

# Exam Prep extended response *[120 marks]*

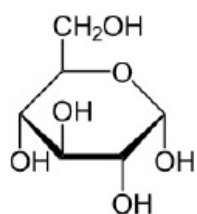
Life is based on carbon compounds.

1a. Draw a molecular diagram of alpha-D-glucose.

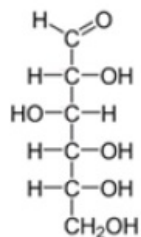
*[3 marks]*

## Markscheme

- a. hexagonal ring structure with O at one point (between C1 and C5);
  - b. correct orientation of OH groups (on carbons 1 to 4); *Hydrogens not required*
  - c. CH<sub>2</sub>OH group shown on fifth carbon with correct orientation;
  - OR**
  - d. 6 carbon chain with oxygen on first C;
  - e. H and OH groups correctly orientated;
- Carbons do not need to be numbered.*  
*Allow boat or chair diagrams.*



**OR**



*Allow **[2 max]** if linear structure drawn.*

1b. Outline how carbon compounds are produced in cells using light energy. *[5 marks]*

# Markscheme

- a. occurs by the process of photosynthesis;
- b. occurs in chloroplasts of plant cells/using chlorophyll;
- c. chlorophyll absorbs red/blue light **AND** reflects green light; *Both needed for marking point.*
- d. raw materials/starting products are carbon dioxide and water/shown in an equation;
- e. water is split by photolysis;
- f. oxygen is produced as waste/by-product/lost;
- g. glucose formed/shown in an equation;
- h. glucose molecules combine to form starch for storage;
- i. light energy transformed to chemical;

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1c. Explain the transformations of carbon compounds in the carbon cycle. [7 marks]

# Markscheme

- a. autotrophs/producers convert carbon dioxide into carbohydrates/carbon compounds in photosynthesis;
- b. carbon dioxide diffuses/moves from the atmosphere /water into autotrophs/plants;
- c. carbon compounds are transferred through food chains/*OWTTE*;
- d. carbon dioxide produced by respiration diffuses out of organisms into water/atmosphere;
- e. decomposers release carbon dioxide during decay/putrefaction;
- f. methane is produced from organic matter in anaerobic conditions (by methanogens);
- g. some methane diffuses into the atmosphere/accumulates in the ground;
- h. methane is oxidized to carbon dioxide (and water) in the atmosphere;
- i. peat forms when organic matter is not fully decomposed because of acidic/anaerobic conditions in waterlogged soils;
- j. partially decomposed organic matter from past geological eras/fossils was converted into coal/oil/gas that accumulated in rocks;
- k. carbon dioxide is produced by the combustion of biomass/fossilized organic matter/fuels;
- l. hard parts of some animals/corals/molluscs are composed of calcium carbonate
- m. can become fossilized in limestone;

*As this is an “explain” question, simply drawing a labelled diagram is not enough for [7]. Diagram would need sufficient annotations to meet the command term.*

*If carbon compounds are referred to instead of carbon dioxide, penalise once then ecf.*

According to the cell theory, living organisms are composed of cells.

- 2a. Draw the ultrastructure of a prokaryotic cell based on electron micrographs.

[3 marks]

# Markscheme

- a. cell wall;
  - b. plasma membrane; *Clearly shown as a separate line under the cell wall or the inner line*
  - c. cytoplasm **AND** 70S ribosomes; *Do not allow (small) circles*
  - d. nucleoid/naked DNA;
  - e. plasmid
- OR**
- pili
- OR**
- flagella/flagellum;
- Structures correctly drawn and labelled.*
- Award [2 max] if any exclusively eukaryotic structures are shown.*
- Do not allow cilia as they are not found in prokaryotes.*

2b. Outline what occurs in cells in the first division of meiosis.

[5 marks]

# Markscheme

- a. halves the chromosome number/produces haploid cells;
  - b. at start of meiosis each chromosome consists of two sister chromatids attached by a centromere;
  - c. prophase (I): pairing of homologous chromosomes;
  - d. crossing over occurs;
  - e. chromosomes condense by supercoiling;
  - f. metaphase (I): pairs of homologous chromosomes/bivalents move to equator of spindle
- OR**
- metaphase (I): orientation of pairs of homologous chromosomes (prior to separation) is random;
- g. anaphase (I): centromeres do not divide
- OR**
- anaphase (I): spindle fibre pulls chromosome/whole centromere with two sister chromatids to opposite poles;
- h. telophase (I): arrival of centromere with sister chromatids at opposite poles;
- Some of these can be awarded for correctly annotated diagrams.*
- No credit for events in meiosis II.*

2c. Explain the role of cells in the defence against infectious disease.

[7 marks]

## Markscheme

a. cells of skin provide a physical barrier/produce fatty acids/lactic acid/lysozyme which stops entry of microbes

**OR**

mucous membranes produce mucus to trap pathogens

**OR**

stomach cells produce hydrochloric acid which kills microbes;

b. platelets start the clotting process preventing access of pathogens;

c. (two types of) white blood cells fight infections in the body;

d. phagocytes ingest pathogens (by endocytosis/phagocytosis);

e. gives non-specific immunity to diseases / ingest any type of pathogen;

f. production of antibodies by lymphocytes/B cells;

g. in response to particular pathogens/antigens;

h. gives specific immunity;

i. lymphocyte/B cell makes only one type of antibody;

j. plasma cells produce large quantity of (one type of) antibody;

k. some lymphocytes act/remain as memory cells;

l. can quickly reproduce to form a clone of plasma cells if a pathogen carrying a specific antigen is re-encountered;

m. results in faster defence against second exposure to specific antigen/pathogen/disease;

3a. Draw a section of the Singer-Nicolson model of an animal cell membrane.

[4 marks]

## Markscheme

a. bilayer of phospholipids with both "tails" towards the inside «of the bilayer»  
✓ *This can be taken unlabeled from diagram.*

b. hydrophilic/polar **and** hydrophobic/non-polar annotation ✓

c. cholesterol between phospholipid tails ✓

d. glycoprotein ✓

e. integral proteins/channel proteins ✓

f. peripheral proteins ✓ *Allow this if it does not extend across the membrane*  
*Elements should be clearly drawn, correctly positioned and annotated.*

3b. Outline the principles used by scientists to classify organisms.

[4 marks]

## Markscheme

- a. use of the binomial system ✓
- b. agreed/developed by scientists / *OWTTE* ✓
- c. hierarchy of taxa used ✓ *Names of the seven taxa not required.*
- d. three domains used/three domain names ✓ *OWTTE*
- e. genome/DNA sequence similarities  
**OR**  
amino acid sequence of specific proteins ✓
- f. species from a common ancestor are grouped together  
**OR**  
included in the same clade/branch in cladogram ✓
- g. use evidence of evolutionary origin ✓ Allow example *e.g.* fossil record comparison
- h. shared characteristics within a group  
**OR**  
similar embryonic development ✓

3c. Explain the movement of energy and inorganic nutrients in an ecosystem.

[7 marks]

# Markscheme

- a. autotrophs/producers/plants obtain inorganic nutrients from the «abiotic» environment ✓
- b. energy provided «mainly» by sunlight ✓
- c. light energy converted «to chemical energy» through photosynthesis ✓
- d. photosynthesis/producers/autotrophs convert inorganic carbon/carbon dioxide and water into carbon/organic compounds ✓
- e. «these» carbon compounds/foods contain/are a source of «useable» energy «for life» ✓
- f. carbon compounds/energy are transferred along food chains when eaten by consumers/heterotrophs ✓ *Allow OWTTE for mpf for passed up trophic levels.*
- g. respiration returns carbon «dioxide» to the environment ✓
- h. respiration releases stored/chemical energy as ATP/heat ✓
- i. energy/ATP is used to carry out life functions/synthesis/growth/movement ✓
- j. energy is lost/not recycled ✓
- k. nutrients are recycled / example of recycled nutrient *e.g.* carbon ✓
- l. decomposers recycle minerals/inorganic nutrients ✓

4a. Outline how cuts in the skin are sealed to prevent blood loss.

[4 marks]

# Markscheme

- a. platelets respond to/detect skin/blood vessel damage ✓
- b. platelets release clotting factors ✓
- c. clotting factors trigger a chain/cascade of reactions ✓
- d. «leading to» formation of thrombin ✓
- e. thrombin causes fibrinogen conversion into fibrin ✓
- f. blood clot seals the wound due to fibrin network of fibres ✓

*Accept answers presented as a flow chart.*

4b. Outline how two parents could have a child with any of the four ABO blood groups.

[4 marks]

# Markscheme

- a. «first set of» gametes/parental genotype  $I^A, i$  ✓
- b. «other set of» gametes/parental genotype  $I^B, i$  ✓
- c. «genotypes of offspring are respectively»  $I^A I^B, I^B i, I^A i, ii$  ✓ *All four correct required.*
- d. «phenotypes of offspring are respectively» AB, B, A, O ✓ *All four correct required linked to genotypes*

*Award marks only for the first grid if more than one drawn;  
e.g. of Punnett grid*

gametes	$I^A$	$i$
$I^B$	$I^A I^B$	$I^B i$
$i$	$I^A i$	$ii$

*Answers can be given in a Punnett grid or in prose.*

*Accept the four possible blood groups of the offspring anywhere in the answer.*

- 4c. Explain how ventilation and lung structure contribute to passive gas exchange. [7 marks]



# Markscheme

- a. air carried through trachea **AND** bronchi/bronchioles **AND** alveoli ✓ *All three required in correct order.*
  - b. alveoli increase the surface area/thin walled for gas exchange ✓
  - c. gas exchange carried out through type I pneumocytes ✓
  - d. type II pneumocytes secrete surfactant to reduce surface tension ✓
  - e. moist surface/surfactant allows gases to diffuse in solution ✓
  - f. ventilation/moving blood maintains concentration gradients of oxygen and carbon dioxide ✓
  - g. between air in alveoli and blood in «adjacent» capillaries
- OR**
- oxygen diffuses from alveoli to capillaries and carbon dioxide from capillaries to alveoli ✓ *OWTTE*
- h. external intercostal muscles/diaphragm contract during inspiration ✓
  - i. lowering air pressure «in lungs»/increasing thorax volume ✓
  - j. relaxation of external intercostal muscles/diaphragm enable «passive» expiration ✓
  - k. internal intercostal «and abdominal muscles» contract «to force» expiration ✓
  - l. expiration due to increasing air pressure «in lungs»/decreasing thorax volume ✓
- Accept correctly annotated diagram.*

5a. Outline the stages in the production of mRNA by transcription.

[4 marks]

# Markscheme

- a. DNA is unwound/strands are separated «by RNA polymerase» ✓
  - b. new nucleotides attached to template strand «by RNA polymerase» ✓
  - c. complementary base pairing/base pairing with an example
- OR**
- adenine with thymine/uracil with adenine/cytosine with guanine/guanine with cytosine ✓
- d. mRNA detaches from template ✓
  - e. DNA rewinds ✓

5b. Describe the functions of proteins in cell membranes.

[4 marks]

# Markscheme

- a. facilitated diffusion by channel proteins ✓
- b. active transport by protein pumps  
**OR**  
protein pumps *eg* sodium-potassium ✓
- c. cell recognition by glycoproteins/protein receptors ✓
- d. communication/receptors for hormones/signal molecules ✓
- e. cell adhesion ✓
- f. allow up to one additional mark for AHL material ✓

5c. Explain how natural selection can lead to speciation.

[7 marks]

# Markscheme

a. natural selection is caused by selection pressures in the environment

**OR**

example of a selection pressure ✓

b. natural selection requires that variation exists within a species ✓

c. variation arises randomly due to mutation

**OR**

variation is enhanced by meiosis/sexual reproduction ✓

d. over-production of offspring promotes selection

**OR**

natural selection occurs when there is  
competition/overpopulation/predators/environmental changes/changes in  
selection pressures ✓

e. well adapted individuals/individuals with best variations survive to  
reproduce/survival of fittest ✓

f. «frequency of» genes/alleles conferring an advantage are selected for

**OR**

genes/alleles conferring a disadvantage are selected against ✓

g. genetic divergence/difference increases

**OR**

natural selection «genetically» isolates members of a species so eventually  
they can no longer produce fertile offspring ✓

h. genetic divergence» leads to reproductive isolation ✓

i. geographical/behavioural/ecological factors may lead to «reproductive»  
isolation ✓

j. prolonged «reproductive» isolation leads to speciation ✓

k. up to one additional mark for AHL information ✓

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6a. Describe how detritivores obtain nutrition and the effects they have in ecosystems. [4 marks]

## Markscheme

- a. «detritivores» obtain nutrition from detritus/waste/dead bodies ✓
- b. are heterotrophic ✓
- c. removes large waste/cleans up the ecosystem
- OR**
- helps control spread of disease ✓
- d. facilitates further decomposition ✓
- e. contribute to the supply of «inorganic» nutrients for autotrophs/nutrient cycling
- OR**
- improve soil conditions/aeration ✓

6b. Outline the role of amylase in digestion in humans.

[4 marks]

## Markscheme

- a. amylase is an enzyme ✓
- b. secreted by salivary glands/pancreas ✓
- c. active/released into the mouth/small intestine ✓
- d. acts on starch/polysaccharides ✓
- e. breaks «glycosidic» bond by hydrolysis/adding water ✓
- f. converts insoluble/large molecule to soluble/small molecules ✓
- g. product is maltose/disaccharide/sugar molecule ✓

6c. Explain how plants capture and use light in photosynthesis.

[7 marks]

# Markscheme

- a. plants convert light energy into chemical energy by photosynthesis ✓
- b. photosynthesis takes place in chloroplasts ✓
- c. chloroplasts «are organelles that» contain the pigment chlorophyll ✓
- d. chloroplasts/chlorophyll «in plants» absorb sunlight ✓
- e. «chlorophyll» absorbs red **AND** blue light most effectively ✓
- f. light causes photolysis/splits water molecule ✓
- g. carbon dioxide **AND** water are reactants «in photosynthesis» ✓
- h. glucose **AND** oxygen are products «of photosynthesis» ✓
- i. light intensity is a limiting factor for the rate of photosynthesis ✓
- j. organic/carbon compounds/glucose provide food/stored energy «for plant itself, animals, food chains» ✓
- k. up to one additional mark for an accurate detail from AHL ✓

7a. Outline **four** types of membrane transport, including their use of energy. *[4 marks]*

## Markscheme

- a. simple diffusion is passive movement of molecules/ions along a concentration gradient ✓
- b. facilitated diffusion is passive movement of molecules/ions along a concentration gradient through a protein channel «without use of energy» ✓
- c. osmosis is the passage of water through a membrane from lower solute concentration to higher ✓ *OWTTE*
- d. active transport is movement of molecules/ions against the concentration gradient «through membrane pumps» with the use of ATP/energy ✓ *Active transport requires mention of the use of energy.*
- e. endocytosis is the infolding of membrane/formation of vesicles to bring molecules into cell with use of energy  
**OR**  
exocytosis is the infolding of membrane/formation of vesicles to release molecules from cell with use of energy ✓
- f. chemiosmosis occurs when protons diffuse through ATP synthase «in membrane» to produce ATP ✓

*The description of each type of transport should include the name and brief description.*

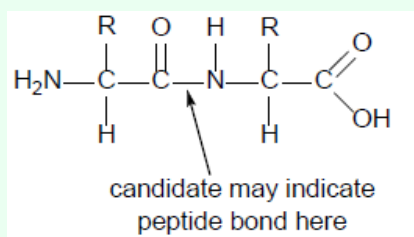
*mpa, mpb and mpc require reference to concentration.*

7b. Draw the structure of a dipeptide.

[3 marks]

## Markscheme

- a. two amino acids, one with  $\text{NH}_2/\text{NH}_3^+$  end and one with  $\text{COOH}/\text{COO}^-$  end ✓
- b. peptide bond between  $\text{C}=\text{O}$  and  $\text{N}-\text{H}$  correctly drawn ✓
- c. «chiral» C with H and R group on each amino acid ✓
- d. peptide bond labelled/clearly indicated between C terminal of one amino acid and N terminal of the second amino acid ✓



*Labels not required for amino group and carboxyl group.*

- 7c. Explain the action of enzymes in digestion and the different roles of at least **two named** enzymes that are produced in the pancreas. [8 marks]

## Markscheme

- a. enzymes catalyse/speed up chemical reactions/lower the energy needed ✓  
*OWTTE*
  - b. have specific active sites to which specific substrates bind ✓
  - c. enzyme catalysis involves molecular motion and the collision of substrates with the active site ✓ *OWTTE*
  - d. enzymes break macromolecules into monomers/smaller molecules indigestion ✓
  - e. smaller molecules/monomers more readily absorbed ✓
  - f. <<pancreas>> secretes enzymes into the «lumen of» small intestine ✓
  - g. the small intestine has an alkaline pH ✓
  - h. enzymes have maximum action at specific pHs
- OR**
- enzymes can be denatured at other pHs ✓
  - i. amylase breaks down starch into sugars/disaccharides ✓
  - j. lipase breaks lipids/triglycerides into monoglycerides/fatty acids and glycerol ✓
  - k. endopeptidase/protease breaks «peptide» bonds in proteins/polypeptides ✓
  - l. accept any other valid pancreatic enzyme, substrate and product ✓

*Award [6 max] if there is no mention of two specific groups of enzymes.*

- 8a. Describe briefly the endosymbiotic theory.

[3 marks]

## Markscheme

- a. eukaryotes evolved from prokaryotes ✓
- b. prokaryotes engulfed other prokaryotes without digesting them ✓
- c. engulfed aerobic cell/prokaryote became mitochondria ✓
- d. engulfed photosynthetic cell/ prokaryotes became chloroplasts ✓
- e. these organelles have a double membrane «due to the engulfing process» ✓
- f. mitochondria/chloroplasts contain DNA/small ribosomes/70S ribosomes ✓

8b. Outline how photosynthesis produces glucose.

[4 marks]

## Markscheme

a. solar/light energy is converted to chemical energy ✓

b. energy needed to produce glucose ✓

c. only specific wavelengths are absorbed by chlorophyll

**OR**

red and blue absorbed most strongly.

**OR**

chlorophyll is the pigment that absorbs light energy ✓

d.  $H^{(+)}$ /electrons from water are used to reduce compounds ✓

e.  $CO_2$  is absorbed/used/reduced to produce carbohydrates ✓

f. correct word/balanced symbol equation of photosynthesis ✓

*Accept correct reference to NADPH/ATP from AHL.*

8c. Discuss the control of blood glucose levels and the consequences if they [8 marks]  
are not maintained.



# Markscheme

*control: [6 max]*

- a. homeostasis is the maintenance of a constant internal environment ✓
- b. the pancreas produces hormones that control the levels of glucose ✓
- c. if glucose levels in blood are high, beta-cells «of the pancreas» produce insulin ✓
- d. «insulin» causes the cells to take up /absorb glucose ✓
- e. liver stores excess glucose as glycogen ✓
- f. if glucose levels in blood are low, alpha-cells «of the pancreas» produce glucagon ✓
- g. «glucagon» causes the liver to break down glycogen into glucose ✓
- h. «glucagon» increase levels of glucose in the blood ✓
- i. negative feedback controls the glucose levels ✓ *OWTTE*

*consequences:*

- j. if the pancreas produces little/no insulin a person can develop type I diabetes ✓
- k. a person with type I diabetes «usually» needs/is dependent on injections of insulin ✓
- l. type II diabetes occurs when the body becomes resistant to insulin/cells do not respond to insulin ✓
- m. type II diabetes can «sometimes» be controlled by diet and exercise ✓
- n. named consequence of having diabetes «eg: eye damage» ✓

*Award [6 max] if no consequences are given.*