EXAM PAPERS PRACTICE

Helping you Achieve Highest Grades in IB

IB Biology SL

Mark Scheme

Fully in-lined with the First Teaching in 2023 & First Assessment Examinations in 2025 & Beyond

Paper: 2 (Data-based Questions Across All Themes)

- **Theme A: Unity & Diversity**
- **Theme B: Form & Function**
- **Theme C: Interaction & Interdependence**
- **Theme D: Continuity & Change**

Marks: 617

Total Marks: / 617

Suitable for Students sitting the 2026 exams onwards
However, students in HL might find it useful

Markschemes

19M.2.SL.TZ1.1

a.i.

Sierra Leone ✓

a.ii. Liberia ✓

b. country with biggest population/Mali has lowest number of deaths *OWTTE*
OR
country with smallest population/Liberia has biggest number of deaths ✓

c. greater density means more frequent contact with infected people/animals ✓

Need both greater density and frequency of contact

d. a. overall pattern similar in both/both show a rise and a fall in the infections ✓

b. both countries show an increase during 2014
OR
neither country shows an increase in 2015 ✓

c. both show a sudden drop at one point
OR
sudden drop earlier «Oct–Nov 14» in Liberia than in Guinea «Dec 14, Jan 15» ✓

d. Guinea fluctuates whereas Liberia rises to a peak and then decreases/no fluctuations ✓

e. epidemic starts earlier «in April 14» in Guinea than in Liberia «in June 14» ✓

f. epidemic peaks earlier «Sept 14» in Liberia than in Guinea «Dec 14» ✓

g. epidemic lasts longer in Guinea than it does in Liberia
OR
last case recorded in Liberia Feb 15 while cases continue «at least» until May 15 in Guinea ✓

h. numbers of cases in Guinea generally lower than in Liberia
OR
number of cases higher in Liberia than in Guinea ✓

e.

a. improved medical care/support/supplies/equipment/training of staff/hygiene/distribution of vaccine ✓

b. improved understanding of how to avoid infection «amongst public»/greater awareness in society/better education✓

c. rise in number of deaths means fewer infectious individuals ✓

d. impact of disease control measures/control policies/quarantine/isolation ✓

e. drop in the number of fruit bats ✓ f. maybe seasonal changes/weather changes ✓

g. people may have left the area ✓ h. international aid arrives ✓ *OWTTE*

f. a. cells not killed/few cells killed «even at high concentrations» ✓

b. «T-705» effective/viruses reduced/viruses killed at 100 μM

«T-705» very effective/viruses much reduced/nearly all viruses killed at 1000 μM ✓

c. virus concentration decreases as T-705 concentration increases ✓

d. drug has «high» potential for treatment «at high enough concentration» ✓

g.

raise awareness/provide information for local population/supply health workers/equipment/ train local staff/share expertise/provide financial support/provide vaccine/travel ban alert to affected country ✓

19M.2.SL.TZ1.11

C

(a)

6.5 m ✓ *Unit required*

(b)

a. a symbiotic/mutualistic relationship ✓

b. *Zooxanthellae* obtain shelter/habitat/exposure to light ✓

c. coral obtains energy/food through photosynthesis of the *Zooxanthellae* ✓

(c)

low light levels/lower temperatures cannot support growth/metabolism ✓

Requires the explanation for the mark

19M.2.SL.TZ1.16

(a.i)

predation was greater in those born in captivity ✓

(a.ii)

a. the marmots have experience with/recognize predators ✓

b. parents shield them from predators
OR
parents teach them about predators ✓

c. those born in the wild are favoured in natural selection ✓

19M.2.SL.TZ1.2

a.

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

Must state observation

b. 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 «7os» ribosomes ***AND*** can manufacture «their own» proteins ✓

e. have organelle«s» similar to free-living prokaryotes ✓

f. similar in size to free-living prokaryotes ✓

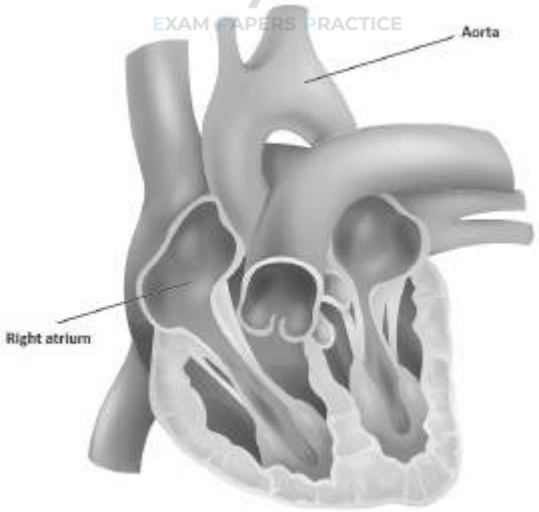
g. mitochondrial inner membranes manufacture ATP like bacterial membranes ✓

h. currently there is no free-living prokaryote like a mitochondrion ✓

19M.2.SL.TZ1.3

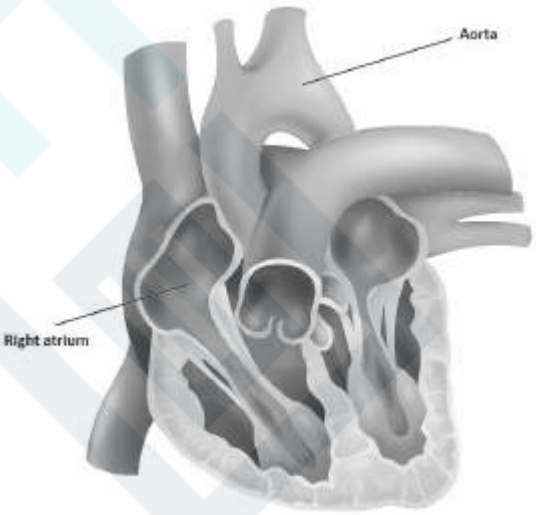
a.i.

both labelled clearly as in diagram ✓



[Source: BlueRingMedia/Shutterstock]

a.ii. both labelled clearly as in diagram ✓



[Source: BlueRingMedia/Shutterstock]

b.

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 ✓

c.

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

clots can cause heart attack/muscle death ✓

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

d. 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 ✓

19M.2.SL.TZ1.4

a.

type I:

a. carry out gas exchange
OR
diffusion of gases/CO_2/O_2 ✓

type II:

b. secrete fluid/surfactant ✓

b.

a. O_2 concentration in alveolar air greater than in capillary/blood «prior to gas exchange»
OR
hemoglobin in blood binds oxygen maintaining the concentration gradient ✓

b. O_2 gas dissolves in water lining the alveolus ✓

c. O_2 diffuses through wall of alveolus and capillary into blood ✓

d. CO_2 concentration in blood greater than in alveolar air «prior to gas exchange» ✓

e. CO_2 diffuses through wall of capillary and alveolus into alveolar airspace ✓

19M.2.SL.TZ1.5

a.

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

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

c.

Hapalemur aureus/Golden bamboo lemur *Canis aureus*/golden jackel/*Canis lupus*/grey wolf/*Vulpes vulpes*/red fox

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

19M.2.SL.TZ1.6

a.

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

b. 21 ***AND*** Down syndrome/trisomy 21 ✓ *Both needed*

19M.2.SL.TZ2.1

a.

10–25 «%» ✓

b.

G1 always respond more than 25% «except control», while G2 and G3 always respond 25% or less ✓

G1 always responds more than G2 and G3/all of the others ✓ *OWTTE*

c. oscilloscope ✓

d.

mouse chemicals cause action potentials «in all six neurons» while control ones cause none «remain in resting potential»/mouse chemicals cause greater responses ✓

OWTTE

e. a. both chemicals cause action potentials
OR
both chemicals respond in the majority of/five/most neurons ✓

b. stoat scent causes a higher action potential/longer/bigger response than mouse alarm compound «in each neuron»
OR
neuron 2 reacts strongly to the stoat scent but has a minimal/no response to the mouse alarm compound ✓

f.

a. there is a positive relationship/correlation between the size of neural traces and the percentage of responding G1 neurons *Accept vice versa*
OR
the chemicals that cause stronger/higher neural traces also cause the greatest percentage of responding G1 neurons ✓

b. fox and stoat scents have «approximately» the same/similar neural traces and the same percentage of responding neurons/>75 % ✓

c. mouse alarm compounds cause smaller neural traces and smaller percentage of responding neurons/25–75 % ✓

d. control chemicals have no response in both cases
OR
no percentage of «G1 neurons» response and no action potential «in neural traces» ✓

g.

the mice would have the same response to another mouse's danger signal as to the actual presence of the predator/fox
OR
adaptation to fool predator by producing a scent similar to predator's own scent
OR
allows a group response to a predator/fox/danger when just one mouse detects the danger ✓

Accept any other feasible answer.

h.

the aphids that were fed on wild-type thale cress/W as they had 80 % «or more» repelled each generation/ always had the higher % response
OR
the aphids that fed on wild-type thale cress plants/W of G3 as they had «about» 85 % repelled/had the higher % response ✓

Answer should refer to a percentage.

i. a. «over the generations» fewer are repelled by EBF ✓

b. «over the generations» more are attracted to EBF ✓

c. by G3 a «slight» increase in no choice ✓

d. aphids respond less to EBF/alarm compound if they feed on plants that produce it/exposed to it constantly ✓

e. mutant aphids with attraction to transgenic plants can arise from aphids with no attraction or repulsion to transgenic plants

aphids with no attraction or repulsion to transgenic plants may produce new type of aphids with attraction to transgenic plants ✓

j.

a. mutant aphids/varieties may be indifferent to/attracted to transgenic plants as these do not present a hazard «not favour» ✓

b. initially/for limited time the plants would thrive as the aphids would be «largely»repelled and thus not eat the plants «so natural selection would favour them» ✓

c. over time/in a few generations, the aphids population become more resistant/more attracted/less repelled to EBF and return to feed on the plants so long-term benefit very limited «so natural selection would not favour them» ✓

d. the aphids resistant to EBF would not respond to other aphid alarms and «likely»be more readily eaten by predators «so the long-term benefit to plants could be supported by natural selection» ✓

The answers must indicate whether natural selection would support or not for each statement.

19M.2.SL.TZ2.2

a.

telophase because the chromosomes/chromatids have reached the poles
OR
«late» anaphase as some chromosomes/chromatids are still moving/tails visible ✓

OWTTE

b.

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.*

19M.2.SL.TZ2.3

a.i.

a. «cell» respiration/loss of CO_2/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 CO_2»/loss of urea/feces/egesta ✓

d. material used/CO_2 released by saprotrophs ✓

e. undigested/uneaten material «teeth, bones, *etc*»/detritus buried/not consumed
OR
formation of peat/fossils/limestone ✓

a.ii.

a. increased CO_2 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 CO_2 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 CO_2 in the atmosphere
OR
increased diffusion/rate of dissolving of CO_2 into ocean from the atmosphere
OR
limestone/carbonate accumulation «more snails» ✓

b.

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

new species may appear «over time» ✓

Accept any valid example of an Arctic ocean organism.

19M.2.SL.TZ2.4

a.

X: Filicinophyta ✓

Y: Coniferophyta/Conifera/Gymnosperms ✓

b.

mpa	mpb
radiation/mutagenic chemicals ✓	can increase mutation rate/frequency of mutations ✓
OR	***OR***
radiation/mutagenic chemicals ✓	can affect nucleotides/bases in DNA ✓
OR	***OR***
errors in replicating DNA ✓	may cause changes in protein functions in some cells ✓

Not chromosomal.

c. a. a clade is a group of organisms that have evolved from a common ancestor ✓

b. identify the base sequences of a gene ✓

c. identify amino acid sequence of a protein ✓

d. comparing homologous structures ✓

e. the fewer the differences, the closer they diverged in time from a common ancestor ✓ *Accept vice versa.*

d. Vombatidae/wombats ✓

19M.2.SL.TZ2.5

a.

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.

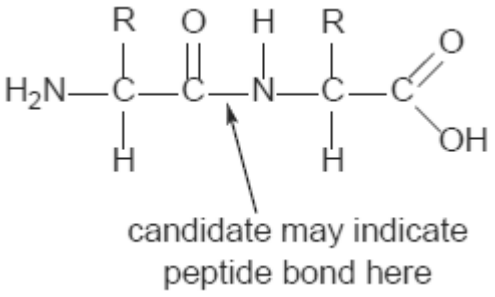
mpa, mpb and mpc require reference to concentration.

b. a. two amino acids, one with NH_2/NH_3+end and one with COOH/COO– end ✓

b. peptide bond between C=O and N—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.

c.

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

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 *if there is no mention of two specific groups of enzymes.*

19M.2.SL.TZ2.6

a.

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 ✓

b. 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/<u>balanced</u> symbol equation of photosynthesis ✓

Accept correct reference to NADPH/ATP from AHL.

c. *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 *if no consequences are given.*

19M.2.SL.TZ2.7

(a)

DNA	RNA
a. double stranded	single stranded ✓
b. deoxyribose	ribose ✓
c. adenine, guanine, thymine, cytosine ***OR*** thymine instead of uracil	adenine, guanine, cytosine, uracil ***OR*** uracil instead of thymine ✓
d. «all» helical	variety of forms ***OR*** mRNA, tRNA and rRNA ✓

A table format is not required but clear distinctions must be apparent.

The full names of the bases must be given.

(b)

a. some traits may involve many genes/be polygenic *eg* : height, skin colour «correct example required» ✓ *Accept any verifiable examples of these types of inheritance.*

b. linked genes/alleles of different genes on same chromosome ✓

c. «small numbers of» recombinant phenotypes due to crossing over «between linked genes» ✓

d. co-dominance of specific alleles/intermediate forms *eg* : pink flowers «from red and white ones»/blood groups «correct example required» ✓

e. sex-linked effects *eg* : colour blindness «correct example required» ✓

f. environmental influence on inheritance/epigenetics/methylation ✓

g. any other example of non-Mendelien inheritance with a specific example ✓

(c)

a. caused by a single nucleotide/base substitution mutation/GAG to GTG ✓

b. «mutation of» a gene of β-globin/a subunit of hemoglobin ✓

c. mRNA copies the mutation of DNA and substitutes an amino acid in hemoglobin «subunit» ✓

d. glutamic acid is substituted by valine ✓

e. sickle cell anemia involves distorted hemoglobin protein/HbS ✓

f. «distorted HbS causes» distortion/sickling/shape change of red blood cells ✓

g. «distorted/sickled red blood cells» block capillaries/blood flow ✓

h. HbS/sickled red blood cells cannot carry enough oxygen «for the body»/leads to fatigue ✓

i. low oxygen concentration seriously affects structure of HbS ✓

j. homozygous «HbS/HbS» state causes severe anemia/death at low oxygen concentrations ✓

k. heterozygous state has less anemia/minor effects/less effect of structure of hemoglobin

heterozygous state only affected at high altitude/extreme exercise/low levels of oxygen ✓

l. «heterozygous state» provides protection against malaria parasite/selective advantage in malaria areas ✓

OWTTE

19M.2.SL.TZ2.8

(a)

a. energy from the sun/light energy is converted to chemical energy by photosynthesis ✓

b. «chemical» energy flows through the food chains by feeding ✓

c. energy is released «from carbon compounds» by respiration
OR
energy from respiration is used by living organisms and converted to heat ✓

d. heat is not recyclable / heat is lost from food chains
OR
heat cannot be converted to other forms of energy ✓

e. energy is lost in excretion/uneaten material/egestion/feces ✓

f. energy losses between trophic levels limits the length of food chains
OR
energy transfer is only 10 % between trophic levels ✓

(b)

a. axes correctly labelled «wavelength and rate of photosynthesis» ✓ *Accept rate of oxygen production for rate of photosynthesis.*

b. 400 and 700 nm as limits ✓

c. correct shape of curve involving two peaks at the correct places, broader in the blue-violet range not starting at zero and a narrower peak in the orange-red range with the trough in the green range that does not reach zero ✓

d. peaks of activity at 430 nm ***AND*** at 660 nm ✓

e. peaks indicated as «violet» blue light AND peak indicated as «orange» red light ✓

19N.2.SL.TZ0.1

a.

cannot interbreed to produce fertile offspring ✓

Accept converse or a good explanation.

b. «*O. sativa*» *japonica* ✓

c.

Similarities
both show diversity
OR
similar pattern/peaks and troughs in the first part of the chromosome / up to «approximately» 1.5 megabases
OR

similar diversity between 2.4 to 2.7 mb
OR
both highest at 0.7 mb ✓

Differences
there are «two» major drops in diversity for *O. sativa indica* whereas none for *O. rufipogon*/much wider fluctuations in *O. s. indica*
OR
O.s. indica much lower at PROG1
OR
O.rufipogon does not drop < 2.5 whereas *O. s. indica* approaches 0
OR
O.rufipogon generally higher than *O. s. indica* after 1.41.5 ✓

One answer from mpa and one from mpb required for 2 [max].

Accept a statement of where the drops occur.

d. $\frac{3}{4}$ /0.75/75% ✓ *Do not accept 0.75% or 75 or ratios*

e.

a. *O.s. indica* has more of the ancestral allele «for all three genes» ✓ *Accept converse.*

b. lower/higher values for ancestral/derived are not for the same genes ✓ *Allow specific gene examples.*

c. for *O. s. indica* the highest proportion is for DPL2 ancestral, but for *O. s. japonica* is GS3 derived allele ✓ *Allow converse for smallest derived.*

f. any reference to comparison ✓

g.

a. large difference in diversity index between *O. s. indica* and *O. s. japonica* «suggests independent evolution» ✓

b. «some of the» peaks/troughs for *O. s. indica* and *O. s. japonica* in different positions «suggests independent evolution» ✓

c. *O.s. indica* has a similar diversity index to *O. rufipogon* «which suggests closer relationship/recent divergence» ✓
Allow converse for japonica

d. *O.s. japonica* has very different proportions of ancestral and derived alleles compared to *O. s. indica* ✓

e. *O.s. indica* has similar large number of ancestral alleles to *O. rufipogon I/II* ✓ *Allow converse for derived*

f. *O.s. japonica* has a large number of derived alleles similar to *O. rufipogon III*

«but» the number of derived alleles is greater in *O. s. japonica* than in *O.rufipogon III* ✓ *Allow converse for ancestral*

g. *O.s. indica* and *O. s. japonica* are in different clades ✓

O.s. indica and *O. rufipogon* I are in the same clade ✓

h. evidence from one chromosome/3 genes/2 studies is not sufficient to form a conclusion ✓

19N.2.SL.TZ0.13

(a)

a large effect on the ecosystem/community structure/environment«relative to abundance»
OR
influence the balance of other populations in the ecosystem
OR
other species in the habitat would also disappear
OR
many other species dependent on them for survival ✓

(b)

a. both describe the habitat/role/relationship occupied by a species ✓

b. the fundamental niche is the potential role of a species in its ecosystem and realized niche is the actual role
OR
the fundamental niche depends on the adaptations of a species whereas the realized niche is limited by competition/predation
OR
realized niche is ‹usually› smaller than fundamental niche ✓

19N.2.SL.TZ0.2

a.

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

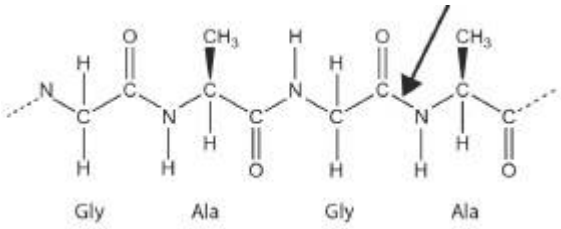
b.i. met-ser-arg-arg
OR
start-ser-arg-arg
OR
met-ser-arg-arg-stop
OR
start-ser-arg-arg-stop ✓

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

b.ii. TAC TCG GCT TCC ATC GAC ✓

c. they occurred after the common origin of life *OWTTE* *Look for alternatives.*
OR
the genetic code is not «in fact» universal ✓

d.i. any annotation between a C=O and the next NH ✓ *e.g.*



d.ii. condensation ✓ *Do not accept anabolism alone.*

e.

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

Award per correct row or correct column.

19N.2.SL.TZ0.3

a.

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 ✓

b. 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.

c. 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 ✓

occur in pairs ✓

e. have same size/length/banding patterns ✓

f. centromeres are in the same position ✓

d.

	Yeasts	Humans
Small yield of ATP	*yes*	*yes*
require oxygen	no	no ✓
produce ethanol and CO_2	yes	no ✓
produce lactate	no	yes ✓

Award per correct row.

19N.2.SL.TZ0.5

a.

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.

b. 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 ✓

c.

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 ✓

19N.2.SL.TZ0.6

a.

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.

b. 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^AI^B, I^Bi, I^Ai, 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^AI^B	I^Bi
i	I^Ai	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.

c.

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.

19N.2.SL.TZ0.7

(b)

a. I^A, i for one set of gametes/parental genotype ✓

b. I^B, i for the other set of gametes/parental genotype ✓

c. «genotypes of offspring are» $I^A I^B$, $I^A i$, $I^B i$, ii ✓

d. «phenotypes of offspring are» AB, A, B, O ✓

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

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

(c)

a. sinoatrial node/SAN is a specialized group of muscle cells
OR
sinoatrial node/SAN is located in the right atrium ✓

b. acts as a pacemaker/controls the heart rate
OR
initiates/generates the heart beat/starts the cardiac cycle ✓

c. sends out electrical signal/impulses/depolarisations ✓

d. electrical signal stimulates contraction «of heart muscle» ✓

e. signal passes through walls of atria/passes to AV node ✓

f. then through walls of the ventricles ✓

g. medulla «oblongata of brain» can change/increase/decrease the rate ✓

h. through nerves/named example of nerve/autonomic/sympathetic/ parasympathetic nervous system ✓ *In mph, only accept vagus nerve for slowing heart rate and sympathetic nerve for accelerating it .*

i. one nerve increases the rate and the other decreases it ✓

j. epinephrine/adrenaline increases heart rate/force of contraction ✓

k. epinephrine/adrenaline prepares the body for vigorous activity/is part of fight or flight response ✓

20N.2.SL.TZ0.1

a.

a. energy is not changed (between the two diets);

b. study diet slightly lower in energy than habitual diet (but means/SD overlap);

c. spread of values show more variation for habitual diet / higher SD in habitual;

b. a. they differ in percent of saturated and unsaturated fats (but not total fat);

b. percent of saturated fats is higher in study diet / lower in habitual diet;

c. (mono/poly) unsaturated fats decreased in study diet compared to habitual diet/more in habitual diet
OR
polyunsaturated fats in study diet only half of what they were in habitual diet;

d. (slightly) less carbohydrate in study;

Allow numerical points if they are a valid comparison using distinguishing terms.

c. ((165–150) ÷ 150) × 100; (=) 10 (%); *Allow up to 167 = 11.3 %*

1 mark for correct working if above 167.

d.i. a. both show same pattern of rise, level and then decrease / show same trend;

b. both show same/similar levels of insulin (at all times) due to overlapping error bars;

c. both rise for 30/45 minutes; *Do not give credit for contrasts.*

d.ii. β cells of pancreas/islets (of Langerhans);

d.iii. as blood glucose rises, insulin rises/increases to reduce the level/*OWTTE*;

Blood glucose must be mentioned as well as a rise in insulin.

e. *Hypothesis is partially supported*
a. Increased saturated fats in study diet resulted in increase in cholesterol levels;

b. cholesterol level is risk for blockage of coronary arteries;

Hypothesis is not supported
c. high insulin levels are sign of (Type II) diabetes;

d. insulin levels were the same in both diets so no increased risk;

e. study only 2 weeks long;

20N.2.SL.TZ0.14

(a.i)

A;

(a.ii)

B;

(b)

B is more diverse/biodiverse than A;

Accept vice-versa. Do not accept greater Simpson's reciprocal diversity index .

(c)

(the larger islands contain) more species as there are more habitats;

20N.2.SL.TZ0.2

a.i.

Paramecium

a.ii. eukaryotes

b.

heterotroph/consumer as it feeds on bacteria/algae/yeast/smaller single celled organisms
OR
heterotroph/consumer as it does not have chloroplasts

Heterotrophic must be qualified.

c. a. lives in fresh water so water enters cell (by osmosis);

b. contractile vacuoles collect and expel water;

c. homeostasis is keeping internal conditions within limit/constant / involves osmoregulation/regulating water content/potential;

d.

a. mitochondria/chloroplasts show features in common with prokaryotes/similar size;

b. multiply by binary fission/in same manner;

c. have naked loop of DNA/circular DNA/own DNA;

d. surrounded by a double membrane;

20N.2.SL.TZ0.3

a.

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.

b.i. synapse/synaptic

b.ii.

a. depolarization of pre-synaptic membrane / action potential/nerve impulse arrives;

b. uptake of calcium / calcium ions diffuse in / calcium channels open;

c. structures containing neurotransmitter/vesicles move to/fuse with membrane;

d. neurotransmitter/acetylcholine released by exocytosis into cleft/binds to postsynaptic membrane/receptors;

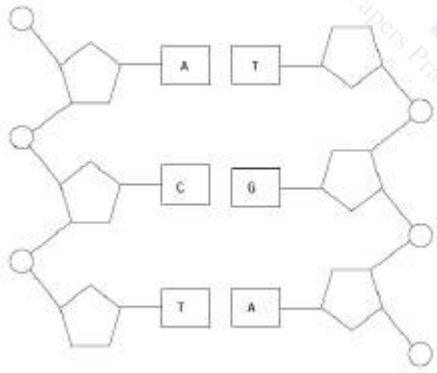
20N.2.SL.TZ0.4

a.

a. correct base sequence: T, G, A;

b. strand drawn anti-parallel;

c. correct shapes used;



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

b.i. change in genetic makeup/DNA/nucleotide/base sequence

b.ii. 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;

20N.2.SL.TZ0.5

a.

a. hexagonal ring structure with O at one point (between C1 and C5);

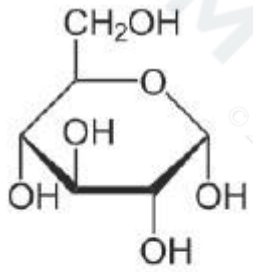
b. correct orientation of OH groups (on carbons 1 to 4); *Hydrogens not required*

c. CH_2OH group shown on fifth carbon with correct orientation;
OR
d. 6 carbon chain with oxygen on first C;

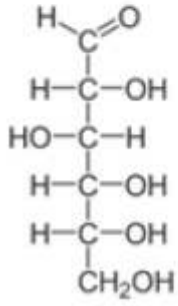
e. H and OH groups correctly orientated;

Carbons do not need to be numbered.

Allow boat or chair diagrams.



OR



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

b. 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;

c.

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 <u>in anaerobic conditions</u> (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;

i. 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 . Diagram would need sufficient annotations to meet the command term.

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

20N.2.SL.TZ0.7

(a)

a. water (molecules) are polar/dipolar/have partially positive and negative poles/have δ+ and δ-;

b. attraction/bonding between positive and negative (poles);

c. hydrogen bond formed between hydrogen and oxygen; *Reject if H and O in same molecule.*

d. bond/attraction between different water molecules/intermolecular;

Marks can be awarded in an annotated diagram.

Reject answers stating or implying that there are whole positive or negative charges for mpa .

(b)

a. water moved/transported in xylem vessels ;

b. transported under tension/suction/pulled up (in xylem vessels);

c. transpiration/loss of water (vapour) generates pulling forces/low pressure/tension;

d. tension/pull generated when water evaporates from cell walls (in mesophyll);

e. transpiration is loss of water vapour from leaf (surface)/stomata;

f. cohesivity / cohesion in water due to hydrogen bonding/attractions between water molecules;

g. cohesion/WTTE so chain/column of water (molecules) doesn't break/remains continuous;

h. transpiration stream is a column of/flow of water in xylem from roots to leaves;

Do not award marks for absorption of water by roots .

21M.2.SL.TZ1.2

a.i.

process Y: photosynthesis ✓

organelle: chloroplast ✓

Both needed.

a.ii. glycerol /glycerin ✓

b. condensation/dehydration/synthesis/anabolic/anabolism ✓

c. aerobic respiration ✓

d. a. used as an energy source ✓

b. supplies/releases energy for biochemical reactions ✓

c. photosynthesis/active transport/other verifiable example of reaction or process ✓

e. a. (letter X) breakdown of monosaccharides/respiration ✓

b. (letter Y) hydrolysis/photolysis in photosynthesis/oxidation of water ✓

Answer must come from the diagram.

21M.2.SL.TZ1.4

a.

−65 mV ✓

Unit required; minus sign required. Accept answers from −62mV to −65mV.

b.

a. sodium/potassium pump pumps sodium ions Na^+ out of axon and pumps potassium ions/K^+ in ✓

b. requires energy/ATP/against concentration gradients/active transport ✓

c. three sodium ions pumped out for every two potassium ions pumped in ✓

d. results in charge difference between inside and outside where outside is positive relative to inside ✓

21M.2.SL.TZ1.5

a.i.

a. analogous traits have a different evolutionary history/ancestry ✓

b. different structures are adaptations for flight ✓

c. selective pressure leads to a similar solution to the problem of flying ✓

a.ii. a. bird and bat share a more recent common ancestor (than the insect) ✓

b. bird and bat are more closely related than insect and bat / insect and bird ✓

c. bird and bat wings evolved from a common ancestor (by natural selection) ✓

b. a. (cladistics) shows evolutionary relationships through a common ancestor ✓

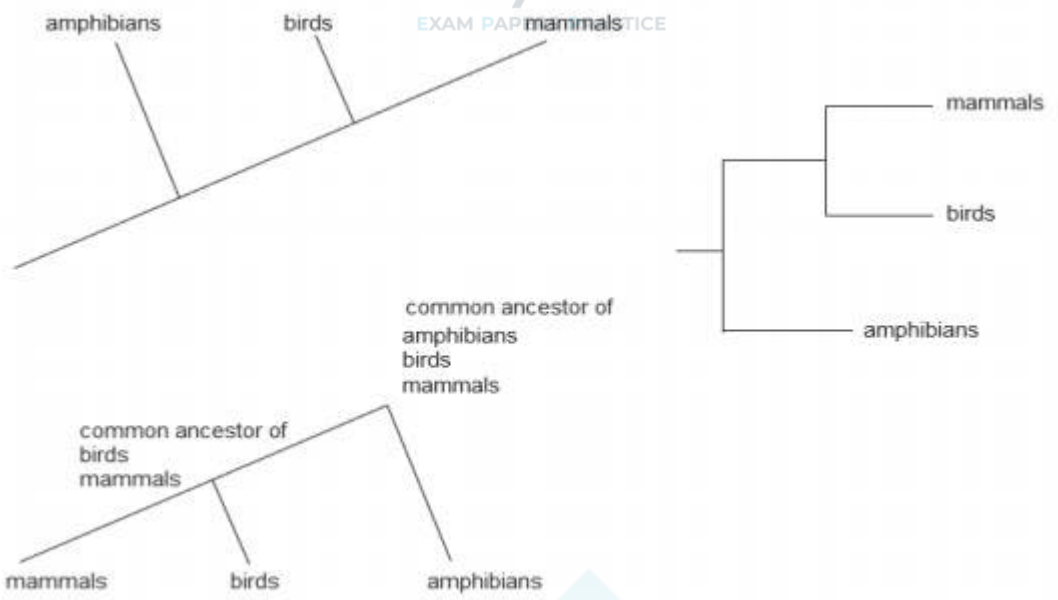
b. cladistics uses DNA/protein/derived/shared anatomical characteristics/traits ✓

c. time of divergence is related to the number of differences in DNA (base sequence) / protein (sequence of amino acids) ✓

d. homologous (versus analogous) traits are used to place an organism in a clade ✓

e. more shared characteristics mean a more recent common ancestor ✓

c.



What is important is that the proper relationships are shown not the style used.

21M.2.SL.TZ1.6

a.

a. protein formed from amino acids
OR
20 different amino acids ✓

b. linked together by peptide bonds ✓

c. may consist of one or more polypeptides linked together ✓

d. have a specific shape/conformation/folding ✓

e. shape determines function ✓

b. a. protein is produced when a gene is expressed / switched on ✓

b. genetic code/codons consists of three nucleotides/bases/base triplet ✓

c. genetic code in DNA is transcribed/transcription (to mRNA) ✓

d. mRNA exits the nucleus ✓

e. mRNA (code) is translated/translation into a polypeptide/protein ✓

f. amino acid sequence/polypeptide formation occurs at a ribosome ✓

g. one codon translates to one amino acid ✓

h. tRNA carries code for specific amino acids ✓

i. tRNA anticodon matches with specific codon in mRNA ✓

j. amino acids joined (by peptide bonds) to form polypeptide ✓

k. sequence of amino acids determined by order of bases/nucleotides/codons in DNA/mRNA ✓

l. proteins vary based on which amino acids are used and their order

protein variety increases by mutations to DNA ✓

c.

a. enzymes that catalyse/speed up/control (the rate and direction of) metabolic reactions ✓

b. proteins can be hormones which are chemical messengers to cells ✓

c. proteins that transport through the membrane such as channel/carrier/pumps / that regulate what enters/leaves the cell ✓

d. hemoglobin in red blood cells that transports/ binds oxygen ✓

e. membrane proteins for cell/tissue recognition/cell adhesion/communication ✓

f. structural elements of muscle fibre/actin/myosin for movement

spindle fibres move chromosomes ✓

g. histones condense DNA into chromosomes ✓

The question requires answer that the function is in cells.

21M.2.SL.TZ1.7

a.

a. diaphragm contracts / moves downwards/flattens ✓

b. external intercostal muscles contract ✓

c. (muscle contraction) moves the rib cage upwards and outwards ✓

d. increases volume of the thorax / lungs ✓

e. difference in pressure/decreasing pressure causes air to flow into lungs / lungs inflate ✓

b. a. O_2 diffuses into blood and CO_2 diffuses out from blood ✓

b. blood entering the alveoli is high in CO_2/low in O_2 ✓
OR
air in alveolus is high in O_2/low in CO_2 ✓

c. diffusion (in either direction) take place due to concentration gradients ✓

d. concentration gradients maintained by ventilation/blood flow ✓

e. large surface area created by many alveoli/spherical shape of alveoli for more efficient diffusion ✓

f. rich supply of capillaries (around alveoli) allows efficient exchange ✓

g. type I pneumocytes are thin to allow easy diffusion/short distances ✓

h. gases must dissolve in liquid lining of alveolus in order to be exchanged ✓

i. type II pneumocytes secrete surfactants to reduce surface tension/prevent lungs sticking together ✓

j. type II pneumocytes create moist conditions in alveoli ✓

c. a. greenhouse effect keeps Earth warm ✓

b. (over-time) earth's temperature has fluctuated naturally ✓

c. changes in human activities have led to increases in CO_2 concentration ✓

d. CO_2 absorbs infrared/long wave radiation / trapping heat ✓

e. increase in atmospheric CO_2 (concentration) correlates with/causes increased global average temperature ✓

f. use of fossil fuels increases atmospheric CO_2 ✓

g. deforestation removes a carbon sink / less CO_2 absorbed ✓

h. loss of polar ice causes less reflection of surface light/ more reradiation as heat contributing to (global) warming ✓

i. CO_2 is not the only greenhouse gas/ there are other greenhouse gases ✓

21M.2.SL.TZ2.2

a.

a. DNA replication ✓

b. cell growth ✓

c. duplication of organelles/mitochondria / production of microtubules/protein synthesis ✓

Accept first two answers only.

b.i. prophase ✓ *The stage should be clearly labelled.*

If more than one stage is shown the candidate does not receive a mark.

b.ii. anaphase ✓ *The stage should be clearly labelled.*

If more than one stage is shown the candidate does not receive a mark.

c. a. mitosis produces two daughter cells while meiosis four ✓

b. mitosis produces cells with same number of chromosomes (2n) while in meiosis they are halved (n) ✓

c. mitosis produces body cells but meiosis produces gametes

mitosis produces genetically identical cells but meiosis does not ✓

Allow answers in a table. Reference to both has to be present for the mark.

d.

number of cells (seen under the microscope) undergoing mitosis divided by the total number of cells (observed in sample area) ✓

Can be given as a %.

21M.2.SL.TZ2.3

a.

a. enzyme involved in photosynthesis/carbon fixation/Calvin cycle
OR
speeds up chemical reactions in photosynthesis ✓

b. carboxylation of RuBP ✓

c. production of carbohydrate in photosynthesis ✓

d. addition of carbon dioxide to form glucose (in Calvin cycle) ✓

Either photosynthesis or carbon fixation must be mentioned.

b. site to which substrate binds *Give credit for the lock and key analogy.*
OR
catalytic site ✓

c. *Pisum* ✓

d. a. name of factor ✓ b. how it affects rate of reaction ✓ *Example answer.*

temperature ✓

as the temperature increases the rate of reaction increases until it reaches a maximum and then decreases rapidly ✓

Accept answers in a graph.

21M.2.SL.TZ2.4

a.

a. (aerobic/cellular) respiration ✓

b. gas exchange / diffusion ✓

Do not accept photosynthesis.

Do not accept breathing

Organism is taken to be a living thing.

b. a. photosynthesis ✓

b. absorption of (dissolved) carbon dioxide / (hydrogen)carbonate directly from the oceans ✓

Accept reference to carbonate or hydrogencarbonate ions.

c.

a. light energy is converted to chemical energy (in carbon compounds/sugars) by photosynthesis ✓

b. (chemical) energy (in carbon compounds) flows by means of feeding/through food chains/webs ✓

c. only (approximately) 10 % of energy is passed to the next trophic level ✓

d. energy released as heat (by respiration) ✓ e. energy is not recycled ✓

f. after death, energy may remain trapped as undigested detritus/fossils/fossil fuels ✓

d.i. crustacean as they have more carbon per unit volume *OWTTE.*
OR
crustacean as jellyfish has little carbon per total body size ✓

The conclusion must be supported from the information given.

d.ii. a. advantage of large size is ability to eat /catch large prey ✓

b. (advantage as) lower rates of predation of large jellyfish ✓

c. (advantage as) can produce more reproductive cells ✓

d. (disadvantage as) can move slower to escape from predators/capture prey ✓

e. (disadvantage as) needs more energy/nutrients to maintain structure/move/grow ✓

f. (disadvantage as) low surface area to volume ratio and thus possibly difficulty with materials/gas/nutrient exchange ✓

g. (disadvantage as) more prone to mechanical damage during storms ✓

Accept other reasonable answer. Must say advantage or disadvantage.

21M.2.SL.TZ2.5

a.

a. starch is a carbohydrate ✓

b. starch is formed by carbon, hydrogen and oxygen ✓

c. it is a polymer/chain/polysaccharide ✓

d. formed from monosaccharides/simple sugars/glucose ✓

e. linked together by condensation/dehydration ✓

f. consists of amylose and amylopectin ✓

g. amylose is a long chain/unbranched ✓

h. amylopectin is branched ✓

b.

a. food is mechanically/physically digested in the mouth through mastication/chewing ✓

b. mixed with saliva (to form the bolus) in mouth ✓

c. moved through esophagus/peristalsis ✓

d. proteins digested in the stomach (pepsin) ✓

e. pancreas secretes enzymes into lumen of small intestine
OR
(endo)peptidases/trypsin) are secreted by pancreas ✓

f. enzymes digest macromolecules to monomers
OR
endopeptidases digest polypeptides to peptides/amino acids ✓

g. villi of small intestine absorb amino acids ✓ *Allow pepsin.*

h. amino acids carried to blood capillaries ✓

i. blood (capillaries) carry amino acids to (hepatic portal) vein/blood vessel going to liver ✓

j. amino acids absorbed by active transport/protein pumps in the villi ✓

c. a. gametes of both parents shown as a capital and small letter (e.g. L and l) ✓

b. possible F1 genotypes ✓

c. 25 % lactose intolerant, 50 % carriers, 25 % lactose tolerant
OR
75 % tolerant and 25 % intolerant
OR
child has 25 %/1:4/$\frac{1}{4}$ chances of inheritance of intolerance ✓

	L	l
L	LL	Ll
l	Ll	ll

a.

a. cell wall ✓

b. pili/flagella ✓

c. 70S ribosomes ✓

d. nucleoid / circular DNA
OR
naked DNA ✓

e. plasmids ✓

As candidates do not need to know the structure of Mycobacterium tuberculosis, all prokaryotic structures are accepted.

Ignore references to membrane bound organelles.

b. a. phagocytes/lymphocytes are white blood cells ✓

b. TB bacterium has a specific antigen ✓

c. this antigen is recognised by white blood cells ✓

d. a clone of lymphocytes/plasma cells/B cells are produced ✓

e. antibodies are produced by lymphocytes ✓

f. each lymphocyte produces just one type of antibody ✓

g. (this is) specific immunity ✓

h. (part of the) antibody/immunoglobulin binds to the antigen / specific antibody binds to the specific antigen ✓

i. antibodies are proteins/immunoglobulins ✓

j. (some) plasma cells become memory cells ✓ k. memory cells reproduce quickly ✓

l. memory cells prevent infection in the future ✓

Allow annotated diagrams to explain the process.

c. a. antibiotics block bacterial processes ✓

b. example of bacterial process ✓ e.g. *cell wall formation*

c. variations exist naturally in a population / some are naturally resistant to the antibiotic ✓

d. bacteria that are not resistant to this antibiotic will die / only resistant will survive (when antibiotic given) ✓

e. this characteristic could be passed to next generation ✓

f. (natural selection) leads to changes in the proportions/frequency in the population ✓

g. human population will be exposed to antibiotic resistant bacteria and will not have antibiotic to kill them ✓

h. (antibiotic resistant bacteria) may pass resistance to other bacteria species/types by means of plasmids (so other bacteria species turn resistant too) ✓

21N.2.SL.TZ0.1

a.i.

Capricorn and Bunkers group;

a.ii. there is no clear trend;

b.i. a. effects (generally) increase with temperature anomalies/WSSTA;
b. effects increase for all different coral covers
OR
in the 2549 cover there is an anomaly/is not an increasing trend;
c. harmful effect is higher in coral covers between1 50-75 % / vice versa;

b.ii. 50 % / 25 % / 49 %
OR
25–49 % (coral cover);

b.iii. a. the closer the corals are (to each other) the easier the transmission;
b. other organisms in the community may act as vectors/carriers / OWTTE;

c.i. ***Similarities***
a. similar range of cover in both periods
OR
weak correlation/no correlation in either;

Differences
b. higher WSSTA range/more WSSTA in 1998–1999 than 2002–2003
OR
positive (2002–2003) versus negative correlation (98–99)
OR
more coral reefs with very low % of coral cover (0–20 %) in 2002–2003;

Must respond with one similarity and one difference for full marks.

c.ii. coral cover lower on reefs with higher temperature;

d. a. corals would not be able to maintain their skeletons;
b. (if coral reefs are lost) habitat will be lost;
c. some organisms/coral can decline if the water becomes too acidified;
d. coral bleaching could occur/become worse
OR

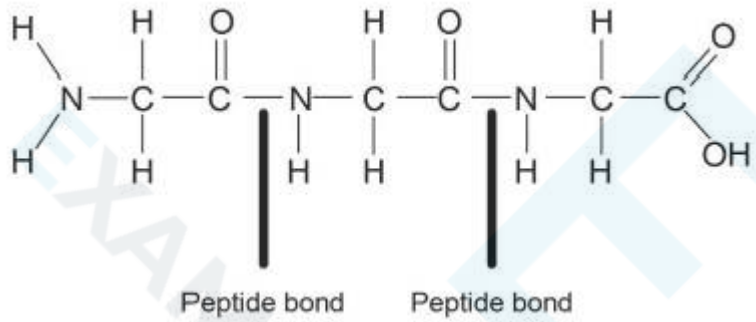
coral could expel their mutualistic alga/zooxanthellae;
e. enzymes could be denatured;

e. real environmental conditions / larger scale investigations / more variables studied;

21N.2.SL.TZ0.2

a.

circle/bracket around peptide bond / arrow pointing to peptide bond / peptide bond labelled;



Allow either peptide bond

Allow if adjacent C=O and NH groups are included in the circle/bracket, but do not allow if other parts of the molecule are included

b. a. Rubisco fixes CO_2 from atmosphere during photosynthesis;
b. insulin controls blood glucose levels;
c. collagen forms connective tissue/ligaments;
d. spider silk forms the spider web;
e. rhodopsin involved in photoreceptor;
f. immunoglobulins/antibodies attach to antigens/pathogens;
g. actin/myosin performs muscle contraction;
h. hemoglobin carries oxygen in red blood cells;

*Accept any other correct **three named** proteins*

If an enzyme is named, the correct substrate must be stated

c. contracts/flattens/becomes less domed/increases volume of thorax;

21N.2.SL.TZ0.3

a.

	Detritivores	Saprotrophs
Similarity	heterotrophic **OR** feed on/obtain nutrients from dead organic matter/dead organisms;	
Difference	internal digestion/digestion in gut **OR** enzymes secreted into gut **OR** food ingested before digestion	external digestion **OR** enzymes secreted into surroundings **OR** food digested before being absorbed;

Accept not autotrophic/not photosynthetic instead of heterotrophic.

Do not accept that both groups are decomposers or consumers for the similarity.

b.i. food chain of three or more organisms starting with plants;

b.ii.

a. energy is lost between the trophic levels;
b. transfer between levels is only usually 10% efficient
OR
energy transformations take place in living organisms / the process is never 100% efficient;
c. energy is lost by the organism/used in respiration / released as heat/movement;
d. energy is lost as waste/feces/urine/undigested food/uneaten parts;
e. as energy is lost between trophic levels and so (higher ones) have less biomass / less biomass available for next level;

c.

a. the rate of reaction will be limited by the limiting factor that is nearest to its minimum value;

temperature:
b. enzymes that control photosynthesis are influenced by temperature;
c. as temperature increases, reaction rate will increase;
d. above a certain temperature, the rate of photosynthesis will decrease;
e. (where temperature is limiting) essential enzymes begin to denature/not working to optimum;

light intensity:
f. light is source of energy / converted into chemical energy;
g. as light intensity increases reaction rate will increase;
h. at a certain light intensity, rate of photosynthesis will plateau;
i. another factor becomes limiting;

CO_2 concentration:
j. CO_2 is fixed to form organic molecules;
k. as CO_2 concentration increases, reaction rate will increase;
l. at a certain concentration of CO_2, rate of photosynthesis will plateau;
m. another factor becomes limiting;

Accept answers using an annotated graph to explain

Only accept the first factor described Do not accept pH as a limiting factor

d. a. mutations;
b. meiosis/crossing over/random assortment of homologous pairs;
c. sexual reproduction/recombination/random fertilisation;

21N.2.SL.TZ0.4

a.

a. arteries carry blood at high pressure;
b. rupture of arteries is prevented by thick muscular/elastic walls;
c. narrow lumen to maintain a high blood pressure;
d. elastic tissue allows artery to stretch and recoil (to even out pressures);
e. arteries have muscle layers which contract to increase/control the blood flow;
f. folding in the endothelium allows stretching
OR
smooth endothelium reduces friction;

b.i. (cell) respiration/photosynthesis;

b.ii.

source of energy (for use in the cell)
OR
example of use of ATP
OR
when ATP is converted to ADP + Pi (is hydrolyzed) the energy stored in the phosphate bond is released to be used by the cell;

c. increases heart rate
OR
prepares the body for action;

21N.2.SL.TZ0.5

a.

a. surface area of the cell affects the rate of material exchange;
b. when the cell increases in size, so does its chemical activity/metabolism;
c. (when the cell increases in size/grows) more substances need to be taken in / more waste products need to be excreted;
d. as the volume of the cell increases, so does the surface area, however not to the same extent
OR
when the cell gets bigger, its surface area to volume ratio gets smaller;
e. substances will not be able enter the cell fast enough/cell volume will not be supplied

OR
metabolic rate will exceed the rate of exchange
OR
when the surface area: volume ratio is higher, the diffusion rate increases;
f. some cells have adaptations to increase their surface area/flatten/microvilli/shape of red blood cells;
g. cells in growth areas tend to divide and remain small
OR
cells divide when maximum size is reached;

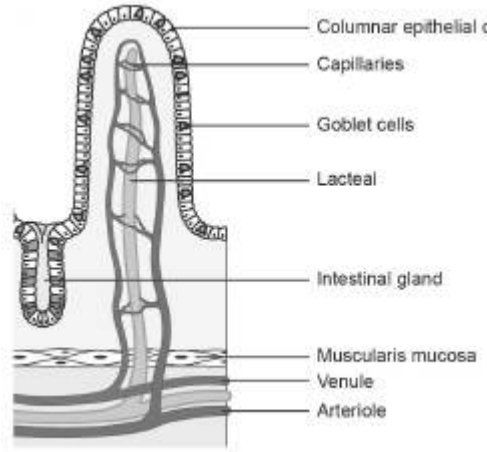
b.

a. form of diffusion;
b. osmosis is the movement of water molecules;
c. (movement) across a selectively/semi/partially permeable membrane/cell membrane;
d. from a region of low solute concentration to a region of high solute concentration (until equilibrium is reached)
OR
movement of water molecules from a high concentration of water to a low concentration of water molecules;
e. it is a passive transport mechanism/does not use ATP;
f. channel proteins/aquaporins are used;

c.

a. small intestine is where nutrients are absorbed into the bloodstream;
b. very long to maximize absorption;
c. (the small intestine) is lined with (smooth) muscle to allow for the mixing/ and moving of digested food;
d. muscles are circular and longitudinal;
e. that perform peristalsis;
f. the pancreas (and gall bladder) secretes substances into the small intestine to aid digestion;
g. contain villi, to increase surface area;
h. villi have microvilli to increase surface area even more;
i. villi absorb products of digestion/mineral ions/vitamins/glucose;
j. dense capillary network rapidly transports absorbed products;
k. lacteal absorbs lipids from the intestine (into the lymphatic system);
l. (most of the) chemical digestion (into monomers) occurs in small intestine/description of specific enzyme action;

Accept annotated diagrams as part of the explanation.



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21N.2.SL.TZ0.6

a.

a. theory that eukaryotic cells evolved from prokaryotes
OR
origin of eukaryotic organisms based on some organisms living inside/engulfed by other organisms
OR
prokaryotic cell engulfed another prokaryote including it in cytoplasm without digesting it;
b. mitochondria/chloroplasts have double membranes;
c. mitochondria/chloroplasts have their own DNA/loop of DNA/naked DNA;
d. mitochondria/chloroplasts have similar size to prokaryotes;
e. mitochondria/chloroplasts can reproduce by binary fission;
f. mitochondria/chloroplasts have 70S ribosomes (same as prokaryotes);

b.

a. chromosome number is halved so the zygote/offspring has same number as the parent / so that chromosome number is not doubled;
b. process is meiosis;
c. DNA/chromosomes replicate (so each chromosome consists of two chromatids);
d. homologous chromosomes pair in prophase I;
e. (these) separate in anaphase I into two cells;
f. (after meiosis I) cells are haploid;
g. in meiosis II chromatids are separated;
h. result is four haploid cells/gametes;
i. each gamete is genetically unique;

j. (uniqueness) is due to crossing over/independent assortment/random alignment of chromosomes;
k. fertilization results in the formation of a diploid zygote;
l. (fertilization) results in variation in a population

c.

a. the binomial system of names for species is universal among biologists
OR
named according to a globally recognized scheme;
b. allows to classify organisms into groups based on similar characteristics/common ancestry/DNA;
c. every species is given a binomial name;
d. members of the same species can mate and reproduce fertile offspring
e. genus is written first, followed by species;
f. genus is capitalized, (followed by) species is lower case
OR
an underlined correct example/stated that it must be underlined or italicized;

22M.2.SL.TZ1.1

a.i.

body temperature increases with ambient temperature / positive correlation;

Since direct can be either –/+, no credit for direct correlation alone.

a.ii.

humans maintain/regulate a constant body temperature at different ambient temperatures/maintained by homeostasis;

b.i. As ambient temperature increases, the sloth spends more time with limbs spread
OR
as ambient temperature increases the sloth spends less time curled in a ball
OR
as ambient temperature rises, the posture changes from 1 to 6;

b.ii.a. less surface area is exposed when curled up
OR
more surface area is exposed when all limbs spread;
b. curled position prevents heat loss/provides warmth
OR
stretched out position allows more heat loss/body cooled;

f. May;

g.a. food intake rises as daily temperature increases / positive correlation;
b. the lowest food intake corresponds to the lowest temperature;

h.

a. the sloth will be more active at higher temperatures as it takes in more food for energy;
b. as temperature rises, the sloth uncurls to dissipate/lose heat;

Reason required.

i.a. mammals have mammary glands; *Characteristic must be exclusive to mammals.*
b. produce milk for their offspring;
c. bodies covered in hair/fur;

If more than one answer, use the first one given.

22M.2.SL.TZ1.2

a.

2o;

b.a. increase in temperature/heat;
b. change of pH;
c. salt;
d. heavy metals;

c.a. changes the shape of the (active site) of the enzyme;
b. substrate would be unable to attach to the enzyme/active site;
c. slows the enzyme activity / prevents reaction/catalysis from proceeding;

22M.2.SL.TZ1.3

a.

0.87; (*accept values between 0.8 and 0.9*)

b. short-term reading could show global temperatures falling while the trend is rising
OR
fluctuations from year to year may not show long-term trend;

c.

a. short wave radiation from sun passes through atmosphere / is not absorbed by CO_2;
b. infrared/long wave (radiation) / heat emitted from/released from (surface of) Earth;
c. CO_2 in the atmosphere absorbs infrared/long wave (radiation)/heat / cannot pass through the greenhouse gases;
d. this results in warm/increased temperatures on Earth/global warming;

Do not accept "reflected" for mpb.

22M.2.SL.TZ1.4

a.

0.5/50 %;

b.a. hemophilia is X-linked/sex-linked/carried on the X chromosome;
b. females have two X chromosomes
OR
males only have one X chromosome;
c. hemophilia is caused by a recessive allele;
d. (trait) must be on both alleles to be expressed
OR
females would require the allele on both X chromosomes to have the disease
OR
females can be carriers when allele is only on one chromosome;

22M.2.SL.TZ1.5

a.

0 mV; (*accept answers in the range of – 10 mV to +10 mV*) (*Units required*)

b. sodium channels (start to) open *Reject pumping of ions.*
OR
depolarization/axon begins to depolarize
OR
action potential occurs;

c. Na^+/sodium ions diffuse into the axon (in the first part/half of *t*);
K^+ /potassium ions diffuse out of the axon (in the second half/part of *t*)

Do not accept the name of the element without indication that it is an ion.

d.

a. impulses pass to another neuron at a synapse/across synaptic gap/cleft;
b. (depolarization causes) Ca^{2+}/calcium ions to diffuse into the (presynaptic) neuron/axon;
c. depolarization (of presynaptic neuron) causes release of a neurotransmitter
OR
neurotransmitters diffuse across the synapse;
d. (neurotransmitters) bind to receptors on postsynaptic neuron/membrane;
e. (if the threshold potential is reached) an action potential occurs/sodium gates open (in the postsynaptic neuron);

22M.2.SL.TZ1.6

a.

a. unspecialized/undifferentiated stem cells can divide / differentiate along different pathways;
b. (stem cells are accessible as they) come from embryos/bone marrow/umbilical cord blood/adult tissue;
c. (stem cells) can regenerate/repair diseased/damaged tissues in people;
d. valid specific example;

e. drugs can be tested on stem cells (in laboratories to see if they are harmful);

b.

a. leaf cells contain chloroplasts;
b. light is absorbed by chlorophyll (in chloroplasts);
c. other pigments absorb different wavelengths;
d. light energy is used in photosynthesis;
e. (light is needed) to combine water and carbon dioxide/fix carbon dioxide;
f. carbon compounds/organic compounds/glucose/starch/carbohydrate are produced;
g. blue **and** red light is absorbed;
h. perform photolysis
OR
split water molecules;

Wavelengths accepted for mpg.

c. *Platelets*: ***[3 max]***

a. damage/cuts to blood vessels causes platelets to be activated;
b. the platelets release clotting factors;
c. initiates cascade of reactions
OR
fibrinogen is converted to fibrin;
d. forms a mesh over the damaged area;
e. prevents pathogens from entering the body;

Phagocytes: ***[3 max]***
f. phagocytes/phagocytic white blood cells in the blood travel to the site of infection;
g. (phagocytes) squeeze between the capillary cells;
h. (phagocytes) engulf/ingest/take in pathogens;
i. the pathogen is digested/broken down by/within the phagocyte;

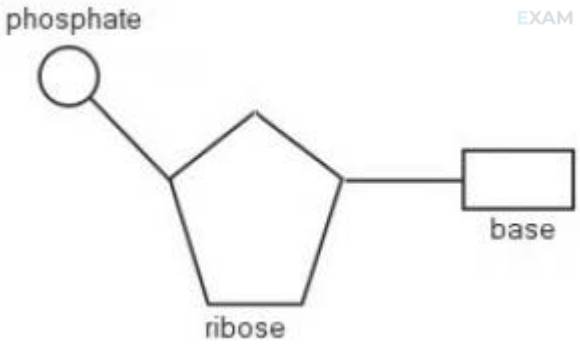
Lymphocytes: ***[3 max]***
j. lymphocytes recognize a particular fragment/antigen of a pathogen;
k. (lymphocytes) release antibodies;
l. (antibodies) provide specific immunity;
m. memory cells provide rapid response giving long-term immunity (to pathogens previously recognized);
n. antibodies destroy pathogens;

ECF may be applied when candidates use white blood cells in place of specific terms.

22M.2.SL.TZ1.7

a.

a. ribose drawn as a pentagon and labelled;
b. base linked correctly (to C1) of ribose and labelled;
c. phosphate linked correctly (to C5) of ribose and labelled;



*Award **[2 max]** if more than one nucleotide drawn.*

"Sugar" alone is insufficient.

b.

	Mitosis	Meiosis
a.	occurs in/produces somatic cells	occurs in/produces sex cells;
b.	one cell division	two cell divisions;
c.	produces two (daughter) cells	produces four (daughter) cells;
d	daughter cells identical to parent cell / does not produce genetic variation	daughter cells differ from parent cell / produces genetic variation;
e	produces cells for growth/repair	produces gametes/for reproduction;
f	chromosome number stays the same/2n/diploid	chromosome number is halved/1n/haploid;
g	pairing of chromosomes does not occur	homologous chromosomes join together/pair;
h	no exchange of material between chromosomes/no crossing over;	exchange of material between chromosomes/crossing over;

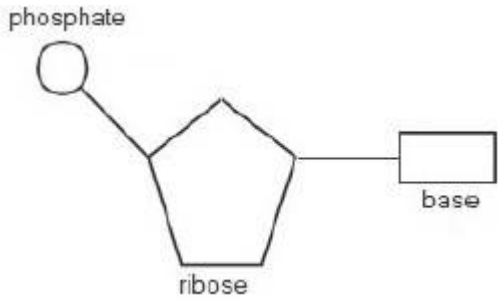
c.

a. antibiotics can (generally) kill/destroy bacteria;
b. some bacteria show variation/antibiotic resistance;
c. variation/resistance is due to a random mutation;
d. resistant bacteria are not killed/destroyed by the antibiotic
   OR
   bacteria without the mutation die;
e. (resistant) bacteria have a selective advantage / unequal success;
f. the bacteria with this variation/resistance reproduces/multiplies;
g. mutation/gene is passed on to the offspring / the offspring will be resistant to the antibiotic;
h. resistant bacteria become more common;
i. bacteria have evolved to be resistant to the antibiotic;

Award if pathogen is used instead of bacteria throughout the answer with no mention of bacteria.

22M.2.SL.TZ1.8

(a)



. ribose drawn as a pentagon and labelled;
. base linked correctly (to C_1) of ribose and labelled;
. phosphate linked correctly (to C_5) of ribose and labelled;

(b)

. DNA sample is collected from the child and its (potential) parents;
. from saliva/mouth swab/blood/other body cells;
. PCR used to amplify/produce more copies of the DNA;
. short tandem repeats/genes consisting of a repeating sequence of bases repeats copied/used;
. number of repeats varies between individuals;
. unlikely that two individuals have same number of repeats for every gene included;
. gel electrophoresis used to separate DNA fragments according to length/number of repeats;
. gel electrophoresis generates a unique pattern of bands
. DNA profile is the pattern of bands / diagram showing pattern of bands as in a DNA profile;
. all bands in the child's profile must be in one of the parents' profiles / OWTTE;

(c)

. environment affects height;
. nutrition/malnutrition affects growth rate / other example of environmental factor affecting height;
. genes/alleles affect height / height is partly heritable;
. polygenic / many genes influence height;
. continuous variation;
. normal/bell-shaped distribution of height;
. some alleles (of these genes) increase height and some reduce it;
. many possible combinations of alleles of these genes;
. specific gene mutations/alleles cause dwarfism/extreme height;
. meiosis generates variation (in height);
. mutations generate variation (in height);
. males tend to be/are on average taller than females;
. loss of height during aging;

22M.2.SL.TZ2.2

a.

undifferentiated/pluripotent/ability to divide/differentiate into any types of cells/differentiate along different pathways;

b.a. correct formula: 1.1cm = 500 µm, 2.7cm = length, $\frac{2.7 \times 500}{1.1} = X\mu m$;
b. correct answer <u>with unit</u>: 1227µm;

Allow answer in range of 1150 µm to 1350 µm.

c.

treatment of Stargardt's disease/leukemia/diabetes/heart disease/Parkinson's disease;

Any other verifiable condition.

d.

a. could improve quality/length of life of the treated person;
b. disease could still be passed on to progeny if defective gene/allele in gametes is not replaced/changed;

22M.2.SL.TZ2.5

a.

a. as temperature rises/is higher (than optimal temperature), the enzyme is denatured;
b. as the temperature drops the enzyme molecules have less kinetic energy
OR
fewer successful collisions;

OWTTE

b.

a. restriction enzymes/(restriction) endonucleases cut the gene and the bacterial/plasmid/vector DNA in the same/specific restriction sites
OR
(restriction) endonucleases work by targeting a specific sequence of base pairs in DNA causing both strands of the DNA to break apart;
b. (DNA) ligase attaches/inserts the gene to the bacterial/plasmid/vector DNA
OR
(DNA) ligase joins the vector and gene by fusing their sugar-phosphate backbones together (with a covalent phosphodiester bond);
c. correct reference to reverse transcriptase;

Accept correct mention of reverse transcriptase.

22M.2.SL.TZ2.6

a.

a. translation occurs on ribosomes when proteins/polypeptides are synthesized;

b. amino acid sequence of a protein is determined by the mRNA;
c. mRNA is determined by the order of bases of DNA/order of bases sequence in a gene;
d. codons (of 3 bases) on mRNA correspond to one amino acid in a polypeptide;
e. codons are on mRNA and anticodons on tRNA;
f. mRNA binds to ribosome/(during initiation) small ribosomal subunit binds to the start of the mRNA sequence;
g. tRNA transfers an amino acid to large ribosomal subunit/to the ribosome;
h. reference to start or stop codon;
i. tRNA moves to the next mRNA codon to continue the process, creating an amino acid chain;
j. peptide bond formed between amino acids
k. translation/order of amino acids depends on complementary base pairing between codons and anticodons;

b.

a. alleles clearly labelled for both parents (in a Punnett square or other format);
b. correct genotypes for all four possibilities for children;

		father	
		X^H	Y
mother	X^h	X^HX^h	X^hY
	X^H	X^HX^H	X^HY

c. phenotypes of the children: the sons would have a 50 % chance of having hemophilia and the daughters would have 0 % chance of having hemophilia/50 % chance of being a carrier;

Sex needs to be mentioned for mpc but info can be taken from the Punnett square.

c. *Clotting process*:

a. blood clotting seals cuts in the skin;
b. clotting factors are released (from platelets);
c. thrombin is activated;
d. a cascade reaction occurs (with thrombin);
e. (thrombin causes) fibrinogen is converted to fibrin;
f. fibrin forms a clot/blocks the cut/prevents blood from being lost;
Consequences of hemophilia:
g. if a person does not have enough clotting factors/hemophilia, the clot will not form;
h. pathogens can enter the body more easily;
i. (in hemophiliacs) blood will be lost from a cut which affects blood pressure/bleeding to death;
j. loss of blood affects amount of hemoglobin/O_2 carried around the body;
k. reference to lifestyle / menstrual/birth problems

e.g. surgery, contact sports

22M.2.SL.TZ2.7

a.

a. communities are made up of populations of different species;
b. plants receive energy from the sun/light;
c. convert it to chemical energy through photosynthesis;
d. chemical energy is stored in organic/C-compounds;
e. the energy is passed to other organisms through feeding / reference to food chain;
f. respiration (of plants and animals) converts the chemical energy (of C-compounds) to other useful forms of energy;
g. eventually the chemical energy is lost as heat energy;
h. energy is non-recyclable/lost from a community/ecosystem;
i. energy losses between trophic levels limit food chains/mass of top trophic levels/only about 10 % of energy is transferred;

b.

a. (natural selection occurs if) there is variation in degree of drought resistance among members of a population/same species;
b. variation is caused by mutations (when changes occur in the DNA/nucleic bases/chromosomes);
c. variation during meiosis occurs (with separation of chromosomes);
d. variation occurs during sexual reproduction (as different alleles combine);
e. some variations make some plants more drought-resistant;
f. example of variations: deeper roots/more storage tissue for water/thicker cuticles/less opening of stomata/other verifiable variations;
g. these variations let some survive and reproduce better/have more offspring
OR
(these variations) confer selective advantage;
h. these variations/characteristics are passed onto offspring which survive better;
i. natural selection increases the frequency of these characteristics;
j. eventually leads to changes/evolution in the species / more drought-resistant plants;

c. *Benefits*:

a. increase crop growth/food productivity;
b. with limited water/ less water is used;
c. increase amount of land available for food production in dry areas;
Risks:
d. these plants may out-compete other species in the community/may cause extinction of some species/affect the food chains in the community;
e. the modified gene/recombinant DNA may pass to other organisms;
f. more grain requires more nutrients from the soil so its quality may diminish/monoculture issues;
g. GMO may have health effects in consumers / OWTTE;

*Must include at least one benefit and one risk for **[3 max]**.*

22M.2.SL.TZ2.8

(a)

. simple/passive diffusion down a concentration gradient / from high concentration to low concentration (without the use of channels/proteins); (*e.g.*, CO_2 / O_2 / H_2O / *steroid hormones*)

. osmosis is the diffusion of water from an area of high water potential / low solute concentration to low water potential / high solute concentration;
. facilitated diffusion is passive transport/diffusion through a protein channel; (*e.g., glucose*)
. active transport requires energy/ATP to move the molecules through a protein channel (*e.g., Na-K pump / sodium potassium pump*) against a concentration gradient / from low solute concentration to high concentration ;
. endocytosis is the infolding of membranes to form a vesicle and take in a large molecule; (*e.g., macrophages engulfing pathogens*)
. exocytosis is the fusion of vesicles with membranes to release a large molecule; (*e.g. neurotransmitters*)

(b)

. humans are osmoregulators/maintain the internal concentrations of the blood/osmolarity within specific/ limited range / OWTTE;
. glomerulus / Bowman's capsule (in the nephron) carry out ultrafiltration;
. proximal convoluted tubule selectively reabsorbs glucose/solute/salts/amino acids;
. loop of Henle maintains hypertonic conditions in the medulla/absorbs salts (by active transport);
. loop of Henle reabsorbs water (by osmosis);
. (osmoreceptors in the hypothalamus) cause production of ADH if the blood is too concentrated / person is dehydrated / OWTTE;
. ADH causes more uptake of water/increases permeability in the collecting duct;
. resulting in a more concentrated urine / lower volume of urine;
. excess amino acids are broken down producing nitrogenous waste / ammonia / urea as a result;
. ammonia is toxic and is converted into non-toxic urea;
. urea is eliminated in the urine;

Marks can be awarded to clearly annotated diagrams .

(c)

. behavioural adaptations to avoid over-heating / hiding in burrows/out of sun during hot period of day / active at cooler times of the day/nocturnal animals / panting;
. adaptations for heat exchange such as large ears;
. may have longer loop of Henle (to reabsorb more water);
. may produce more ADH (according to osmotic concentrations of the blood) / produce concentrated urine / lower volume of urine;
. camel humps that store fat that releases (metabolic) water when broken down;
. reduced sweat;
. any other valid adaptation; (e.g., light coloured coats)

23M.2.SL.TZ1.6

(a)

. supercoiling/condensation of chromosomes ;
. breakup of nuclear membrane;
. growth of spindle/microtubules;

. attachment of spindle/microtubules to chromosomes/centromeres;
. chromosomes line up at the equator/middle
. division of centromeres;
. separation of sister chromatids/chromosomes
OR
sister chromatids/chromosomes move to opposite poles;
. reformation of nuclear membranes around chromosomes at each pole;

If events are not in the correct order, then award a maximum of 4 marks.

Names of phases of mitosis not required.

Award a max of 1 mark for listing the phases in the correct order when the list constitutes the entire response.

(a)

. supercoiling/condensation of chromosomes ;
. breakup of nuclear membrane;
. growth of spindle/microtubules;
. attachment of spindle/microtubules to chromosomes/centromeres;
. chromosomes line up at the equator/middle
. division of centromeres;
. separation of sister chromatids/chromosomes
OR
sister chromatids/chromosomes move to opposite poles;
. reformation of nuclear membranes around chromosomes at each pole;

If events are not in the correct order, then award a maximum of 4 marks.

Names of phases of mitosis not required.

Award a max of 1 mark for listing the phases in the correct order when the list constitutes the entire response.

(c)

. gene/genetic information on Y chromosome causes embryo to develop testes;
. (developing) testes in embryo secrete testosterone;
. testosterone causes male genitalia/penis to develop;

Accept SRY gene in mp-a

23M.2.SL.TZ1.7

(a)

. binomial naming
OR
genus and species name;
. plants constitute a kingdom
. plants are eukaryotes/belong to the domain eukaryota

. classified using a hierarchy of taxa
OR
kingdom, phylum, class, order, family, genus, species
. bryophyta/filicinophyta/coniferophyte/angiospermophyta is a phylum (of plants);
. bryophytes have only rhizoids/spores (produced in a capsule)/no roots/ no vascular tissue;
. filicinophytes have stems/roots/xylem-phloem/reproduce by spores/leaves that uncurl; but no seeds
. coniferophytes have seeds in cones/ vascular tissue/xylem-phloem/cambium/ but no flowers/no fruits
. angiospermophytes have flowers/produce seeds/produce fruits/vascular tissue/xylem-phloem;
. named example showing of the classification of a plant from species to domain or vice versa
. cladistics is used to reclassify groups of plants
OR
named example of a group of plants reclassified by cladistics ;
. use a dichotomous key to discriminate among plant features

Each phylum of plants requires at least 2 features for the mark.

Mp-e does not require all 4 phyla to be named.

(a)

. pairing/synapsis of homologous chromosomes / homologous chromosomes form bivalents;
. crossing over / chromatid breaks then rejoins to non-sister chromatid;
. exchange of DNA/alleles/genetic information between chromatids/chromosomes;
. recombination / new combinations of alleles/genes generated;
. condensation/shortening/thickening/supercoiling of chromatids/chromosomes;
. formation of a chiasma where crossing over occurred;

(b)

. absorption/diffusion of carbon dioxide from the atmosphere/water by plants;
. photosynthesis fixes/converts carbon (dioxide) to carbohydrates/carbon compounds;
. respiration in plants converts carbohydrates/carbon compounds to carbon dioxide;
. saprotrophs/detritivores digest dead plants/plant matter releasing carbon/carbon dioxide;
OR
decomposition returns carbon to the soil/releases CO_2 to atmosphere/water/environment
. peat forms when decomposition of dead plant matter is incomplete storing carbon/ creating a reservoir;
OR
fossilization of carbon stores carbon as coal/oil/natural gas;
. forest fires/combustion of plants converts (carbohydrates/carbon compounds) to carbon dioxide;
. plants are eaten by consumers (moving carbon in the food chain)
. humans use plant products for making cloth/household items/building/arts creating a reservoir for carbon

Humans burn fossil fuels releasing CO_2;
. Plants act as carbon sinks/reservoirs

Carbon may be used in place CO_2 an carbohydrates

23M.2.SL.TZ2.6

(a)

. speed of reaction/catalysis increases as temperature rises;
. faster molecular motion so more collisions between substrate and active site;
. denaturation at higher temperatures;
. (denaturation causes) shape/conformation/structure of enzyme/active site altered/damaged;
. an enzyme works fastest at its optimum temperature;
. inactivation at lower temperatures (due to very few collisions);
. sketch graph to model the effect of temperature on enzyme activity;

Graphs would need to be well annotated. Must not be bell shaped.

(a)

. speed of reaction/catalysis increases as temperature rises;
. faster molecular motion so more collisions between substrate and active site;
. denaturation at higher temperatures;
. (denaturation causes) shape/conformation/structure of enzyme/active site altered/damaged;
. an enzyme works fastest at its optimum temperature;
. inactivation at lower temperatures (due to very few collisions);
. sketch graph to model the effect of temperature on enzyme activity;

Graphs would need to be well annotated. Must not be bell shaped.

(c)

. release of carbon dioxide;
. combustion of fossil fuels produces carbon dioxide;
. forest fires (caused by humans) produce carbon dioxide;
. deforestation reduces carbon dioxide uptake by photosynthesis;
. release of methane;
. from cattle/sheep/ruminant digestive systems / other verified source of anthropogenic methane;
. greenhouse effect / carbon dioxide/methane is a greenhouse gas;
. carbon dioxide/methane allow short wave radiation in sunlight to pass through the atmosphere;
. longer wave/infra-red radiation emitted by the warmed Earth's surface;
. carbon dioxide/methane absorbs/reflects back longer wave/infra-red radiation;

23M.2.SL.TZ2.7

(a)

. plasma membrane is thin layer forming outer boundary;
. cytoplasm fills space between membrane and nucleus;
. nucleus enclosed in nuclear membrane / nuclear membrane enclosing nucleus;
. chromosomes inside the nucleus/ visible during mitosis/ as rods (of condensed DNA);
. mitochondria with cristae/double membranes;
. (80S) ribosomes seen as dots free in cytoplasm/attached to rough ER;
. endoplasmic reticulum is a network interconnected tubes/ membranes /rough ER has ribosomes/ smooth ER does not;
. Golgi apparatus with stack of sacs/cisternae/curved or folded membranes/vesicles budding off;
. vesicles which are small membrane sacs;
. lysosome which contains enzymes/which is densely staining;
. any other organelle that would be visible correctly described;

Allow any point made on an annotated diagram.

Do not award any marks for just labels. Descriptions are needed.

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(b)

. respiration/cell respiration;
. energy released from glucose/lipids/organic compounds;
. anaerobic respiration does not require oxygen;
. lactate is produced in anaerobic respiration/word equation for anaerobic respiration;
. oxygen used in aerobic respiration;
. carbon dioxide and water produced in aerobic respiration/word equation for aerobic respiration;
. mitochondria used for aerobic respiration;
. larger yield of ATP from aerobic than anaerobic respiration;

SPM.2.SL.TZ0.6

(a)

. genetically determined/determined by (pair of) sex chromosomes/X and Y chromosomes;
. sperm carry either an X or a Y chromosome;
. egg is X and if fertilized by X sperm leads to a female child / XX female
OR
egg is X and if fertilized by Y sperm leads to a male child / XY male;

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(b)

. recombination of parental alleles during fertilization;
. fertilized egg contains a mixture of paternal and maternal chromosomes;
. crossing over/meiosis gives rise to new combinations of alleles;

SPM.2.SL.TZ0.7

(a)

. mutations are random changes in the sequences of genes/DNA;
. (mutation) may involve addition/deletion/substitution/inversion of DNA bases;
. (mutations) in tumour suppressor genes/oncogenes;
. uncontrolled cell division/mitosis occurs;
. abnormal cells cannot perform their function;
. they divide repeatedly to form tumours;

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(b)

. name of condition e.g. PKU / other example;
. mutation in the gene for (the enzyme) phenylalanine hydroxylase (PAH) / if other example used name of gene that is mutated;
. outline of inheritance pattern, e.g. both parents need to carry the recessive allele;

. (without dietary modification, result is) toxic build-up of phenylalanine in the blood / low levels of tyrosine / symptoms if other example used;
. phenylalanine is not converted to tyrosine (by the enzyme) / effect of the mutation on the protein/enzyme/metabolism if other example used;
. requires dietary modification (as treatment) / treatment for other example used;

(c)

. new phenotypes/traits may result from mutations;
. mutations increase variation/differences between individuals in a population/species;
. individuals with new phenotype/trait may have more chances of survival;
. (more chances of survival) in a changing environment / presence of selection pressures;
. (selection pressure can be) intraspecific competition/abiotic factor;
. natural selection occurs;
. individuals with (advantageous) mutation have longer life spans/live longer;
. (so) more chances of reproduction;
. mutated gene passed on to new generations;
. allele frequencies change in the population over time;
. evolution is a consequence of natural selection;

SPM.2.SL.TZ0.8

(a)

. normal body temperature is 37 °C;
. peripheral thermoreceptors detect environmental temperature;
. supporting conscious behaviour to avoid temperature extremes, e.g. wearing more clothing;
. sends messages to hypothalamus/temperature control centre of the brain;
. the hypothalamus sends messages to pituitary gland;
. (pituitary) releases TSH;
. stimulating thyroxin release from thyroid;
. thyroxin controls metabolic rate / production of heat;
. muscle random contraction/shivering to generate heat;
. (brown) adipose tissue burns fat to generate waste heat;
. vasoconstriction to conserve heat / vasodilation to exchange heat with the environment;

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(b)

. as temperature increases, the rate of molecular motion increases;
. increasing the frequency of collision between enzyme and substrate;
. increasing the rate of reaction;
. until an optimum temperature is reached;
. with further increase in temperature, enzymes denature;

(c)

. water has a (much) higher specific heat capacity (than air);
. water requires more energy gain/loss to change temperature;
. (water) provides more stable thermal habitats than air / temperature of water bodies remains more constant than air temperature;
. water has a higher thermal conductivity than air;
. more heat is transferred from organisms to water than to air;
. water is a good evaporative coolant and air is not;
. aquatic mammals have (proportionally) more body fat as insulation;