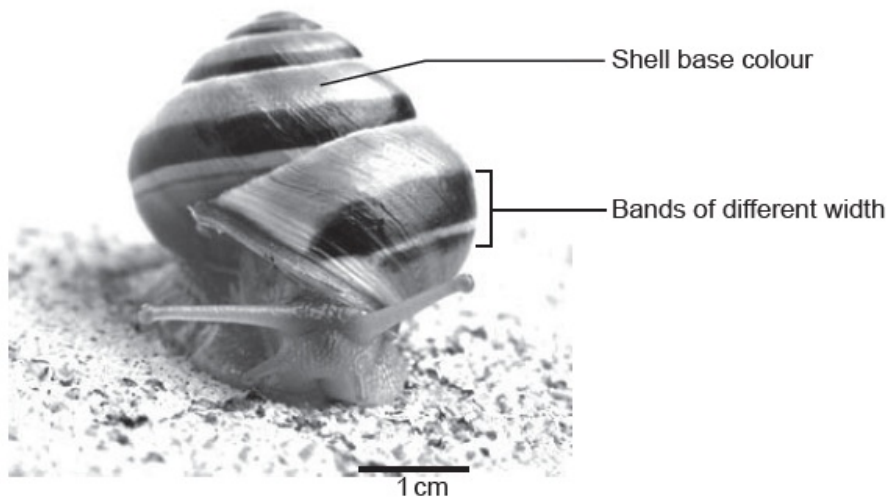
18b. State the plant phylum which is characterised by the absence of vascular tissue. [1 mark]

Markscheme

bryophyta

18c. *C. nemoralis* (pictured below) is a mollusc. Identify **two** external features that distinguish this snail from an arthropod.

[2 marks]



[Source: © International Baccalaureate Organization 2018]

Markscheme

- a. unsegmented body (whereas arthropods are segmented)
- b. shell (versus exoskeleton in arthropods)
- c. muscular foot (which arthropods do not have)
- d. no (jointed) appendages/(jointed) legs (whereas arthropods have jointed legs/appendages)
- e. slimy/mucus-covered / arthropod is not slimy

Do not award marks for any answers after the first two given.

18d. Outline the role of plant pigments in the process of photosynthesis.

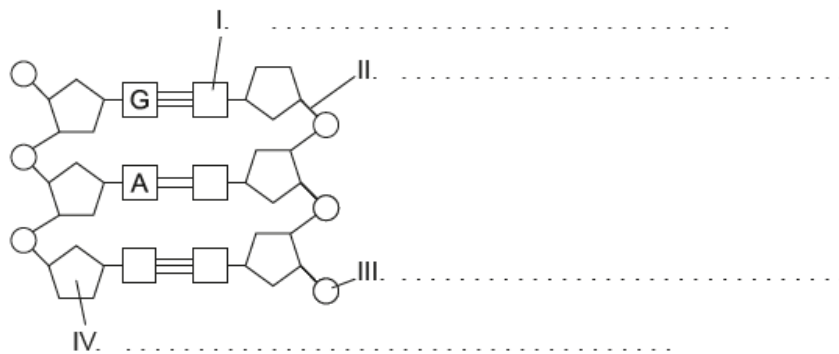
[3 marks]

Markscheme

- a. pigments/chlorophyll absorb light
- b. red and blue/violet light absorbed
- c. absorption of light energy is necessary for photolysis/use of water in photosynthesis
- d. other pigments allow for wider action spectrum than the absorption spectrum of chlorophyll

19a. Label the parts of the DNA diagram indicated by I, II, III and IV.

[2 marks]



[Source: © International Baccalaureate Organization 2018]

Markscheme

- a. I. cytosine
- b. II. sugar-phosphate/covalent/phosphodiester bond
- c. III. phosphate
- d. IV. deoxyribose

*Award **[1]** for any two correct responses.*

19b. Explain how model making helped Watson and Crick to establish the structure of DNA.

[2 marks]

Markscheme

- a. decided to combine what was known about chemical content of DNA with information from X-ray diffraction studies *OWTTE*.
- b. built scale models of components of DNA
- c. then attempted to fit them together in a way that agreed with the data «from separate sources»
- d. made several arrangements of scale model until found best one that fitted all the data

19c. Distinguish between the chromosomes of eukaryotic cells and prokaryotic cells.

[1 mark]

Markscheme

- a. associated with «histone» proteins in eukaryotes but not prokaryotes
- b. is linear in eukaryotes but circular in prokaryotes
- c. in cytoplasm in prokaryotes, but within nucleus in eukaryotes.

19d. Outline the role of the enzyme helicase in replication.

[1 mark]

Markscheme

unwinds/separates strands/double helix (by breaking hydrogen bonds)

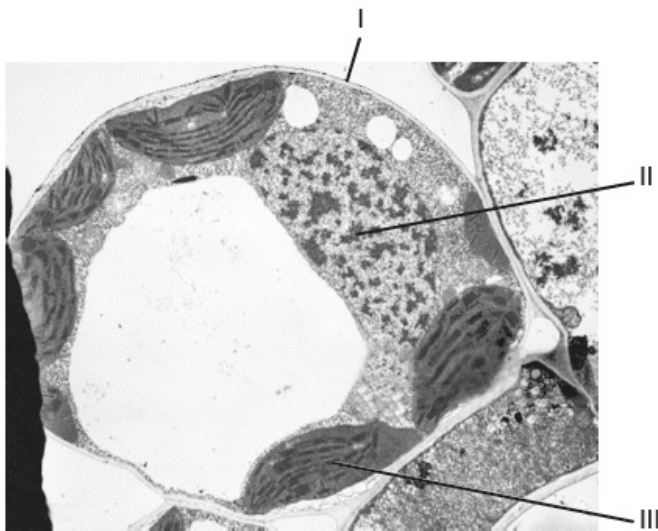
19e. Outline the role of the enzyme DNA polymerase in replication.

[2 marks]

Markscheme

- a. links nucleotides together to form a new strand of DNA
- b. uses pre-existing strand of DNA as template
- c. makes covalent bonds between nucleotides

The electron micrograph shows a palisade mesophyll cell.



[Source: BIOPHOTO ASSOCIATES/Getty Images]

20a. State the name of the structures labelled I and II.

[1 mark]

Markscheme

I. cell wall

II. nucleus/chromatin

Both needed.

20b. Outline the function of the structure labelled III.

[2 marks]

Markscheme

a. necessary for photosynthesis/converts light energy into chemical energy

b. contains chlorophyll to absorb light

c. (contains enzymes) for production of carbohydrate/glucose/starch

20c. The plant from which this cell was taken is in the group angiospermophyta. State **one** characteristic that is unique to this group of plants.

[1 mark]

Markscheme

- a. produce flowers
- b. enclosed seeds/have fruit

20d. Distinguish between autotrophic nutrition and heterotrophic nutrition. [2 marks]

Markscheme

	autotroph	heterotroph
a.	inorganic source of carbon	organic source of carbon compounds ✓
b.	synthesizes organic molecules from inorganic sources ✓	obtains organic molecules from other organisms/cannot make organic molecules from inorganic ✓
c.	autotrophs photosynthesise/require light (or chemicals) for building its own nutrients ✓	heterotrophs require chemical energy from ingested nutrients ✓

*Table format not required.
Must be paired statements.*

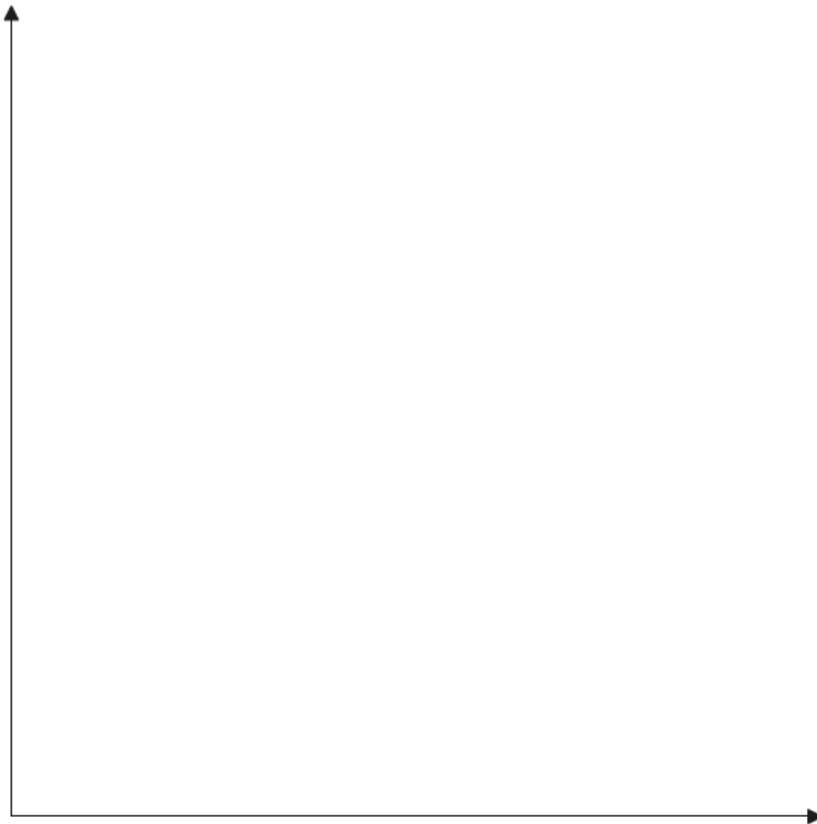
20e. Explain how energy and nutrients are transferred in ecosystems. [3 marks]

Markscheme

- a. energy enters ecosystems from the Sun / continuous supply from the Sun
- b. light energy is converted into chemical energy and lost with movement along food chains
OR
energy needs to be «constantly» added «to ecosystem» as lost with movement along food chains / energy lost as heat with movement along food chains
- c. nutrients are recycled within ecosystems / nutrients in an ecosystem are finite and limited
- d. nutrients not lost but transformed into different compounds
- e. nutrients «carbon compounds»/energy flow through food chains by means of feeding

21a. Sketch a graph to show the effect of temperature on the activity of enzymes.

[2 marks]

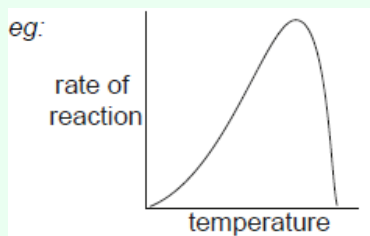


Markscheme

a. axes labelled correctly: x-axis as temperature **AND** y-axis as rate of reaction/enzyme activity

b. correct shape of graph: increases gradually to max and then decreases more rapidly

eg:



Fall should be at least twice as steep as rise.

21b. Explain enzyme-substrate specificity.

[3 marks]

Markscheme

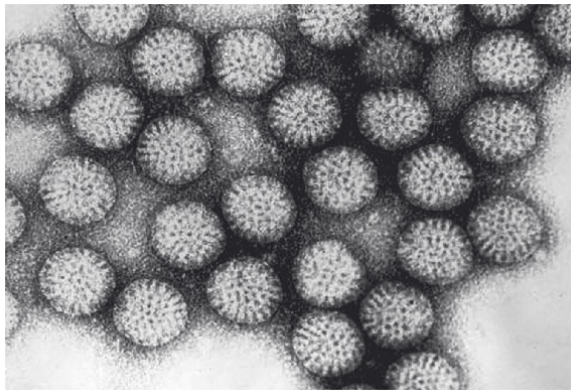
- a. enzymes are proteins with specific 3-D geometry/shape
- b. enzymes with active site that binds with the substrate/reactants
- c. active site shape only allows it to bind with specific substrates «with complementary shapes»
- d. when enzyme-substrate complex formed allows reaction to occur
- e. products are released and enzyme returns to original shape and can be reused

OR

denaturing changes shape «of active site» so changes ability to bind with substrate

Accept marks from clear annotated diagrams.

The figure shows a transmission electron micrograph of rotavirus particles. Each rotavirus is about 70 nanometres in diameter.



[Source: CDC / Dr. Erskine L. Palmer]

- 22a. State a reason for using an electron microscope to view this virus rather [1 mark] than a light microscope.

Markscheme

electron microscope has greater resolution/magnification

OR

70 nm is too small/viruses are too small to be viewed by a light microscope

22b. Rotavirus causes diarrhea and vomiting. Explain why viral diseases cannot be treated using antibiotics. [2 marks]

Markscheme

- a. viruses are not living
- b. viruses lack metabolism/lack enzymes «for metabolism»/lack cell walls
- c. antibiotics target metabolic «pathways»/cell wall production

[Max 2 Marks]

22c. State an application of plasmids in biotechnology. [1 mark]

Markscheme

transfer/vector of genetic material/genes/DNA fragments

OR

to produce insulin/useful protein

The diagram shows a leaf from *Dryopteris arguta*.



[[https://commons.wikimedia.org/wiki/File:E20161208-0001%E2%80%94Dryopteris_arguta_\(Reverse\)%E2%80%94RPBG_\(30698925004\).jpg](https://commons.wikimedia.org/wiki/File:E20161208-0001%E2%80%94Dryopteris_arguta_(Reverse)%E2%80%94RPBG_(30698925004).jpg)]
E20161208-0001—Dryopteris arguta (Reverse)—RPBG Source:
https://www.flickr.com/photos/john_d_rusk/30698925004/ Author: John Rusk from Berkeley, CA, United States of America, licensed under Creative Commons licence:
<https://creativecommons.org/licenses/by/4.0/legalcode>]

23a. State the phylum of this plant. [1 mark]

Markscheme

Filicinophyta/Filicinophytes/Pteridophytes

Reject "ferns"

23b. State **two** characteristics of plants from the phylum you stated in (a)(i). [2 marks]

Markscheme

a. have roots, stem and leaves

All three, roots, stem and leaves required

b. pinnate leaves/leaves divided «repeatedly» into leaflets

c. have vascular tissue/xylem and phloem

d. produce spores/sporangia

OR

no flowers/fruits/seeds

[Max 2 Marks]

23c. Outline why the number of trophic levels is limited in a food chain. [1 mark]

Markscheme

energy losses between trophic levels

OR

only part of the energy in one trophic level will become part of the next trophic level

24a. State **one** disaccharide and the **two** monomers from which it can be synthesized. [2 marks]

Disaccharide:

1:

Monomers:

1:

and 2:

Markscheme

a. disaccharide name

eg: lactose, glucose and galactose

b. both monomers that make up mpa

eg: maltose, glucose and glucose

eg: sucrose, glucose and fructose

24b. Discuss the roles of the enzymes secreted by the pancreas during digestion. [3 marks]

Markscheme

a. amylase breaks down/catalyzes/hydrolyses starch to maltose

b. lipase breaks down/catalyzes/hydrolyses fats to fatty acids and glycerol

c. proteases/peptidases break down/catalyze/hydrolyze proteins into smaller polypeptides/dipeptides/amino acids

Award [2] if all three enzymes and substrates named correctly and one further mark for all three products named correctly.

Allow specific enzymes

24c. Compare and contrast cis-fatty acids and trans-fatty acids. [2 marks]

Markscheme

a. both are unsaturated fatty acids

OR

both have two carbon atoms joined by a double bond

b. in cis-fatty acids the two H atoms are on the same side while in trans-fatty acids they are on opposite sides

OR

cis-fatty acids are healthier than trans-fatty acids

OR

cis-fatty acids have a lower boiling/melting point than trans

OR

cis-fatty acids have a kink «in the chain» but trans do not

Accept answer in an annotated diagram

Reproduction in eukaryotes can be sexual or asexual.

25a. Describe the origin of eukaryotic cells according to the endosymbiotic theory. [4 marks]

Markscheme

- a. mitochondria and chloroplasts are similar to prokaryotes
- b. «host» cell took in another cell by endocytosis/by engulfing «in a vesicle»
Allow “taking in” in place of “engulfing”
- c. but did not digest the cell/kept the «ingested» cell alive

OR

- symbiotic/mutualistic relationship «between engulfed and host cell»
- d. chloroplasts and mitochondria were once independent/free-living «organisms»
 - e. DNA «loop» in chloroplast/mitochondrion
 - f. division/binary fission of chloroplast/mitochondrion
 - g. double membrane around chloroplast/mitochondrion
 - h. 70s ribosomes «in chloroplast/mitochondrion»

Award up to [2] for evidence from mpe to mph

[Max 4 Marks]

25b. Explain how hormones are used to control the human menstrual cycle. *[8 marks]*

Markscheme

- a. FSH stimulates the development of follicles
- b. follicles produce estrogen
- c. estrogen stimulates the repair of the uterus lining
- d. estrogen stimulates LH secretion
- e. LH causes/stimulates ovulation
- f. LH causes/stimulates the development of the corpus luteum
- g. corpus luteum secretes progesterone
- h. progesterone causes/stimulates thickening of the uterus lining

OR

prepares uterine lining for implantation

OR

maintains the endometrium

- i. progesterone/estrogen inhibits the secretion of LH/FSH
- j. falling progesterone levels at the end of the cycle allow FSH production/menstruation
- k. negative/positive feedback «control» described correctly
- l. LH/FSH are pituitary hormones

[Max 8 Marks]

25c. Outline natural methods of cloning in some eukaryotes.

[3 marks]

Markscheme

a. clones are genetically identical organisms

OR

group of cells derived from a single parent cell

b. asexual reproduction in plants such as tubers/runners/bulbs

Allow other verifiable examples of plants

c. common in non-vertebrates such as budding in hydra

Allow other verifiable examples of invertebrates

d. budding in yeast/fungi

Allow other verifiable examples of fungi

e. identical twins «in humans» are clones because they originate from the same cell

Plants have widespread influences, from food chains to climate change.

26a. Draw a diagram of a palisade mesophyll cell labelling only the structures that would not be present in a pancreatic cell.

[3 marks]

Markscheme

a. cell wall

Must be shown as a double line

b. large vacuole

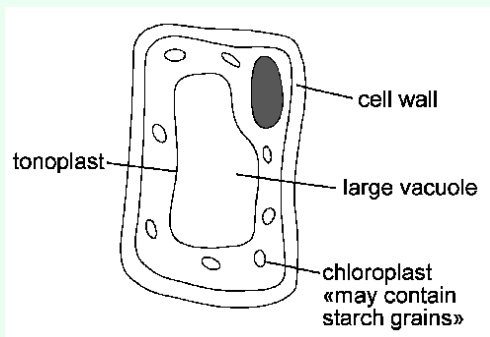
Labelled either inside or on the membrane

c. chloroplast/plastid

d. starch grain

e. tonoplast

*Allow **[2 max]** if any features common to both plant cells and animal cells are labelled*



[Max 3 Marks]

26b. Explain the process of photosynthesis.

[8 marks]

Markscheme

- a. autotrophs perform photosynthesis
- b. carbon dioxide and water are the reactants/raw materials required for «photosynthesis»
- c. light splits water molecules/causes photolysis
- d. «photolysis» releases oxygen as a «waste» product
- e. light energy is converted into chemical energy
- f. «photosynthesis» produces organic compounds/glucose/carbohydrates
- g. photosynthesis occurs in chloroplasts
- h. chlorophyll «photosynthetic pigment» absorbs light
- i. different pigments absorb different wavelengths «of light»
- j. chlorophyll absorbs red and blue light/ends of the spectrum
- k. carbon dioxide concentration/temperature/light intensity are limiting factors

*Award only **[1]** for correct display of equation unless further annotated or explained*

*Allow up to **[2]** for correct use of understandings specified as AHL topic 8*
[Max 8 Marks]

26c. Describe the process of peat formation.

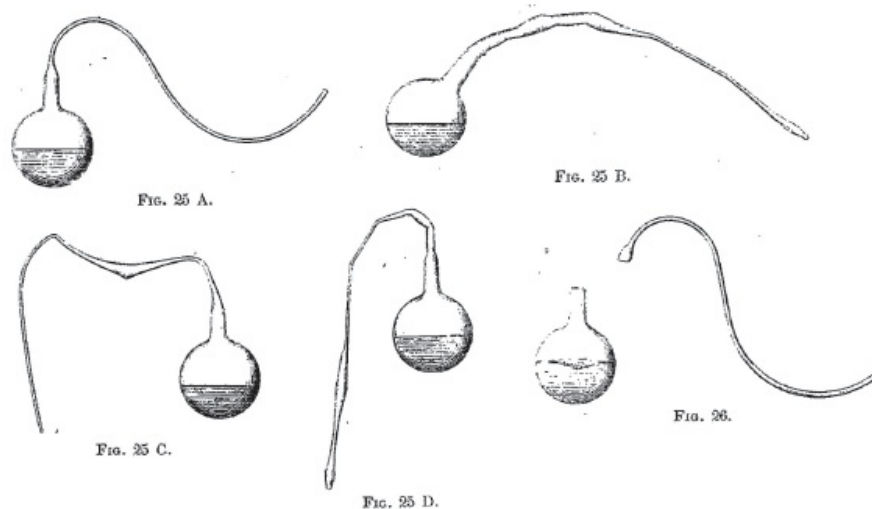
[4 marks]

Markscheme

- a. formed from dead plant material/leaves/mosses/Sphagnum
 - b. formed in waterlogged sites/bogs/mires/swamps
 - c. where bacteria/fungi/saprotrophs are not active/are inhibited
 - d. organic matter not fully decomposed
 - e. «occurs» in acidic conditions
 - f. «occurs» in anaerobic conditions
- Reject anaerobic respiration*
- g. «very» slow process/takes a long time

[Max 4 Marks]

27a. Pictured below are Louis Pasteur's original drawings of swan-necked flasks. [3 marks]



[Source: L Pasteur and L Pasteur Vallery-Radot, (1922), *Œuvres de Pasteur*, Vol II Fermentations et générations dites spontanées, pages 260–261]

Describe how Pasteur's experiments provided convincing evidence to falsify the concept of spontaneous generation.

Markscheme

- a. spontaneous generation is life appearing from nothing / from non-living / cells only come from pre-existing cells/life
- b. broth/culture medium (for bacteria) (used/placed) in flasks
- c. broth boiled/sterilized «in some flasks» to kill microbes
- d. no clouding/signs of bacterial growth/reproduction / microbes did not appear «in flasks of boiled broth»

Allow bacteria or organisms instead of microbes.

- e. after necks of flasks were snapped boiled broth became cloudy/growth of microbes
- f. because microbes from the air contaminated the «boiled» broth
- g. curved necks allowed indirect exposure to air but prevented entry of microbes

27b. State the function of life in *Paramecium* that is carried out by: [1 mark]
cilia.

Markscheme

movement/locomotion

OR

feeding/nutrition

27c. State the function of life in *Paramecium* that is carried out by:
the contractile vacuole.

[1 mark]

Markscheme

homeostasis

OR

maintain osmotic balance / expels «excess» water / maintains «cell» water content

27d. Discuss the advantages and disadvantages of the use of adult stem cells.

[3 marks]

Markscheme

Advantages:

- a. «adult stem cells» can divide «endlessly» / can differentiate
- b. «adult stem cells» can be used to repair/regenerate «tissues»
- c. fewer ethical objections «than with embryonic stem cells»
- d. adults can give «informed» consent for use of their stem cells
- e. adult source is not killed / «source» would not have grown into new human / no death of embryos used to provide stem cells
- f. no rejection problems / patient's own cells used
- g. less chance of cancer/«malignant» tumor development «than from embryonic stem cells»
- h. most tissues in adults contain some stem cells

Disadvantages:

- i. difficult to obtain/collect/find in adult body/very few available
- j. some «adult» tissues contain few/no stem cells
- k. «adult stem cells» differentiate into fewer cell types «than embryonic cells» /OWTTE

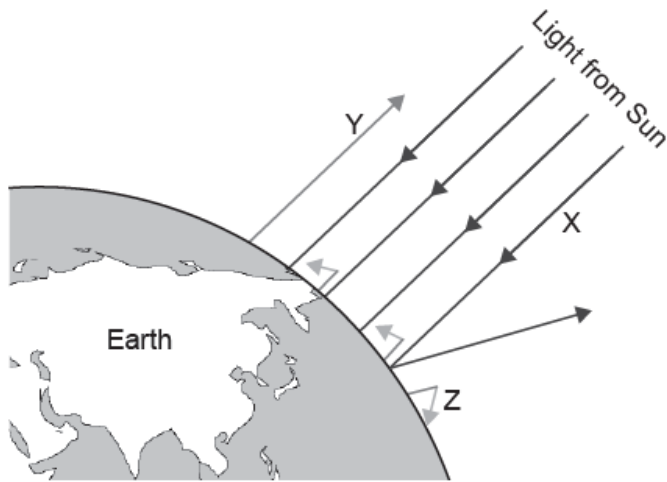
27e. Explain the role of decomposers in an ecosystem.

[2 marks]

Markscheme

- a. saprotrophs/decomposers feed on/break down dead «organic» matter
 - b. saprotrophs/decomposers release energy «heat» accelerating decomposition/warming soil
 - c. saprotrophs/decomposers recycle nutrients / make nutrients available (to producers)
- OR**
- improves soil fertility / returns nutrients (minerals/nitrates/phosphates/carbon) to soil/water/environment
- d. saprotrophs/decomposers detoxify waste

The diagram shows the greenhouse effect.



[Source: © International Baccalaureate Organization 2017]

28a. State the type of wavelength of the radiation labelled X and Y.

[2 marks]

X:

Y:

Markscheme

X: short-/ultraviolet/UV/visible/EMR/electromagnetic radiation

Y: long-/infrared/IR

28b. Outline reasons for the change occurring at Z.

[2 marks]

Markscheme

a. greenhouse gases present (at Z)

b. greenhouse gases «CO₂, methane, nitrous oxide, water vapour» absorb long-wavelengths/infrared

OR

long wavelengths/infrared waves blocked from leaving the atmosphere

c. (long-wavelengths/infrared absorbed and) reradiated/re-emitted (heat Earth)

28c. The short-tailed albatross (*Phoebastria albatrus*) nests and breeds on remote low-lying coral islands in the Pacific Ocean. Predict how global warming may threaten the survival of such an ocean bird.

[1 mark]

Markscheme

a. rising ocean levels/more extreme weather «due to global warming» may destroy breeding/nesting sites

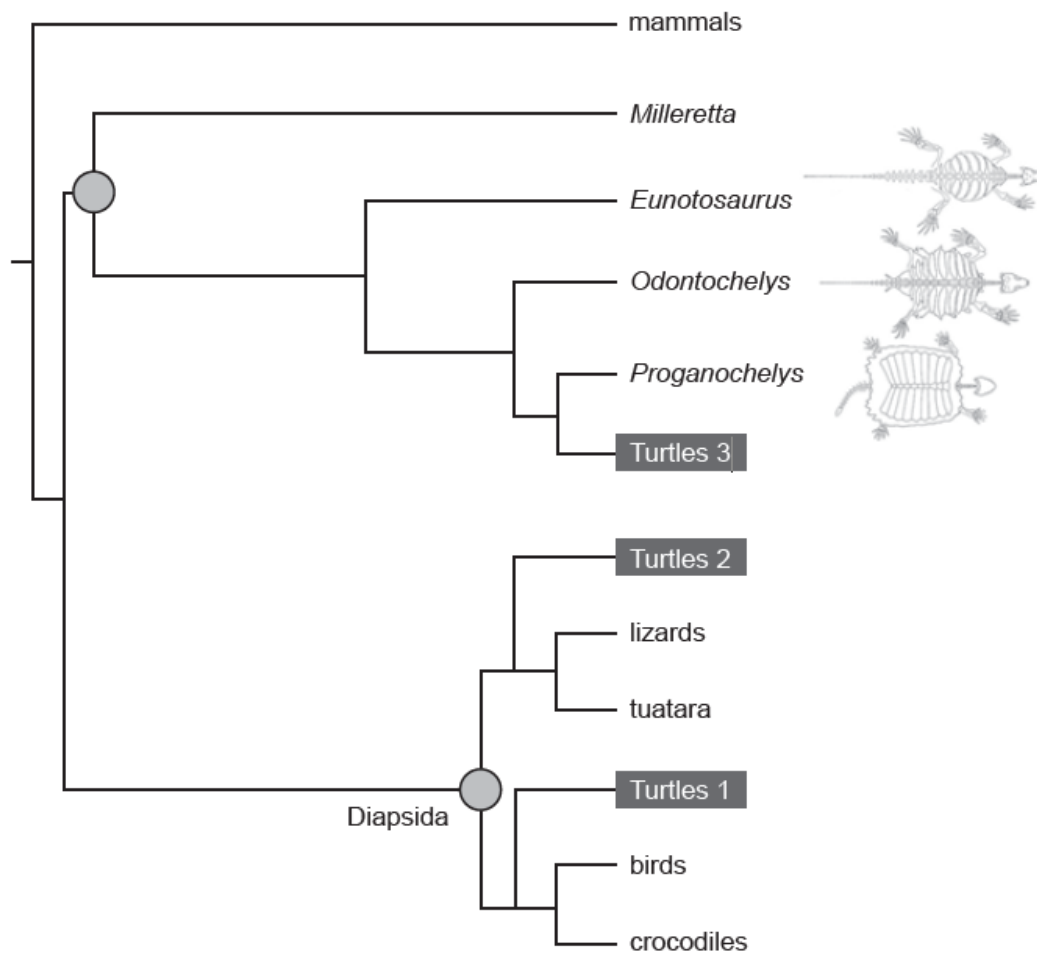
OR

rising sea level may put island underwater causing young birds/chicks to drown

b. populations may not find/adapt to new colony sites

c. warming seas may affect the food supply

The following cladogram shows three possible evolutionary routes for the turtle (Turtles 1, Turtles 2 and Turtles 3). The taxa in italics are extinct.



[Source: Tyler R. *et al.*, Transitional fossils and the origin of turtles, *Biology Letters* 6, Dec 23, 2010, pages 830–833, by permission of the Royal Society.]

29a. State the organism most closely related to the lizards.

[1 mark]

Markscheme

Tuatara

- 29b. Based on the taxa shown, deduce a difficulty in gathering data to study turtle ancestry. [1 mark]

Markscheme

some «taxa» are extinct

OR

convergence «of body form» could have occurred (confusing interpretation of the data)

- 29c. Molecular evidence is often used to construct a cladogram. Describe **one** type of molecular-based evidence to identify members of a clade. [2 marks]

Markscheme

a. base sequences of a gene/DNA/mtDNA

OR

amino acid sequences of a protein

b. species with the most similarities «in base sequence/amino acid sequence/genomes» have recently diverged/a common ancestor/are closely related

OR

members of a clade accumulate the fewest mutations on same base sequences/ *vice versa* / OWTTE

- 29d. Suggest **one** type of additional evidence that could provide strong support for Turtles 3 as the evolutionary route for turtles rather than Turtles 1 or Turtles 2. [1 mark]

Markscheme

fossils / comparative anatomy / homologous structures / vestigial structures

29e. Taxonomists aim to place species into genera, families and higher taxa [2 marks] according to their evolutionary origins. This is known as natural classification.

Explain the usefulness of natural classification in biodiversity research.

Markscheme

- a. «because» it allows easier identification of a species
- b. «because» it can help identify common ancestors/evolutionary paths/close relationships (showing degree of biodiversity) / OWTTE
- c. «because» it is universal/cross-cultural language that avoids problems of local names of organisms
OR
«because» it promotes international collaboration
OR
«because» it facilitates access to the history/background of the species /indexing for retrieval of relevant «taxonomic» information / OWTTE
- d. «because» it allows «biodiversity» research of larger taxa «/e examination of a family of large cats rather than one species»