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Previous IB Exam Essay Questions: Unit 1: Cells

Use these model essay question responses to prepare for essay questions on your in class tests, as well as the IB Examination, Paper 2. These questions have appeared on recent IB examinations, exactly as shown below. Following each question is the markscheme answer which was used to evaluate student answers on the examination paper.

1. Discuss possible exceptions to cell theory. *4 marks*

- skeletal muscle fibers are larger/have many nuclei/are not typical cells
- fungal hyphae are (sometimes) not divided up into individual cells
- unicellular organisms can be considered acellular
- because they are larger than a typical cell/carry out all functions of life
- some tissues/organs contain large amounts of extracellular material
- *e.g.* vitreous humor of eye/ mineral deposits in bone/ xylem in trees/other example
- statement of cell theory/all living things/most tissues are composed entirely of true cells

2. Explain how the surface are to volume ratio influences cell sizes. *3 marks*

- small cells have larger ratio (than larger cells)/ratio decreases as size increases
- surface area/membrane must be large enough to absorb nutrients/oxygen/substances needed
- surface area/membrane must be large enough to excrete/pass out waste products
- need for materials is determined by (cell) volume
- cell size is limited (by SA/Volume ratio)/cells divide when they reach a certain size
- reference to diffusion across/through membrane/surface area

3. Outline differentiation of cells in a multicellular organism. *4 marks*

- differentiation is development in different/specific ways
- cells carry out specialized functions/become specialized
- example of a differentiated cell in a multicelluar organism
- cells have all genes/could develop in any way
- some genes are switched on/expressed but not others
- position/hormones/cell-to-cell signals/chemicals determine how a cell develops
- a group of differentiated cells is a tissue

4. Draw a labelled diagram showing the structure of a prokaryotic cell *6 marks*

- cell wall shown clearly and labelled
- cell surface membrane shown thinner than and adjacent to cell wall and labelled
- cytoplasm shown with no nucleus present and labelled
- ribosomes shown free in the cytoplasm and labelled

- loop of DNA shown in the cytoplasm/nucleoid and labelled as DNA
- plasmid shown as a small loop and labelled
- slime capsule shown as a layer outside the cell wall and labelled
- mesosome shown as a membrane invagination and labelled
- flagellum shown and labelled*(reject if shown with microtubules)*

5. Draw a labelled diagram to show the organelles which are found in the cytoplasm of plant cells.*6 marks*

Award 1 mark for each of the following structures accurately drawn and labelled

- rough endoplasmic reticulum
- free ribosomes
- Golgi apparatus
- mitochondrion
- chloroplast
- vacuole
- nucleus
- lysosome
- smooth endoplasmic reticulum

6. State one function of each of the following organelles: lysosome, Golgi apparatus, rough endoplasmic reticulum, nucleus, mitochondrion.*5 marks*

- *lysosome*: hydrolysis/digestion/break down of materials (macromolecules)
- *Golgi apparatus*: synthesis/sorting/transporting/secretion of cell products
- *rough endoplasmic reticulum*: site of synthesis of proteins (to be secreted)/ intracellular transport of polypeptides to Golgi apparatus
- *nucleus*: controls cells activities/mitosis/replication of DNA/transcription of DNA (to RNA)/directs protein synthesis
- *mitochondrion*: (aerobic) respiration/generates ATP

7. Draw a labelled diagram showing the ultra-structure of an animal cell as seen in an electron micrograph.*6 marks*

Award 1 mrak for each of the following structure clearly drawn and labelled correctly. Award marks for labelled eukaryotic structures, then deduct 1 mark per labelled prokaryotic structure shown, e.g. mesosome, cell wall.

- nuclear membrane/nucleus (with nuclear membrane shown double with pores)
- ribosomes (free or attached to ER)
- endoplasmic reticulum/ ER
- plasma/cell membrane (*reject if shown as a double line*)
- mitochondria (shown with inner and outer membrane)
- Golgi (apparatus)

- lysosomes

8. Distinguish between the structure of plant and animal cells.*6 marks*

Award 1 mark per differenceplant cells

- have cell walls, animals do not
- have plastids/ chloroplasts, animals do not
- have a large central vacuole, animals do not
- store starch, animal cells store glycogen
- have plasmodesmata, animal cells do not

animal cells

- have centrioles, plant cells do not
- have cholesterol in the cell membrane, plant cells do not
- plant cells are generally have a fixed shape/ more regular whereas animal cells are more rounded

9. Using a table, compare the structures of prokaryotic and eukaryotic cells.*5 marksprokaryotic cellseukaryotic cells*

- DNA naked/loop of DNA associated with protein/histones/nucleosomes/DNA in chromosomes
- location of DNA in cytoplasm/nuceloid/no nucleus within a nucleus/nuclear membrane
- membrane bound organelles none present
- ribosomes 70S 80S
- plasma membrane same structure within both groups
- cell wall peptidoglycan/not cellulose/not chitin cellusose/chitin/not peptidoglycan
- respiratorystructuresmesosomes/no mitochondriamitochondria

Previous IB Exam Essay Questions: Unit 2

Use these model essay question responses to prepare for essay questions on your in class tests, as well as the IB Examination, Paper 2. These questions have appeared on recent IB examinations, exactly as shown below. Following each question is the markscheme answer which was used to evaluate student answers on the examination paper.

1. Draw a diagram to show the structure of a cell membrane*5 marks*

- phospholipids labelled with hydrophillic (heads) and hydrophobic (tails)
- phospholipid bilayer clearly shown and labelled
- proteins shown in the bilayer and labelled
- transmembrane and peripheral/extrinsic proteins shown and labelled
- glycoproteins shown and labelled
- cholesterol shown and labelled
- glycolipids shown and labelled
- thickness shown as 10 nm/ + or - 2 nm

2. Explain how the structure and properties of phospholipids help to maintain the structure of cell membranes.*9 marks*

phospholipid structure

- hydrophobic tail/hydrophilic head

- head made from glycerol and phosphate
- tail made from two fatty acids
- saturated/ unsaturated fatty acid (in tail)

arrangement in membrane

- phospholipids form a bilayer
- heads face outside the membrane/ tails face inside the membrane/ hydrophic interior/ hydrophilic exterior of membrane

A suitable annotated diagram may incorporate all or many of the above points. Award 5 marks maximum for a suitable diagram that is labelled correctly.

- phospholipids held together by hydrophobic interactions
- phospholipid layers are stabilized by interaction of hydrophilic heads and surrounding water
- phospholipids allow for membrane fluidity/ flexibility
- fluidity/ flexibility helps membranes to be (functionally) stable
- phospholipids with short fatty acids/ unsaturated fatty acids are more fluid
- fluidity is important in breaking and remaking membranes (e.g. endocytosis/ exocytosis)
- phospholipids can move about/ move horizontally/ "flip flop" to increase fluidity
- hydrophilic/ hydrophobic layers restrict entry/ exit of substances

3. Explain the role of vesicles in transportation of materials within cells.*8 marks*

- vesicles are membrane bound packages/droplets
- formed by pinching off/budding off a piece from a membrane
- can carry proteins
- rough ER synthesizes proteins
- proteins enter/accumulate inside the ER
- transported to Golgi apparatus for processing
- targeted to/transported to specific cellular organelles
- fuse with membrane of organelle so contents of vesicle join the organelle
- transported to the plasma membrane
- fuses with plsma membrane releases/secretes contents
- exocytosis

4. Describe the process of active transport.*4 marks*

- uses/ requires energy/ ATP
- goes against concentration gradient/ lower to higher concentration
- requires a protein in the cell membrane/ pump/ carrier protein (*reject channel*)
- hydrolysis of ATP/ ATP --> ADP + phosphate
- involves a conformational change in the pump/ protein/ diagram to show this

5. Outline the ways in which substances move passively across membranes. *5 marks*

- diffusion (is a method of passive transport across the membrane)
- pore/ channel proteins for facilitated diffusion/ to allow hydrophilic particles across
- movement from high to low concentration/ down the concentration gradient
- membrane must be permeable to the substance diffusing
- oxygen/ other named example of a substance than can diffuse through membranes
- osmosis is movement of/ diffusion of water through a membrane
- from a region of lower to a region of higher solut concentration/ higher to lower water potential
- membranes are (nearly) always freely permeable to water

6. Explain the reasons for cell division in living organims. *8 marks*

- to increase the number of cells in an organism
- to allow differentiation/ cell specialization
- for greater efficiency
- to replace damaged/ lost cells
- example
- binary fission
- asexual reproduction of unicellular organisms
- gamete/ spore formation
- cells only arise from pre-existing cells
- refer to Virchow
- cells cannot grow beyond a certain size
- surface area to volume ratio becomes too small
- transport across the membrane too slow
- example
- nucleus cannot control the cell
- control of cell division sometimes lost
- tumor formation

7. Outline the processes that occur in a cell during interphase, including those needed to prepare for mitosis. *4 marks*

- DNA replication
- DNA transcription
- enzyme/ protein synthesis
- biochemical reactions/ example of a biochemical reaction
- cell respiration
- growth

- organelles replicated

Previous IB Exam Essay Questions: Unit 3

Use these model essay question responses to prepare for essay questions on your in class tests, as well as the IB Examination, Paper 2. These questions have appeared on recent IB examinations,

exactly as shown below. Following each question is the markscheme answer which was used to evaluate student answers on the examination paper.

1. Describe the significance of water to living organisms.*6 marks***SL**

Each feature or property must be related to living organisms in order to receive a mark.Features may include:

- surface tension - allows some organisms (e.g. insects) to move on water's surface
- polarity / capillarity / adhesion - helps plants transport water
- transparency - allows plants to photosynthesize in water / allows animals to see
- (excellent) solvent - capable of dissolving substances for transport in organisms
- (excellent) thermal properties (high heat of vaporization) - excellent coolant
- ice floats - lakes / oceans do not freeze, allowing life under the ice
- buoyancy - supports organisms
- structure - turgor in plant cells / hydrostatic pressure
- habitat - place for aquatic organisms to live

2. Describe the use of carbohydrates and lipids for energy storage in animals.*5 marks*

Answers must discuss both carbohydrates and lipids to receive full markscarbohydrates: 3 max

- stored as glycogen (in liver)
- short-term energy storage
- more easily digested than lipids so energy can be released more quickly
- more soluble in water for easier transport

lipids: 3 max

- stored as fat in animals
- long-term energy storage
- more energy per gram than carbohydrates
- lipids are insoluble in water so less osmotic effect

3. Describe the structure of triglycerides.*6 marks***SL**

- composed of C, H and O (*must be stated*)
- relatively more C and H/less O than carbohydrates
- composed of fatty acids and glycerol
- glycerol is CH2.OH.CH.OH.CH2OH/ diagram showing it separately or as part of a triglyceride
- fatty acids are carboxyl groups with hydrocarbon chain attached/ diagram showing it separately or as part of a triglyceride
- ester bonds/diagram showing C-O-C=O
- three fatty acids/hydrocarbon chains linked to each glycerol (*must be stated*)
- 12-20 carbon atoms per hydrocarbon tail/diagram showing this number

- saturated if all the C-C bonds are single/unsaturated if one or more double bonds
- whole molecule is nonpolar/hydrophobic

4. List three functions of lipids.*3 marks***SL**

- energy storage / source of energy / respiration substrate
- (heat) insulation
- protection (of internal organs)
- water proofing / cuticle
- buoyancy
- (structural) component of cell membranes
- electrical insulation by myelin sheath
- (steroid) hormones
- glycolipids acting as receptors

5. Describe the significance of polar and non-polar amino acids.*5 marks*

For the maximum mark the response must have polar and non-polar amino acids

polar amino acids: 3 max

- hydrophilic
- can make hydrogen bonds
- found in hydrophilic channels/parts of proteins projecting from membranes
- found on surface of water-soluble protein

non-polar amino acids: 3 max

- hydrophobic
- forms van der Waals/hydrophobic interactions with other hydrophobic amino acids
- found in protein in interior of membranes
- found in interior of water soluble proteins

6. Outline the role of condensation and hydrolysis in the relationship between amino acids and dipeptides.*4 marks***SL**

- diagram of peptide bond drawn
- condensation / dehydration synthesis: water produced (when two amino acids joined)
- hydrolysis: water needed to break bond
- dipeptide --> amino acids - hydrolysis occurs
- amino acids --> dipeptide - condensation occurs

7. Describe the structure of proteins.*9 marks***HL**

- (primary structure is a) chain of amino acids/sequence of amino acids
- (each position is occupied by one of) 20 different amino acids
- linked by peptide bonds

- secondary structure formed by interaction between amino and carboxyl/-NH and -C=O groups
- (weak) hydrogen bonds are formed
- (å-) helix formed / polypeptide coils up
- or (ß-) pleated sheet formed
- tertiary structure is the folding up of the polypeptide
- stabilized by disulfide bridges / hydrogen / ionic / hydrophobic bond
- quaternary structure is where several polypeptide subunits join
- conjugated proteins are proteins which combine with other non-protein molecules
- for example metals / nucleic acids / carbohydrates / lipids

8. List four functions of proteins, giving an example of each.*4 marks***SL**

name of function and named protein must both be correct for the mark

- storage - zeatin (in corn seeds)/casein (in milk)
- transport - hemoglobin/lipoproteins (in blood)
- hormones - insulin/growth hormone/TSH/FSH/LH
- receptors - hormone receptor/neurotransmitter receptor/receptor in chemoreceptor cell
- movement - actin/myosin
- defense - antibodies/immunoglobin
- enzymes - catalase/RuBP carboxylase
- structure - collagen/keratin/tubulin/fibroin
- electron carriers - cytochromes
- pigments - opsin
- active transport - sodium potassium pumps/calcium pumps
- facilitated diffusion - sodium channels/aquaporins

mark first four functions only, but allow other named examples

9. Describe, with examples, the secondary structures of proteins.*5 marks***HL**

- å helix is a secondary structure
- polypeptide is coiled into a helix / diagram showing this
- ß-**pleated** sheet is a secondary structure
- polypeptide folds back on itself (several times) to form a sheet / diagram showing this
- å helix /ß (pleated) sheet / secondary structures held together by hydrogen bonds
- hydrogen bonds at regular spacing
- hydrogen bonding between C=O and N-H groups
- dimensions of secondary structures are constant
- not all of a polypeptide form secondary structures (in most proteins)

10. Discuss the solubility of proteins in water.*4 marks***HL**

- solubility depends on what amino acids /R groups are present
- smaller proteins are more soluble than big ones
- proteins with many polar / hydrophilic amino acids / R groups are more soluble / soluble
- proteins with polar / hydrophilic amino acids / R groups *on the outside* are soluble
- example of a polar amino acid / group
- globular proteins are more soluble than fibrous proteins
- solubility of proteins may also be affected by conditions (pH, temperature, salinity)
- denaturation makes proteins insoluble
- proteins do not form true solutions in water but colloidal solutions

11. The complex structure of proteins can be explained in terms of four levels of structure, primary, secondary, tertiary and quaternary.*5 marks***HL**

a. Primary structure involves the sequence of amino acids that are bonded together to form a polypeptide. State the name of the linkage that bonds the amino acids together.1 mark

- peptide bonds / peptidic bonds

b. Beta pleated sheets are an example of secondary structure. State one *other example.1 mark*

- alpha-helix / alpha helices

c. Tertiary structure in globular proteins involves the folding of polypeptides. State ***one*** *type of bond that stabilizes the tertiary structure.1 mark*

- ionic / polar / hydrogen / hydrophobic / van der Waals' / disulfide (not covalent)

d. Outline the quaternary structure of proteins.2 marks

- linking together of polypeptides to form a single protein
- using the same bonding as for tertiary structure
- linking of a non-polypeptide structure / prosthetic group
- named example of quaternary structure e.g. hemoglobin (has four polypeptides)

12. Explain the use of lactase in biotechnology.*4 marks***SL**

- yeast/*Kluveromyceslactis*/cultured
- lactase extracted from yeast/*Kluveromyceslactis*/culture
- lactase used in lactose-free milk production
- lactase breaks down lactose into glucose plus galactose
- allows lactose-intolerant people to consume milk products
- galactose and glucose are sweeter than lactose, so less sugar needs to be added to sweet foods containing milk
- bacteria ferment glucose and galactose more quickly than lactose, so production of yoghurt and cottage cheese is faster

13. Distinguish between fibrous and globular proteins, giving one example of each.*5 marks*

award 1 for each of the following pairs up to 3 max

- fibrous has repetitive amino acid sequences whereas globular has irregular amino acid sequences
- fibrous are long and narrow whereas globular are spherical
- fibrous used for structural functions whereas globular have metabolic/other functions
- fibrous tend to be insoluble in water whereas globular tend to be soluble in water

award one max for example of fibrous proteins

- collagen/myosin/keratin/fibroin/elastin/silk

reject fibrinogenaward one max for example of globular proteins

- catalase/other named enzyme/hemoglobin/myoglobin/insulin/other named peptide hormone/immunoglobulin/other globulin protein

reject examples of fibrous and globular proteins apart from the first named examples

14. Outline enzyme-substrate specificity*5 marks*

- *active site* of enzyme binds to specific *substrate*
- shape of the active site and substrate fit/complement each other
- *lock and key* model
- chemical properties of substrate and enzyme attract/opposite charges
- enzyme/active site is not rigid and substrate can induce slight changes in shape
- allows substrates of similar structure to bind with same enzyme
- *induced fit*
- causes weakening of bonds in substrate to lower activation energy

15. Explain how allosteric control of metabolic pathways by end-product inhibition includes negative feedback and non-competitive inhibition.*8 marks*

- allosteric enzyme has binding site away from/other than active site
- (shape of an) allosteric enzyme alternates between active and inactive (form)
- non-competitive inhibitor binds to allosteric site/away from active site
- non-competitive inhibitor changes shape of active site
- non-competitive inhibitors do not compete with substrate for the active site
- end-product can inhibit enzyme needed for early/first step in metabolic pathway
- negative feedback since increased level of product decreases rate of its own production
- metabolic pathway regulated according to the requirement for its end-product
- idea that inhibition is reversible

award one for named enzymeaward one for its non-competitive/end-product inhibitor

16. Define the term *active site* of an enzyme.*1 mark***SL**

- the site (on the surface of and enzyme) to which substrate(s) bind / the site (on the enzyme) where it catalyzes a chemical reaction

17. Outline how enzymes catalyze biochemical reactions.*2 marks***SL**

- bring substrates close together in active site / in correct orientation
- forms enzyme-substrate complex / substrate(s) bind to active site
- lowers the **activation** energy for the reaction

18. Explain the effect of pH on enzyme activity.*3 marks***SL**

- enzymes have an optional pH
- lower activity above and below optimum pH / graph showing this
- too acidic / base pH can determine enzyme
- change shape of active site / tertiary structure altered
- substrate cannot bind to active site / enzyme-substrate complex cannot form
- hydrogen / ionic bonds in the enzyme / active site are broken / altered

19. Compare the induced fit model of enzyme activity with the lock and key model.*4 marks***HL**

- in both models substrate binds to active site
- substrate fits active site exactly in lock and key, but does not in induced fit
- substrate / active site changes shape in induced fit, but does not in lock and key
- in both models an enzyme - substrate complex is formed
- in lock and key binding reduces activation energy but in the induced fit change to substrate reduces activation energy
- lock and key model explains narrow specificity but induced fit allows broader specificity
- induced fit explains competitive inhibition, but lock and key does not

20. Draw graphs to show the effect of enzymes on the activation energy of chemical reactions*5 marks***HL**

*(for the first graph, which may be either exothermic or endothermic, award up to **{1 mark}** for any of the following, up to **{4 marks}**)*

- vertical axis with energy label **and** horizontal axis with time label
- labels showing reactant / substrate and product
- labeled line showing correct shape and curve without enzyme
- labeled line showing correct shape and curve with enzyme
- labels for activation energy with **and** without enzymes

*(Award **{1 mark}**for a second graph which shows the correct curves for an endergonic reaction if the first graph was exothermic or vice versa. For the second graph, no marks will be awarded for labels)*

21. Explain how proteins act as enzymes, including control by feedback inhibition in allosteric enzymes.*9 marks***HL**

- enzymes are globular proteins
- there is an active site
- substrate(s) binds to active site

- shape of substrate (and active site) changed / induced fit
- bonds in substrate weakened
- activation energy reduced
- sketch of energy levels in a reaction to show reduced activation energy
- in feedback inhibition a (end) product binds to the enzyme
- end-product is a substance produced in last / later stage of a pathway
- modulator / inhibitor / effector / product binds at the allosteric site / site away from the active site
- binding causes the enzyme / active site to change shape
- substrate no longer fits the active site
- the higher the concentration of end-product the lower the enzyme activity
- enzyme catalysts the first / early reaction in pathway so whole pathway is inhibited
- prevents build-up of intermediates
- allosteric inhibition is non-competitive

22. Explain, using one named example, the effect of a competitive inhibitor on enzyme activity.*6 marks***HL**

- competitive inhibitor has similar shape/structure to the substrate
- therefore it fits to the active site
- no reaction is catalyzed so the inhibitor remains bound
- substrate cannot bind as long as the inhibitor remains bound
- only one active site per enzyme molecule
- substrate and inhibitor compete for the active site
- therefore high substrate concentrations can overcome the inhibition
- as substrate is used up ratio of inhibitor to substrate rises
- named example of inhibitor plus inhibited enzyme / process / substrate

Previous IB Exam Essay Questions: Unit 4

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1. Draw as simple diagram of the molecular structure of DNA.*5 marks***SL**

- two sugar-phosphate backbones shown
- A with T and C with G
- double helical shape shown
- antiparallel nature of strands indicated
- ten base pairs per turn of helix
- correct hydrogen bonding shown (A=T and C=G)

2. Describe the genetic code.*6 marks***SL**

- composed of mRNA base triplets

- called codons
- 64 different codons
- each codes for the addition of an amino acid to a growing polypeptide chain
- the genetic code is degenerate
- meaning more than one codon can code for a partiuclar amino acid
- the genetic code is universal
- meaning it is the same in almost all organisms
- (AUG is the) start codon
- some (nonsense) codons code for the end of translation

3. Explain the relationship between genes and polypeptides.*5 marks***SL**

- genes code for proteins/ polypeptides
- one gene one polypeptide
- (one) gene is transcribed into (one) mRNA
- mRNA is translated by a ribosome to synthesize a polypeptide
- if the information on a gene is changed/ mutated this may alter the structure of a protein
- genetic information transcribed by eukaryotes is edited before it is translated
- polypeptides may be altered before they become fully functional proteins

4. Living organisms use DNA as their genetic material. Explain how DNA is replicated within the cells of living organisms*8 marks***SL**

- helix is unwound
- two strands are separated
- helicase (is the enzyme that unwinds the helix separating the two strands)
- by breaking hydrogen bonds between bases
- new strands formed on each of the two single strands
- nucleotides added to form new strands
- complementary base pairing
- A to T and G to C
- DNA polymerase forms the new complementary strands
- replication is semi-conservative
- each of the DNA molecules formed has one old and one new strand

5. Explain how the process of DNA replication depends on the structure of DNA.*9 marks***HL**

- DNA molecule is double (stranded)
- hydrogen bonds linking the two strands are weak/ can be broken
- DNA can split into two strands
- split by helicase

- helicase moves progressively down the molecules
- backbones are linked by covalent/ strong bonds
- strands do not therefore break/ base sequence conserved
- reference to semi-conservative replication
- base pairing/ sequences are complementary
- A=T and C=G
- the two original strands therefore carry the same information
- the two new strands have the same base sequence as the two original ones
- the strands have polarity
- base/ nucleotides added in 5` to 3` direction
- the two strands have opposite polarity
- discontinuous segments/ Okazaki fragments added to one strand
- DNA ligase needed to connect the segments

6. Compare the processes of DNA replication and transcription.*9 marks***HL**

- both involve unwinding the helix
- both involve spearating the two strands
- both involve breaking hydrogen bonds between bases
- both involve complementary base pairing
- both involve C pairing with G
- both work in a 5` --> 3` direction
- both involve linking/ polymerization of nucleotides
- replication with DNA nucleotides and transcritpion with RNA nucleotides
- details of ribose/ deoxyribose difference
- adenine pairing with uracil instead of thymine
- only one strand copied not both
- no ligase/ no Okazaki fragments with transcription
- DNA or RNA polymerase
- both require a start signal
- but this signal is different for each
- transcripiton has only one starting point
- but replication has multiple starting points
- replication gives two DNA molecules whilst transcription gives mRNA

7. Describe the roles of mRNA, tRNA and ribosomes in translation.*6 marks***HL**

- mRNA with genetic code/ codons
- tRNA with anticodon

- tRNA with amino acid attached
- ribosome with two sub-units
- mRNA held by ribosome
- start codon
- two tRNA molecules attached with mRNA on ribosome
- peptide bond between amino acids on tRNA
- polypeptide forms
- continues until a stop codon is reached
- polypeptide is released

8. Explain briefly the advantages and disadvantages of the universality of the genetic code to humans.*4 marks***HL**

- genetic material can be transferred between species/ between humans
- one species could use a useful gene from another species
- transgenic crop plants/ livestock can be produced
- bacteria/ yeasts can be genetically engineered to make a useful product
- viruses can invade cells and take over their genetic apparatus
- viruses cause disease

9. Explain how DNA replication is carried out by eukaryotes.*8 marks***HL**

- DNA replication is semi-conservative
- helicase cause the double helix to unwind
- helicase separates the two strands of the DNA molecules
- hydrogen bonds between bases broken to separate the two strands
- DNA polymerase attaches nucleotides
- nucleotides are in the form of deoxynucleoside triphosphates
- complementary base pairing/ A only pairs with T and C with G
- DNA polymerase III can only work in a 5` to 3' direction
- on the lagging/ 3` to 5` strand DNA replication occurs discontinuously
- Okazaki fragments are formed on the lagging/ 3` to 5` strand
- DNA polymerase III cannot start a new chain of nucleotides
- RNA primase inserts a RNA primer
- DNA polymerase I replaces the RNA primer/ nucleotides with DNA
- DNA ligase seals the nicks between the nucleotides

10. State a role for each of four different named enzymes in DNA replication.*6 marks***HL***Award 1 mark for any two of the following up to 2 marks maximum.*

- helicase
- DNA polymerase / DNA polymerase III

- RNA primase
- DNA polymerase I
- (DNA) ligase

Award 1 mark for one function for each of the named enzymes.

helicase

- splits/ breaks hydrogen bonds/ uncoils DNA/ unwinds DNA

(DNA) polymerase III

- adds nucleotides (in 5' to 3' direction)/ proof reads DNA

(RNA) primase

- synthesizes a short RNA primer (which is later removed) on DNA

(DNA) polymerase I

- replaces RNA primer with DNA

(DNA) ligase

- joins Okazaki fragments/ fragments on lagging strand/ makes sugar-phosphate bonds between fragments

11. Explain the process of translation.*9 marks***HL**

- consists of initiation, elongation and termination
- mRNA translated in a 5' to 3' direction
- binding of ribosome to mRNA
- small sub-unit then large
- first/ initiator tRNA binds to start codon/ to small subunit of ribosome
- AUG is the start codon
- second tRNA binds to ribosome
- large subunit moves down mRNA after a second tRNA binds
- amino acid/ polypeptide on first tRNA is transferred/ bonded to amino acid on second tRNA
- peptide bonds between amino acids/ peptidyltransferase
- requires GTP
- movement of ribosome/ small subunit of ribosome down the mRNA
- loss of tRNA and new tRNA binds
- reach a stop codon/ termination
- polypeptide released
- tRNA activating enzymes link correct amino acid to each tRNA
- (activated) tRNA has an anticodon and the corresponding amino acid attached

12. Explain the structure of the DNA double helix, including its subunits and the way in which they are bonded together.*8 marks***HL**

- subunits are nucleotides
- one base, one deoxyribose and one phosphate in each nucleotide
- description/ diagram showing base linked to deoxyribose C1 and phosphate to C6
- four different bases - adenine, cytosine, guanine and thymine
- nucleotides linked up with sugar-phosphate bonds
- covalent/ phosphodiester bonds
- two strands (of nucleotides) linked together
- base to base
- A to T and G to C
- hydrogen bonds between bases
- antiparallel strands
- double helix drawn or described

13. Compare DNA transcription with translation.*4 marks***HL**

- both in 5` to 3` direction
- both require ATP
- DNA is transcribed and mRNA is translated
- transcription produces RNA and translation produces polypeptides/ protein
- RNA polymerase for transcription and ribosomes for translation/ ribosomes in translation only
- transcription in the nucleus (of eukaryotes) and translation in the cytoplasm/ at ER
- tRNA needed for translation but not transcription

14. Outline how a protein combines with DNA to form the eukaryotic chromosome.*4 marks***HL**

- proteins are histones
- eight protein molecules linked/octomeres
- DNA wound around protein
- protein with DNA wrapped around a nucleosome

15. Outline the structure of the nucleosomes in eukaryotic chromosomes.*4 marks***HL**

- contain histones
- eight histone molecules form a cluster in a nucleosome
- DNA strand is wound around the histones
- wound around twice in each nucleosome
- (another) histone molecule holds the nucleosome(s) together

16. Outline how enzymes in the cytoplasm of cells are produced.*8 marks***HL**

- synthsized by ribosomes
- free ribosomes/ribosomes not attached to ER

- mRNA is translated
- mRNA binds to the ribosome
- tRNAs bring amino acids
- anticodon on tRNA binds to codon on mRNA
- formation of peptide linkage
- two tRNAs can bind to the ribosome at once
- growing polypeptide linked to amino acid on tRNA
- ribosome moves on down mRNA
- 5' to 3'
- reference to stop/start codons
- coenzymes added

17. The process of translation involves the use of transfer RNA (tRNA) and amino acids. Outline the structure of tRNA.*5 marks***HL**

- tRNA is composed of one chain of (RNA) nucleotides
- tRNA has a position/end/site attaching an amino acid (*reject tRNA contains an amino acid*)
- at the 3' terminal / consisting of CCA/ACC
- tRNA has an anticodon
- anticodon of **three** bases which are not base paired / single stranded / forming part of a loop
- tRNA has double stranded sections formed by base pairing
- double stranded sections can be helical
- tRNA has (three) loops (somethimes with an extra small loop)
- tRNA has a distinctive three dimensional / clover leaf shape

Accept any of the points above if clearly explained using a suitably labelled diagram

18. Explain the process of translation.*9 marks***HL**

- 5' to 3' (direction of movement along mRNA)
- (small subunit of) ribosome binds to mRNA
- moves along mRNA until it reaches the start codon / AUG / translation starts at AUG
- tRNA binds to ribosome / mRNA
- large subunit binds to small subunit
- two tRNAs bound to ribosome at the same time
- bind of tRNA with anticodon **complementary** to codon on mRNA
- tRNAs carry an amino acid
- anticodon / codon codes for an amino acid
- amino acid linked by a peptide bond to the polypeptide / to another amino acid

- ribosome moves on along the mRNA
- tRNA displaced and another attaches to vacant binding site
- stop codon reached
- polypeptide/protein is released / tRNA and mRNA detached from ribosome
- ribosome splits into (large and small) subunits

Previous IB Exam Essay Questions: Unit 5

Use these model essay question responses to prepare for essay questions on your in class tests, as well as the IB Examination, Paper 2. These questions have appeared on recent IB examinations, exactly as shown below. Following each question is the markscheme answer which was used to evaluate student answers on the examination paper.

1. Explain the similarities and differences in anaerobic and aerobic cellular respiration.*8 marks***SL**

Answers must include both similarities and differences to receive full marks.

- aerobic requires oxygen and anaerobic does not utilize oxygen

similarities:3 max

- both can start with glucose
- both use glycolysis
- both produce ATP/energy(heat)
- both produce pyruvate
- carbon dioxide is produced
- (both start with glycolosis) aerobic leads to Krebs' cycle and anaerobic leads to fermentation

differences:5 maxanaerobic:

- (fermentation) produces lactic acid in humans
- (fermentation produces ethanol and CO2 in yeast
- occurs in cytoplasm of the cell
- recycles NADH (NAD+)

aerobic cellular respiration

- pyruvate transported to mitochondria
- further oxidized to CO2 and water (in Krebs cycle)
- produce a larger amount of ATP (36-38 ATP)/anaerobic produces less ATP (2)
- can use other compounds / lipids / amino acids for energy

4. Draw the structure of a mitochondrion as seen in an electron microscope.*5 marks***HL**

Award 1 mark for each of the following structures clearly drawn and labelled correctly.

- outer membrane
- intermembrane space / outer compartment
- inner membrane
- matrix
- cristae
- ribosome

- naked / circular DNA
- ATP synthase

Do not accept plasma membrane.

5. Explain how the structure of the mitochondrion allows it to carry out its function efficiently.*8 marks***HL**

- membranes to compartmentalise / separate from processes in the cytoplasm
- small size gives large surface are to volume ratio
- large surface area to volume ratio allows rapid uptake / release of materials
- matrix contains enzymes of the Krebs cycle / matrix carries out Krebs cycle
- inner membrane invaginated / infolded / forms cristae to increase the surface area
- large surface area gives more space for electron transport chain / oxidative phosphorylation
- inner membrane contains ATP synthetase / ATPase / stalked particles that make ATP
- (narrow) gap between inner and outer membranes / intermembrane space (*must be stated or labeled*)
- pH / H+ / proton concentration gradient rapidly established / steeper
- chemiosmosis therefore more efficient / chemiosmosis can occur
- inner membrane contains the electron transport pathway
- DNA present to act as genetic material
- ribosomes for protein synthesis
- some proteins do not need to be imported

6. Outline the process of glycylosis. *5 marks***HL**

- glucose/hexose/6C sugar converted to form pyruvate
- splitting of hexose (phosphate) / lysis
- oxidation of triose phosphate
- net gain of 2 NADH (+ H+) / reduced NAD
- net gain of 2 ATP
- substrate level phosphorylation
- occurs in cytoplasm of cell
- no O2 required
- under feedback control / inhibition

7. Explain the reactions that occur in the matrix of the mitochondrion that are part of aerobic respiration.*8 marks***HL**

- pyruvate is decarboxylated/ CO2 removed
- link reaction/ pyruvate combined with CoA/ ethanoyl/acetyl CoA formed
- pyruvate is oxidized/ hydrogen removed

- reduction of NAD/ formation of NADH + H+
- whole coversion called oxidative decarboxylation
- Krebs cycle
- C2 + C4 ---> C6
- C6 ---> C5 giving off CO2
- C5 ---> C4 giving off CO2
- hydrogen atoms removed collected by hedrogen-carrying coenzymes
- ATP formed by substrate level phosphorylation
- oxygen accepts electrons/ oxygen combines with hydrogen
- total yield perturn of Krebs cycle = 2 CO2,, 3 NADH + H+, 1 FADH2, 1 ATP (directly produced)

8. Explain the process of aerobic respiration.*8 marks***HL**

- by glycolysis, glucose is broken down into pyruvate (two molecules) in the cytoplasm
- with a small yield of ATP/ net yield of 2 ATP
- and NADH + H+/ NADH
- aerobic respiration in the presence of oxygen
- pyruvate converted to acetyl CoA
- by oxidative decarboxylation / NADH and CO2 formed
- fatty acids / lipids converted to acetyl CoA
- acetyl groups enter the Krebs cycle *(accept acetyl CoA)*
- Krebs cycle yields a small amount of ATP/ one ATP per cycle
- and FADH2/ FADH + H+/ NADH /NADH + H+/ reduced compounds/ electron collecting molecules
- these molecules pass electrons to electron transport chain *(reject donates H+)*
- oxygen is final electron acceptor/ water produced
- electron transport chain linked to creation of an electrochemical gradient
- electrochemical gradient/ chemiosmosis pwers creation of ATP
- through ATPase/synthase/synthetase

Accept any appropriate terminology for NAD and FAD.

9. Outline the role of oxygen in providing cells with energy.*6 marks***HL**

(Award 1 mark for any of the below; up to 6 marks max.)

- needed for aerobic (but not anaerobic) resp./simple equation for aerobic resp.
- used in oxidative phosphorylation
- oxygen accepts electrons at the end of the ETC
- also accepts protons to form water / water formed using oxygen
- allows more electrons along the ETC

- allows NAD to be regenerated / reduced NAD to be oxidised
- allows ATP production
- allows a high yield of ATP from glucose in respiration / 32-38 instead of 2

10. Explain the formation of ATP by chemiomosis in cellular respiration.*8 marks***HL**

Credit can be given for any of these points shown on a correctly drawn and labelled diagram.

- occurs in mitochondria
- oxidative phosphorylation
- electrons passed along carriers/electron transport chain
- carriers in *inner* mitochondrial membrane/ cristae
- energy from electrons used to pump protons/ H+ into intermembrane space
- proton/H+ (concentration) gradient formed
- ATPase/synthase in inner membrane
- movement of proton/H+ down concnetration gradient through ATPase/synthase
- rotation of (head of) ATPase/synthase
- energy released produces ATP
- by phosphorylating ADP/ADP + Pi --> ATP
- oxygen is terminal (electron) acceptor (plus H+ to make water)

11. Describe the central role of acetyl (ethanoyl) CoA in carbohydrate and fat metabolism.*5 marks***HL**

- acetyl CoA enters Krebs cycle
- glucose / carbohydrates converted to pyruvate in glycolysis
- pyruvate enters mitochondria
- pyruvate converted to acetly CoA
- by oxidative decarboxylation / hydrogen and CO2 removed
- fats enter mitochondria
- fats oxidised to acetyl CoA / oxidation of fatty acids / fats converted to acetyl CoA

Previous IB Exam Essay Questions: Unit 6: Photosynthesis

Use these model essay question responses to prepare for essay questions on your in class tests, as well as the IB Examination, Paper 2. These questions have appeared on recent IB examinations, exactly as shown below. Following each question is the markscheme answer which was used to evaluate student answers on the examination paper.

1. Explain the similarities and differences in anaerobic and aerobic cellular respiration.*8 marks***SL**

Answers must include both similarities and differences to receive full marks.

- aerobic requires oxygen and anaerobic does not utilize oxygen

similarities:3 max

- both can start with glucose
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- (fermentation) produces lactic acid in humans
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- recycles NADH (NAD+)

aerobic cellular respiration

- pyruvate transported to mitochondria
- further oxidized to CO2 and water (in Krebs cycle)
- produce a larger amount of ATP (36-38 ATP)/anaerobic produces less ATP (2)
- can use other compounds / lipids / amino acids for energy

2. Outline the effect of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis.*6 marks***SL**

light:

- rate of photosynthesis increases as light intensity increases
- photosynthetic rate reaches plateau at high light levels

CO2:

- photosynthetic rate reaches plateay at high light levels
- up to a maximum when rate levels off

temperature:

- rate of photosynthesis increases with increase in temperature
- up to optimal level / maximum
- high temperatures reduce the rate of photosynthesis

Some of the above points may be achieved by means of ***annotated*** *diagrams or graphs.*

3. Explain how the rate of photosynthesis can be measured. *7 marks* **SL**

- $CO_2 + H_2O \rightarrow (CH_2O)_n + O_2$/ suitable photosynthesis equation
- amount of CO_2 absorbed (per unit time) can be measured
- increase in biomass (per unit time) can be measured
- O_2 excretion (per unit time) can be measured

methods for measuring the above:

- volume of O_2 (bubbles) produced per unit time can be measured
- dry mass can be measured
- increase in starch concentration in leaves (as measured by iodine)
- use of pH indicator can monitor CO_2 uptake in water
- the rate of photosynthesis measured is relative because some of the CO_2 is produced by the plant internally through respiration
- the rate of photosynthesis measured is relative because some of the carbohydrates are used internally by the plan for respiration

4. Draw the structure of a mitochondrion as seen in an electron microscope. *5 marks* **HL**

Award 1 mark for each of the following structures clearly drawn and labelled correctly.

- outer membrane
- intermembrane space / outer compartment
- inner membrane
- matrix
- cristae
- ribosome
- naked / circular DNA
- ATP synthase

Do not accept plasma membrane.

5. Explain how the structure of the mitochondrion allows it to carry out its function efficiently. *8 marks* **HL**

- membranes to compartmentalise / separate from processes in the cytoplasm
- small size gives large surface are to volume ratio
- large surface area to volume ratio allows rapid uptake / release of materials
- matrix contains enzymes of the Krebs cycle / matrix carries out Krebs cycle
- inner membrane invaginated / infolded / forms cristae to increase the surface area
- large surface area gives more space for electron transport chain / oxidative phosphorylation
- inner membrane contains ATP synthetase / ATPase / stalked particles that make ATP

- (narrow) gap between inner and outer membranes / intermembrane space (*must be stated or labeled*)
- pH / H+ / proton concentration gradient rapidly established / steeper
- chemiosmosis therefore more efficient / chemiosmosis can occur
- inner membrane contains the electron transport pathway
- DNA present to act as genetic material
- ribosomes for protein synthesis
- some proteins do not need to be imported

6. Outline the process of glycylosis. *5 marks***HL**

- glucose/hexose/6C sugar converted to form pyruvate
- splitting of hexose (phosphate) / lysis
- oxidation of triose phosphate
- net gain of 2 NADH (+ H+) / reduced NAD
- net gain of 2 ATP
- substrate level phosphorylation
- occurs in cytoplasm of cell
- no O2 required
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7. Explain the reactions that occur in the matrix of the mitochondrion that are part of aerobic respiration.*8 marks***HL**

- pyruvate is decarboxylated/ CO2 removed
- link reaction/ pyruvate combined with CoA/ ethanoyl/acetyl CoA formed
- pyruvate is oxidized/ hydrogen removed
- reduction of NAD/ formation of NADH + H+
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- C2 + C4 ---> C6
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8. Explain the process of aerobic respiration.*8 marks***HL**

- by glycolysis, glucose is broken down into pyruvate (two molecules) in the cytoplasm

- with a small yield of ATP/ net yield of 2 ATP
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- these molecules pass electrons to electron transport chain *(reject donates H+)*
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- electron transport chain linked to creation of an electrochemical gradient
- electrochemical gradient/ chemiosmosis pwers creation of ATP
- through ATPase/synthase/synthetase

Accept any appropriate terminology for NAD and FAD.

9. Outline the role of oxygen in providing cells with energy.*6 marks***HL**

(Award 1 mark for any of the below; up to 6 marks max.)

- needed for aerobic (but not anaerobic) resp./simple equation for aerobic resp.
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- oxygen accepts electrons at the end of the ETC
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- allows NAD to be regenerated / reduced NAD to be oxidised
- allows ATP production
- allows a high yield of ATP from glucose in respiration / 32-38 instead of 2

10. Explain the formation of ATP by chemiomosis in cellular respiration.*8 marks***HL**

Credit can be given for any of these points shown on a correctly drawn and labelled diagram.

- occurs in mitochondria
- oxidative phosphorylation
- electrons passed along carriers/electron transport chain
- carriers in *inner* mitochondrial membrane/ cristae
- energy from electrons used to pump protons/ H+ into intermembrane space
- proton/H+ (concentration) gradient formed
- ATPase/synthase in inner membrane

- movement of proton/H+ down concnetration gradient through ATPase/synthase
- rotation of (head of) ATPase/synthase
- energy released produces ATP
- by phosphorylating ADP/ADP + Pi --> ATP
- oxygen is terminal (electron) acceptor (plus H+ to make water)

11. Describe the central role of acetyl (ethanoyl) CoA in carbohydrate and fat metabolism.*5 marks***HL**

- acetyl CoA enters Krebs cycle
- glucose / carbohydrates converted to pyruvate in glycolysis
- pyruvate enters mitochondria
- pyruvate converted to acetly CoA
- by oxidative decarboxylation / hydrogen and CO2 removed
- fats enter mitochondria
- fats oxidised to acetyl CoA / oxidation of fatty acids / fats converted to acetyl CoA

12. Explain the role of water in photosynthesis.*4 marks***HL**

- water is a substrate / reactant / raw material / for photosynthesis / equation for photosynthesis
- water is a source of electrons
- to replace those lost by chlorophyll / photosystem II
- water is a source of H+ needed to produce NADPH + H
- photolysis / splitting / breaking of water
- water for non-cyclic photophosphorylation / ATP production
- water is transparent so photosynthesis can take place underwater / light can penetrate to chloroplasts

13. Explain photophosphorylation in terms of chemiosmosis.*8 marks***HL**

- chemiosmosis is synthesis of ATP coupled to electron transport and proton movement
- photophosphorylation is the production of ATP with energy from light
- light energy causes photolysis/splitting of watter
- electrons energized (from chlorophyll)/photoactivation
- photolysis provides (replacement) electrons for those lost from excited chlorophyll
- photolysis provides protons/H+ (for thylakoid gradient)
- electron transport (carriers on membrane of thylakoid)
- causes pumping of protons/H+ across thylakoid membrane/ into thylakoid space
- protons/H+ accumulate in thylakoid space/proton gradient set up
- protons/H+ move down concentration gradient
- into stroma

- flow through ATPase/synthetase
- leading to ATP formation

14. Outline the light-independent reactions of photosynthesis.*8 marks***HL**

Award 1 mark for any of the below; up to a maximum of 8 marks)

- reactions take place in the stroma
- carbon dioxide reacts with RuBP
- catalysed by RuBP carboxylase
- GP formed
- GP converted to triose phosphate
- reduction reaction involving use of NADPH + H+
- energy from ATP also needed from this conversion
- triose phosphate converted to glucose(phosphate)/starch
- RuBP regenerated from triose phosphate
- Calvin cycle

15. Explain why the light-independent reactions of photosynthesis can only continue for a short time in darkness.*6 marks***HL**

Award 1 mark for any of the below; up to a maximum of 6 marks)

- light independent reaction involve ATP/NADPH + H+ / intermediates which are made in light dependent reactions
- supply of ATP/NADPH + H+ / intermediates used up / runs out in the dark
- ATP **and** NADPH + H+
- GP therefore not reduced / converted to triose phosphate
- RuBP therefore not regenerated
- carbon dioxide fixation therefore stops
- GP accumulates
- stomata close in the dark
- carbon dioxide is therefore not absorbed

16. Explain how the light-independent reactions of photosynthesis rely on light-dependent reactions.*8 marks***HL**

- light-independent reaction fixes CO2
- to make glycerate 3-phosphate
- to triose phosphate / phosphoglyceraldehyde /glyceraldehyde 3-phosphate
- using NADPH
- ATP needed to regenerate RuBP
- ATP is made in light-dependent reactions
- light causes photoactivation / excitation of electrons

- flow of electrons causes pumping of protons into thylakoid membrane
- electrons are passed to NADP/NADP+
- NADPH produced in the light dependent reactions

17. Explain the reactions involving the use of light energy that occur in the thylakoids of the chloroplast.*8 marks***HL**

- chlorophyll / photosystem absorbs light
- electron raised to higher energy level / photoactivated
- splitting of water/photolysis replaces electron
- passing of excited electrons between chlorophyll molecules in photosystems
- electron passed from photosystem II to carriers (in thylakoid membrane)
- production of ATP in this way is called photophosphorylation
- electron causes pumping of protons into the thylakoid
- proton gradient used by ATPase to drive ATP production
- electron passes to photosystem I at end of carrier chain
- electron re-excited and emitted by photosystem I
- electron passed to / used to reduce NADP+
- NADPH + H+ / reduced NADP produced
- cyclic photophosphorylation using photosystem I electron and ATPase only

Accept any of the above points if clearly drawn and correctly labelled in a diagram.

18 Outline the formation of carbohydrate molecules in photosynthesis starting from the absorption of light energy.*6 marks***HL**

light-dependent reaction: 3 max

- chlorophyll absorbs light (energy)/photons
- electron activated/excited
- electron passed down electron carriers
- ATP produced
- NADP+ reduced/ reduced NADP produced/ NADPH produced

light-independent reaction: 3 max

- CO2 fixed by/reacts with 5C molecule (RuBP)
- rubisco/ribulosebisphosphate carboxylase/RuBP carboxylase catalyses reaction
- (two) 3C molecules/ glycerate 3-phosphate/GP produced
- reduced NADP and ATP used to reduce glycerate 3-phosphate/GP
- triose phosphate/TP produced

19. Compare the structure of a chloroplast and a mitochondrion in relation to function.*8 marks***HL**

similarities:

- both are double membrane organelles
- both contain DNA
- both contain ribosomes
- both have an electron transport chain
- both produce ATP by chemiomosis
- both contain ATP synthase /ATPase
- *3 max for labelled diagrams without the similarities stated*

chloroplast:

- site of photosynthesis
- third membrane system / thylakoid membranes
- photosynthetic pigments/chlorophyll to absorb light
- light generated ATP production
- H+ gradient across thylakoid membrane

mitochondrion:

- site of respiration
- ATP production by oxidation of organic molecules / fats / amino acids
- H+ gradient across inner membrane

Previous Exam Essay Questions: Unit 7
Biology IB HL 1

Previous IB Exam Essay Questions: Unit 7

Use these model essay question responses to prepare for essay questions on your in class tests, as well as the IB Examination, Paper 3. These questions have appeared on recent IB examinations, exactly as shown below. Following each question is the markscheme answer which was used to evaluate student answers on the examination paper.

1. Define the terms *gene* and *allele* and explain how they differ. *4 marks*

- gene is a heritable factor / unit of inheritance
- gene is composed of DNA
- gene controls a specific characteristic / codes for a polypeptide / protein
- allele is a form of a gene
- alleles of a gene occupy the same gene locus / same position on chromosome
- alleles differ (from each other) by one / a small number of bases(s)/ base pair(s)

2. Describe the consequences of a base substitution mutation with regards to sickle cell anemia. *7 marks*

- the sequence of nucleotide bases in DNA codes for the sequence of amino acids in proteins
- DNA is transcribed into mRNA, which is translated into amino acids of protein
- normal (ß chain) hemoglobin gene / DNA produces normal (ß chain) hemoglobin protein / amino acids
- substitution= the replacement of one (or more) nucleotide base with another
- caused by a copying mistake during DNA replication
- as a result of a mutagen / X-rays / chemical / UV radiation / other mutagen

- mutation in normal (ß chain) hemoglobin gene alters the sequence of nucleotide bases
- normal nucleotide sequence = CTC altered to CAC
- resulting in altered mRNA (GAG to GUG) during transcription
- resulting in altered sequence of amino acids in (ß chain) hemoglobin protein (glutamic acid to valine) during translation
- causing red blood cells to change shape / sickle under low oxygen conditions
- causing sickle cells anemia when two copies of the mutated gene are inherited
- producing a sickle cell carrier when one copy of the mutated gene is inherited
- sickle cells anemia reduces oxygen flow to organs, leading to their deterioration

3. Outline how the process of meiosis can lead to Down's syndrome.*4 marks*

- in metaphase homologs in ceter of cell / spindles attached
- homologs are separating
- one pair doesn't separate / non-disjunction
- in telophase cells divide into two
- cells have either one more / one less chromosome
- can occur in second division of meiosis
- sister chromatids fail to separate
- fertilization with one gamete / sperm / egg carrying extra chromosome
- Down's syndrome is trisomy of chromosome 21

4. Karyotyping involves arranging the chromosomes of an individual into pairs. Describe one application of this process, including the way in which the chromosomes are obtained.*5 marks*

application of karyotyping {2 max}

- find gender / test for Down's syndrome / other chromosome abnormality
- identify sex chromosomes / numbers of chromosome 21 / other chromosomes counted
- XX = female and XY = male / third chromosome 21 indicates Down's syndrome / other chromosome abnormality (e.g. Klinefelter's syndrome)

obtaining chromosomes {3 max}

- fetal cells obtained from amniotic fluid / amniocentesis / other named source
- white blood cells obtained
- cells encouraged to divide
- cells accumulated / blocked in metaphase
- prepare slide / chromosomes examined

5. Compare the processes of mitosis and meiosis.*6 marks*

answers must be pair-wise comparisons to receive any marks.

- Mitosis: one cell division **&** Meiosis: two divisions / reduction division

- Mitosis: chromosome number does not change **&** Meiosis: converts diploid to haploid cells
- Mitosis: products genetically identical **&** Meiosis: products genetically diverse
- Mitosis: separation of sister chromatids in anaphase **&** Meiosis: separation of homologous chromosomes in anaphase I and sister chromatids in anaphase II
- Mitosis: no crossing over **&** Meiosis: crossing over in prophase I
- Mitosis: no formation of tetrads / no synapsis **&** Meiosis: formation of tetrads / synapsis
- Mitosis: produce cells for growth/repair/asexual reproduction **&** Meiosis: produce sexual cells / gametes for sexual reproduction
- Mitosis: two cells produced **&** Meiosis: four cells produced
- Mitosis: daughter cells with both copies of chromosomes/random assortment does not occur **&** Meiosis: random assortment of maternal/ paternal chromosomes
- Mitosis: replication of DNA in interphase **&** Meiosis: replication of DNA in interphase I
- Mitosis: four phases: prophase, metaphase, anaphase, telophase**&** Meiosis: same four phases twice

6. Outline one example of inheritance involving multiple alleles.*5 marks*

- multiple alleles means a gene has three or more alleles / more than two alleles
- ABO blood groups / other named example of multiple alleles
- ABO gene has three alleles / equivalent for other example
- IA IB and i shown (at some point in the answer) / equivalent for other example

accept other notation for alleles if clear

- any two of these alleles are present in an individual
- homozygous and heterozygous genotye with phenotypes (shown somewhere)
- all six genotypes with phenotypes given (shown somewhere)
- example / diagram of a cross involving all three alleles

7. Describe the inheritance of ABO blood groups including an example of the possible outcomes of a homozygous blood group A mother having a child with a blood group O father.*5 marks*

- example of co-dominance
- multiple alleles / 3 alleles
- (phenotype) O has (genotype) ii
- B can be IB IB or IB i
- A can be IA IA or IA i
- AB is IA IB
- (P are) i i x IA IA
- (gametes) i and IA
- (F1 genotype) IA i

- (F1 phenotype) blood group A

accept other notations if used consistently and if phenotype and genotype are clearly distinguished

8. Outline sex linkage.*5 marks*

- gene carried on sex chromosome / X chromosome / Y chromosome
- inheritance different in males than in females
- males have only one X chromosome therefore, only one copy of the gene
- mutation on Y chromosome can only be inherited by males
- women can be carriers if only one X chromosome affected
- example of sex linked characteristics (e.g. hemophilia / color blindness)
- example of cross involving linkage

9. Explain, using a named example, why many sex-linked diseases occur more frequently in men than women.*9 marks*

- named example of sex-linked disease
- caused by recessive allele
- on the X chromosome
- example of pair of alleles (e.g. X H and X h) *(reject if alleles do not correspond)*
- females are XX and males are XY
- females have two alleles of the gene and males have only one
- allele causing the disease is rare / uncommon
- probability of femles inheriting rare allele twice as low
- calculation of squaring the gene frequency
- female would have to inherit the allele from her father
- who would have suffered from the disease
- so females can carry the gene but still be normal
- but males (with the gene) will have the disease

Previous IB Exam Essay Questions: Unit 8
Biology IB HL 1

1. Calculate and predict; genotypic and phenotypic ratios of offspring of dihybrid crosses involving unlinked autosomal genes.*HL only*

```
P:AaBb      x      AaBb
                                  (genotypic ratios)
                       F1:     1: AABB     2: AaBB     1: aaBB
                               2: AABb     4: AaBb     2: aaBb
                               1: AAbb     2: Aabb     1: aabb
                                  (phenotypic ratios)
                       F1:     9: dominant - dominant
                               3: dominant - recessive
                               3: recessive - dominant
                               1: recessive - recessive
```

2. Identify which of the offspring in dihybrid crosses are recombinants.*HL only*

Recombination = the reassortment of alleles into combinations different from those of the parents as a result of:

- independent assortment
- crossing over
- fertilization.

Parents:	Aabb	x	aaBb
Offspring:	Aabb	parental	
	aaBb	parental	
	AaBb	recombinant	
	aabb	recombinant	

3. Outline the process of DNA profiling (genetic fingerprinting), including ways in which it can be used.*6 marksSL and HL*

- sample of DNA obtained / leucocytes / from mouthwash / hair / other named source
- satellite DNA / repetitive sequences used for profiling
- amplification of DNA by polymerase chain reaction / PCR
- cutting DNA into fragments using restriction enzymes
- separation of fragments of DNA (by electrophoresis)
- separation according to the length of the fragments
- pattern of bands obtained / different pattern of bands with DNA from different individuals
- used for criminal investigations / example of use in criminal investigation
- used to check paternity / who is the father / mother / parent
- used to check whether two organisms are clones

4. Outline DNA profiling (genetic fingerprinting), including one way in which it has been used.*5 marksSL and HL*

DNA profiling: 4 max

- sample of DNA / blood / saliva / semen is obtained
- reference samples of DNA are obtained
- PCR used to amplify / produce more copies of the DNA
- DNA broken into fragments by restriction enzymes
- DNA fragments are separated by gel electrophoresis
- DNA separated into a series of bands
- bands compared between different samples
- if pattern of bands is the same then DNA is (almost certainly) from same source
- if some bands are similar then individuals are (almost certainly) related

specific example: 1 max

- testing of paternity / forensics / classification / archeology / another specific example

5. Outline a technique for transferring genes between species.*5 marksSL and HL*

- gene of interest is cut out
- with restriction enzyme
- RNA used to produce DNA
- using reverse transcriptase
- plasmid cut open with same restriction enzyme

- gene inserted into plasmid
- blunt ends / sticky ends
- spliced together by DNA ligase
- recombinant plasmids are cloned / many copies produced
- recombinant plasmids are inserted into new host cells / virus / bacteriophage / yeast
- inserted by shooting / spraying / microencapsulation / by heat treatment

6. Describe the technique for the transfer of the insulin gene using *E. coli*.*6 marksSL and HL***

- mRNA is extracted
- DNA copy of RNA is made using reverse transcriptase
- plasmids are cut open with endonucleases (at specific sequences)
- insulin gene and plasmid are mixed together
- addition of 'sticky ends' to the DNA copy (so that it will combine with the cut plasmid)
- DNA ligase will seal the plasmid
- recombinant plasmid is inserted into *E. coli*
- *E. coli* is cultured
- *E. coli* begins to make insulin

7. Discuss the potential benefits and possible harmful effects of genetic modification.*7 marksSL and HL*

- named example of desired outcome *e.g.* herbicide resistance

Award 6 max if no named example given. Award 5 max if both possible benefits and possible harmful effects are not addressed.

Possible benefits: 4 max

- benefits include more specific (less random) breeding than with traditional methods
- faster than traditional methods
- some characteristics from other species are unlikely in the gene pool / selective breeding cannot produce desired phenotype
- increased productivity of food production / less land required for production
- less use of chemical (*e.g.* pesticides)
- food production possible in extreme conditions
- less expensive drug preparation
- *e.g.* pharmaceuticals in milk
- human insulin engineered so no allergic reactions
- may cure genetic diseases

Possible harmful effects: 4 max

- some gene transfers are regarded as potentially harmful to organism (especially animals)
- release of genetically engineered organisms in the environment

- can spread and compete with the naturally occurring varieties
- some of the engineered genes could also cross species barriers
- technological solution when less invasive methods may bring similar benefits
- reduces genetic variation / biodiversity

8. Discuss the ethical arguments for and against the cloning of humans.*4 marksSL and HL*

arguments against cloning: 3 max

- reduces the value / dignity of the individual / causes psychological problems
- high miscarriage rates / cloned individuals are likely to have developmental disorders / health problems / cloned individuals may show premature aging
- costly process and money could be better spent on other types of healthcare
- cloning may be done for inappropriate motives / replace lost loved one / perfect race etc.

arguments for cloning: 3 max

- identical twins are formed by cloning so it is a natural process
- cloned embryos can be tested for genetic disease / genetic screening
- increased chance of children for infertile couples
- cloning research may lead to spin-offs for other research areas such as cancer / transplant research / regeneration research

9. Outline the ethical issues of cloning humans.*6 marksSL and HL*

- clones are genetically identical individuals / cell lines / tissues

risks to society

- cloning mammals is expensive / allocation of resources
- cloning could lead to copying selected individuals / equity concerns
- could lead to uncontrolled / unethical eugenics

risks to individuals

- many cloned animals die soon after birth / die for complications / premature aging of clones
- cloned humans could experience identity crises / problems in psychological development
- reduction of human dignity
- cloned tissues will still possess genetic diseases
- risk for unknown consequences too great

belief systems

- artificial cloning in humans is opposed by some as being unnatural / against their religion
- cloning occurs naturally when identical twins form

benefits

- cloning humans may help to provide tissues / organs for transplantation

- research in cellular mechanisms / developmental biology / possible medical breakthroughs

Previous IB Exam Essay Questions: Unit 9
Biology IB HL 1

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1. Draw a labeled diagram of the reproductive system of a human female.*6 marksSL/HL*

*Award **1** for each of the following structures, clearly labeled and drawn in the correct position relative to the other organs.*

- ovary
- oviduct / fallopian tube
- uterus
- cervix
- vagina
- vulva / labia
- clitoris
- endometrium

2. Draw a labeled diagram of an adult male reproductive system.*6 marksSL/HL*

*Award **1** for each of the following structures clearly drawn and correctly labeled. Connections between organs must be correct for full marks.*

- penis
- scrotum
- prostate gland
- sperm duct
- urethra / urinary tract
- seminal vesicle
- bladder
- testes
- epididymis
- sperm duct / Vas deferens
- Cowper's gland
- seminiferous tubules
- erectile tissue

3. Explain the hormonal control of puberty in boys.*5 marksSL/HL*

- LH levels rise and stimulate more testosterone production
- testosterone levels are very low before puberty
- testosterone levels rise during puberty
- testosterone causes puberty / secondary sexual characteristics
- testosterone has many target organs and response
- example of target organs and response
- ref to sequence of changes being related to level of testosterone needed
- testosterone stimulates sperm production
- FSH levels rise and cause sperm maturation

4. Explain the processes involved in oogenesis in humans.*9 marksHL*

- mitosis used to produce many / 100 000s of cells
- so that the ovaries never run out of cells for use in oogenesis
- oogonia / cells must grow to a size large enough for meiosis
- growth involves accumulation of yolk / food reserves in cytoplasm
- replication of DNA is necessary before meiosis
- (first division of) meiosis needed to halve the chromosome number
- chromosome number must be halved as fertilization will double it
- first meiotic division takes place just before ovulation
- meiosis gives rise to genetically different cells
- variation needed for evolution
- second meiotic division occurs after fertilization
- division of cytoplasm is unequal
- because oocyte / egg needs a large amount of cytoplasm
- yolk / food reserves needed by developing zygote / embryo
- polar bodies / cells receiving little cytoplasm degenerate
- because only small numbers of female gametes are needed
- because humans only produce one / few babies at a time

5. Explain oogenesis.*5 marksHL*

- mitosis multiplies the germ cells to produce oogonia
- cell volume increased / cell grows (after mitosis) (oogonium to primary oocyte)
- meiosis
- unequal division of cytoplasm during meiotic divisions
- small polar bodies formed and break down *(accept three polar bodies formed)*
- one haploid egg formed per meiosis
- oogenesis begins in the fetal ovary of the girl and it is only totally completed at fertilization

6. Draw the structure of a mature human egg.*HL4 marks*

Award 1 mark for each structure accurately drawn and correctly labeled.

- haploid nucleus
- centrioles
- cytoplasm (must show large volume relative to nucleus: minimum 4:1 diameter)
- polar body (must be drawn outside of egg cell)
- plasma membrane
- follicle cells / corona radiata

- cortical granules (must be drawn in vicinity of plasma membrane)
- zonapellucida

7. Explain the role of hormones in the regulation of the menstrual cycle in human females.*8 marksSL/HL*

- FSH and LH are produced by the pituitary
- estrogen and progesterone are produced by the ovary
- FSH stimulates the ovary to produce a follicle
- developing follicles secrete estrogen
- estrogen inhibits FSH / negative feedback
- estrogen stimulates growth of endometrium / uterine lining
- estrogen stimulates LH secretion / positive feedback
- LH stimulates ovulation
- follicle becomes corpus luteum
- corpus luteum secretes estrogen and progesterone
- estrogen and progesterone maintain the lining of the uterus / endometrium
- estrogen and progesterone inhibit LH and FSH / negative feedback
- after two weeks corpus luteum degenerates
- ovarian hormone levels / progesterone / estrogen fall
- menstrual bleeding begins / lining of uterine wall / endometrium lost

Credit marking points above for a clearly drawn and correctly labeled diagram or flow chart.

8. Outline the levels of each of the hormones that control the menstrual cycle immediately before ovulation.*SL/HL3 marks*

(An answer in graphical form is also acceptable)

- LH levels very high / LH surge
- FSH levels are high
- estrogen levels are high
- progesterone levels are very low

9. Explain the roles of LH and FSH in the menstrual cycle, including the timing of their secretion during the cycle.*6 marksSL/HL*

- FSH is secreted at the start of the cycle / early in the cycle / days 1 to 5 / when progesterone / estrogen is low
- FSH stimulates follicle development
- FSH stimulates secretion of estrogen (by the follicle / ovary)
- LH is secreted in the middle of the cycle / before ovulation / days 10 to 14
- LH stimulates ovulation
- LH stimulates the development of the corpus luteum

- LH stimulates less estrogen
- more progesterone secretion / high progesterone / estrogen inhibits FSH and LH release

10. Draw a labeled diagram of the structure of an ovary as seen using a light microscope.*HL5 marks*

- developing oocytes
- primary oocyte
- zonapellucida
- mature / Graafian follicle
- secondary oocyte
- corpus luteum
- corpus albacans
- egg being released / site of ovulation
- outer layer of germ cells / germinal epithelium
- medulla
- stroma
- region where blood vessels enter and leave

11. Draw the structure of the human female reproductive system immediately before ovulation. (Only the ovaries, oviducts and uterus need to be shown.)*6 marksSL/HL*

(The word 'immediately' can be interpreted broadly - but answers correctly justified will be acceptable)

- two ovaries shown with oval shape
- follicle containing oocyte in one ovary (or both ovaries)
- Graafian follicle
- funnel of oviduct close to follicle
- oviduct shown as a narrow tube connecting ovary and uterus
- uterus shown either in side or front view
- thickened uterus lining / endometrium shown

12. Describe the process of spermatogenesis.*8 marksHL*

- mitosis
- in the germ layer / germinal epithelium
- spermatogonia produced
- mitosis to allow many cells to be produced / continuous cell production
- cell growth
- enlarged cells are primary spermatocytes
- meiosis
- diploid to haploid

- two divisions of meiosis
- secondary spermatocytes produced by first division / carry out second division
- spermatids formed by (second division of) meiosis
- differentiation into spermatozoa / mature sperm cells
- growth of a tail / acrosome / other feature
- ref to role of Sertoli cells

13. Production of semen involves a series of processes, which in total take many weeks to carry out. Outline the processes involved in semen production from the start of sperm formation (spermatogenesis) to ejaculation.*8 marksHL*

- cell division by mitosis to form more cells / spermatogonia
- growth of cells / spermatogonia to form larger calls / primary spermatocytes
- cells / primary spermatogonia divide by meiosis
- haploid cells / spermatids formed
- differentiation of haploid cells / spermatids into sperm
- growth of tail / other feature of differentiation
- FSH, testosterone and LH all needed for spermatogenesis
- sperm stored / maturation in epididymis / gain motility
- fluid added to sperm by seminal vesicle (during ejaculation)
- fluid from seminal vesicle contains nutrients / mucus
- fluid added to sperm by prostate gland (during ejaculation) / fluid from prostate gland contains alkali / minerals

14. Compare the process of spermatogenesis and oogenesis.*7 marksHL*

- both involve meiosis
- both involve cell proliferation / mitosis (before meiosis)
- both involve cell growth /enlargement (before meiosis)
- LH /FSH involved in both
- spermatogenesis starts at puberty versus oogenesis starts in the fetus
- spermatogenesis until death versus oogenesis until menopause
- millions of sperm versus one egg per month
- ejaculation of sperm any time versus ovulation in middle of menstrual cycle
- four sperm per meiosis / spermatogenesis versus 2 or 3 polar bodies in oogenesis
- spermatogenesis involves equal divisions versus oogenesis involves unequal cell / cytoplasm divisions
- no polar bodies in spermatogenesis versus 2 or 3 polar bodies in oogenesis
- spermatogenesis involves Sertoli / nurse cells versus oogenesis does not
- meiosis II completed before fertilization in spermatogenesis versus after in oogenesis

- testosterone needed for spermatogenesis versus not needed for oogenesis

15. Discuss how, in humans, a larger number of sperms are produced than eggs.*4 marksHL*

- more germ cells in testes than ovary / more germinal epithelium
- all four products of meiosis become sperm versus one only becoming an egg
- continuous sperm production versus monthly egg production
- early stages of oogenesis only in the fetus so finite number of cells for oogenesis
- reference to progesterone inhibiting FSH secretion and thus egg production
- no eggs produced during pregnancy
- eggs not produced after menopause

16. Describe the process of fertilization in humans.*8 marksHL*

- sperm approaches ovum in oviduct
- sperm attaches to receptors in zonapellucida
- acrosome reaction /release of enzymes by exocytosis
- hyaluronidase / other named enzyme
- zonapellucida enzymatically broken down
- many sperm needed to allow one to penetrate
- membrane of sperm fuses with oocyte membrane
- fast block to polyspermy / depolarization of oocyte / sodium gates open
- head / sperm nucleus / sperm penetrates the egg membrane
- cortical reaction / cortical granules released / lysosomes release enzymes
- slow block to polyspermy / zonapellucida glycoproteins cross-link / harden
- so additional sperm can't enter
- male nucleus swells
- secondary oocyte completes meiosis II

17. Describe the development of the early human embryo.*SL/HL5 marks*

- fertilization in the oviduct / fallopian tube
- fertilized egg is a zygote / diploid single cell
- cleavage after zygote formation
- cleavage divisions reduce quantity of cytoplasm per cell / no increase in overall size of embryo
- cilia propel embryo along oviduct
- rapid mitosis leads to morula / ball of cells
- blastocyst / hollow ball of cells forms
- implantation of blastocyst in the lining of uterine wall / endometrium
- implantation occurs up to seven days after fertilization

- chorionic villi penetrate the lining of uterine wall / endometrium

Credit marking points above for a clearly drawn and correctly labeled diagram or flow chart.

18. Outline the regulation of pregnancy by two named hormones.*4 marksHL*

Award 1 mark for each named hormone and one mark for its correct function.

- estrogen
- builds up uterine lining / endometrium / prevents ovulation
- progesterone
- maintains uterine lining / endometrium / prevents ovulation / pregnancy ends when progesterone drops / prevents contractions of uterus
- HCG
- maintains / stimulates growth of corpus luteum
- oxytocin
- stimulates contraction of uterine muscle wall

19. Outline the role of human chorionic gonadotropin (HCG) in early pregnancy*2 marksHL*

- stimulates / maintains the corpus luteum
- stimulates secretion of estrogen / progesterone levels
- maintains pregnancy / uterine lining / progesterone levels

20. Outline the way in which a pregnancy can be detected at a very early stage.*4 marksHL*

- test strip dipped into urine
- embryo produces HCG
- HCG is present in the urine if the woman is pregnant
- (monoclonal) antibodies detect / bind to HCG
- (monoclonal antibodies have dye attached so) a color change if the woman is pregnant

21. Compare the roles of LH and HCG in female reproduction.*2 marksSL/HL*

- both stimulate the development of the corpus luteum
- both stimulate the secretion of progesterone
- before fertilization by LH and after by HCG

22. State the role of the amniotic sac and the amniotic fluid.*2 marksSL/HL*

- support the fetus / weightless / fetus floats in amniotic fluid
- protect the fetus / absorb shock / protect against infection
- allows the fetus to move

23. Outline the process of in vitro fertilization (IVF).*6 marksSL/HL*

- (IVF) is fertilization outside body / "in glass"
- (drug) stops normal menstrual cycle
- (inject FSH) to stimulate ovaries / stimulate production of eggs

- (HCG) matures the follicles
- eggs are removed from follicles / ovaries / mother
- male provides sperm / sperm donor
- washing / capacitation of sperm
- eggs are mixed with sperm
- 2-3 embryos are implanted into uterus
- pregnancy test is done to see if implantation / pregnancy has occurred

24. Outline the role of positive feedback in the process of birth in humans.*4 marksSL/HL*

- levels of progesterone falls
- level of estrogen rises
- falling progesterone make the uterus sensitive to oxytocin
- rising estrogen levels make the uterus start to contract
- oxytocin causes contraction of the uterus
- contraction the uterus causes release of oxytocin
- contractions therefore become more and more frequent
- contractions therefore become stronger

Previous IB Exam Essay Questions: Unit 11
Biology IB HL 1

1. Outline what is meant by the trophic level of an organism with *three* examples from one named habitat.*(4 max)*

(Award **1 mark** for the meaning)

- feeding level for an organism in a food chain
- naming of habitat **(1 mark)**
- naming three trophic levels correctly **(1 mark)**
- three examples froming a food chain from the named habitat **(1 mark)**

2. Compare the way in which autotrophic, heterotrophic and saprotrophic organisms obtain energy.*(6 max)*

- autotrophs use an external / non-organic energy source

(reject statements suggestion that energy is made)

- (some) autotrophs use light / (some) autotrophs use photosynthesis
- (some) autotrophs use inorganic chemical reactions / (some) autotrophs use chemosynthesis
- heterotrophs obtain energy from other organisms
- heterotrophs (usually) ingest food / consume food
- saprotrophs obtain energy from non-living matter / dead organisms
- saprotrophs digest organic matter extracellularly

3. Discuss ways in which equilibrium is maintained in the biosphere.*(Award **1 mark** for any of the below, up to 9)*

- O2 used / CO2 produced in respiration
- CO2 used / O2 produced in photosynthesis
- water evaporates from lakes / oceans / soil
- water given off in transpiration

- water condensnes / falls as rain
- reference to mineral nutrient cycles
- nitrogen from atmosphere is fixed
- denitrification returns nitrogen to the atmosphere
- plants / autotrophs make organic compounds / biomass
- heterotrophs / decomposers break down organic compounds / biomass
- numbers of prey controlled by numbers of predators
- numbers of predators controlled by numbers of prey
- energy in sunlight continually supplied to biosphere
- energy lost from biosphere as heat

4. Explain the factors that cause a population to follow the sigmoid (S-shaped) growth curve.*(8 max)*

- during exponential growth the population grows at an increasing rate
- all / most / many offspring survive / birth rate higher than death rate
- all / most / many offspring reproduce
- each generation produces more offspring that the last
- plateau reached eventually / population levels off / birth rate equals death rate
- when carring capacity of environment is reached
- *e.g.* when no more food / nutrients / resources available
- *e.g.* when no more space for nesting / space for another purpose is available
- *e.g.* when numbers of predators have increased
- *e.g.* when levels of parasites / diseases have become very high
- transitional phase when limits to growth are starting to act

(for exponential growth phase, accept converse examples)

5.

6. Apply the concept of carrying capacity to the struggle for survival resulting from overproduction of offspring.*(5 max)*

- the environment can only support a certain maximum population
- this population is sometimes exceeded (due to overproduction of offspring)
- food / space / resources are insufficient / competition for resources
- some individuals fail to obtain enough
- deaths / failure to reproduce / survival of the fittest
- population falls to carrying capacity
- reference to evolution by natural selection

7. Outline the international system used for naming species of living organisms.*(4 max)*

- binomial system

- devised by Linnaeus
- the first name is the genus name
- the second name is the species name
- genus name can be abbreviated
- genus consists of a group of (closely related) species
- upper case for first letter of genus name and the rest of the binomial is lower case
- *Sequoia sempervirens* / other example
- first published name is the correct one
- local / colloquial names can be very confusing / helps international communication

8. Discuss the definition of the term species.*(8 max)*

- a species is a group of organisms
- a species shares a common gene pool
- showing similar morphology / characteristics
- capable of interbreeding
- and producing fertile offspring
- but dissimilar organisms sometimes interbreed
- mule formed by crossing horse and donkey / other example of interspecific hybridisation
- interspecific hybrids are sometimes fertile
- sometimes organisms that are very similar will not interbreed
- *Drosophila pseudoobscura* and *persimilis* / other example of sibling species
- reference to the problem of defining fossil species
- reference to the problem of species that only reproduce asexually
- reference to the problem of isolated populations gradually diverging

9. Describe the value of classifying organisms.*(Award **1 mark** for any of the below; up to **4 marks** max)*

- makes it easier to identify / compare / distinguish organisms
- helps us study with the huge numbers / diversity
- has predictive value / no need to study every organism in a group
- suggests evolutionary relationships / how closely related organisms are
- makes communication between biologists more effective
- allows generalisations about groups of organisms

10. Name the levels and the specific taxa in the hierachy of classification using humans as an example.*(2 max)*

- (Kingdom) Animalia
- (Phylum) Chordata
- (Sub-phylum) Vertebrata

- (Class) Mammalia
- (Order) Primata
- (Family) Hominidae
- (Genus) *Homo*
- (Species) *sapiens*

*(4 to 6 correct **1 mark**, 7 to 8 correct **2 marks**. Award **1** if 7 to 8 correct but incorrect order.)*

11. Outline one example of how human activity has caused environmental change.*(4 max)*

*(Award up to **4 marks** according to this scheme)***1 mark** for human activity **1 mark** for name of impact **1 mark** for mechanism of impact **1 mark**for environmental change

- An example might be:
- electric power production causing
- air pollution through
- sulphur dioxide emmision from coal burning power plants leading to acid rain
- which can acidify freshwater lakes killing aquatic organisms

12. Explain the value of conservation programs.*3 max*

- all wild plants should be conserved
- trees should be conserved as sinks of carbon dioxide / habitats for animals
- wild species which may have commercial value *(e.g. pharmaceuticals)*
- wild relatives of domesticated plants / crop plants / e.g. of crop plant that should be conserved
- as they carry useful genes / characteristics for breeding programs
- sepcies of plants which are endangered / threatened
- species upon which endangered animals depend

13. Outline the structural differences which characterize bryophytes, filicinophytes, coniferophytes and angiospermophytes.*9 marks*

*(**9** for the following)*

bryophytes

- small plants
- no true stems or leaves
- rhizoids only
- dominant plant is haploid / is the gametophyte
- spores produced in a capsule
- non-vascular / lack of xylem and phloem

filicinophytes

- seedless
- vascular tissues / xylem and phloem

- roots
- leaves and stems
- spores produced in clusters / spores usually produced under the leaves
- prothallus / small gametophyte / gametophyte grows independently

coniferophyta

- seeds not enclosed in ovary / pericarp / fruit
- pollen and ovules
- cones
- often have narrow leaves / thick waxy cuticle
- vascular tissue / xylem and phloem

angiospermophytes

- flowers / flowering plants
- ovules / seed are enclosed
- fruits
- xylem vessels

14. List the structures that are found in angiospermophytes but not in bryophytes.*4 marks*

*(Award 1 mark for any of the below, up to 4) (The question does not state the **number** of structures; allowance has to be made for a candidate that responds, say with four correct responses, two of which overlap and thus would receive only three marks. However, candidates should be directed to the fact that 4 marks indicates 4 points to be made.) (Bearing this in mind the comment above - award marks on the basis of the correctness of the first four points made eg., if seven points are made and the first one is incorrect then the maximum is three. Marks cannot be awarded where candidates contradict themselves)*

- roots
- flowers
- fruits
- seeds
- xylem and phloem / well developed vascular tissue
- cuticle
- two spore types
- lignified tissue

15. List the structural differences between bryophytes and angiospermophytes.*5 marks*

*(Award **1 mark** for each structure not found in the other group, up to **5 marks**)*

- bryophytes have a thallus
- bryophytes have rhizoids
- bryophytes contain archegonia and antheridia
- bryophytes main plant is a gametophyte

- angiospermophytes have a (complex) vascular system /xylem / phloem
- angiospermophytes have a cuticle / bark on their surface
- angiospermophytes have lignified tissues
- angiospermophytes have flowers
- angiospermophytes grow pollen tubes / produce pollen
- angiospermophytes have (enclosed) seeds / fruits
- angiospermophytes have roots / stems / leaves
- angiospermophytes main plant is a gametophyte

16. Briefly explain Darwin`s theory of evolution.*4 marks*

- parents produce more offspring than survive
- there is competition among members of a species for survival/struggle for existence
- species show variation
- certain variations will give a selective advantage/survival of fittest
- depending on environment
- these variations will be passed on to the next generation
- leading to change in allele frequency

17. Outline two modern examples where evolution can be observed.*2 marks*

- change of beak shape in Galapagos finches
- resistance to pesticides/antibiotics
- bird predation on moths
- heavy metal tolerance in plants
- melanism in ladybird beetles

18. Outline five types of evidence which support the theory of evolution by natural selection.*6 marks*

- geographic distribution
- ring species/other evidence from geographical distribution
- biochemistry
- cytochrome c/other biochemical evidence
- fossils/paleontological
- fossilized horse ancestors/other evidence
- homologous structures
- pentadactyl limb/vertebrate embryos/other
- recent observed evolution
- resistance to antibiotics/insecticides/heavy metal tolerance/other recent example

19. Outline one modern example of observed evolution by natural selection.*2 marks*

- named example
- selective pressure
- result

example

- beaks of Galapagos finches
- competition for food
- change in numbers/proportion of birds with different sized beaks

20. Explain the evidence from homologous anatomical structures that supports the theory of evolution.*6 marks*

- homologous structures are various different structures of the same basic plan
- derived from a similar embryonic origin
- variations on the basic structure allow different functions
- permitting exploitation of differnt ways of life/adaptive radiation
- the suggests divergence from a common ancestor
- named example of a homologous structure (*e.g.*pentadactyl limb, flower, birds` beaks)
- description of basic structure of this example
- variation related to different functions of this example

Cells & Organelles Name _____

Directions: Match the function cards and memory items by gluing them into the correct locations in the chart below.

Organelle	Function/Description	How can I remember it?
Cell Membrane		
Cell Wall		
Cytoplasm		
Mitochondria		
Lysosomes		
Vacuoles		
Golgi Bodies		
Chloroplasts		
Endoplasmic Reticulum		
Ribosomes		
Nucleus		
Nucleolus		
Chromatin		

Function Cards

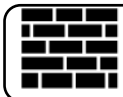
Captures energy from the sunlight and uses it to produce food in a plant cells	Receives proteins & materials from the ER, packages them, & distributes them
Controls what comes into and out of a cell; found in plant and animal cells	Produces the energy a cell needs to carry out its functions
Gel-like fluid where the organelles are found	Assesembles amino acids to create proteins
Control center of the cell; contains DNA	Stores food, water, wastes, and other materials
Found inside the nucleus and produces ribosomes	Has passageways that carry proteins and other materials from one part of the cell to another
Ridged outer layer of a plant cell	Tiny strands inside the nucleus that contain the instructions for directing the cell's functions
Uses chemicals to break down food and worn out cell parts	

Memory Items


Make me something sweet to eat


Members only can come and go.


I'm a "GOLden" packer.


I'm a brick wall.


I am the little nucleus.


I'm a transportER.


I am a "mighty" power house.

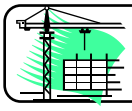

I clean things up! (Hint: Lysol)


I'll store anything, (Hint: Vacuum Bags)


I'm the control center.

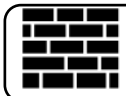
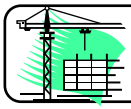

I'm a "tin" of information.


Sail through my plasma.


I make “some” nice proteins.

Cells & Organelles **ANSWER KEY**

Directions: Match the function cards and memory items by gluing them into the correct locations in the chart below.

Organelle	Function/Description	How can I remember it?
Cell Membrane	Controls what comes into and out of a cell; found in plant and animal cells	 Members only can come and go.
Cell Wall	Ridged outer layer of a plant cell	 I'm a brick wall.
Cytoplasm	Gel-like fluid where the organelles are found	 Sail through my plasma.
Mitochondria	Produces the energy a cell needs to carry out its functions	 I am a "mighty" power house.
Lysosomes	Uses chemicals to break down food and worn out cell parts	 I clean things up! (Hint: Lysol)
Vacuoles	Stores food, water, wastes, and other materials	 I'll store anything, (Hint: Vacuum Bags)
Golgi Bodies	Receives proteins & materials from the ER, packages them, & distributes them	 I'm a "GOLden" packer.
Chloroplasts	Captures energy from the sunlight and uses it to produce food in a plant cells	 Make me something sweet to eat
Endoplasmic Reticulum	Has passageways that carry proteins and other materials from one part of the cell to another	 I'm a transportER.
Ribosomes	Assesembles amino acids to create proteins	 I make “some” nice proteins.
Nucleus	Contains DNA, which controls the functions of the cell and production of proteins	 I'm the control center.
Nucleolus	Found inside the nucleus and produces ribosomes	 I’m in “control” of the number of “ribos”.
Chromatin	Tiny strands inside the nucleus that contain the instructions for directing the cell's functions	 I'm a "tin" of information.

Unit 1: We are the warriors

1. Explain each characteristic of living organisms using the acronym MRS.GREN. Provide examples to illustrate each characteristic.
- Living organisms exhibit several characteristics that distinguish them from non-living matter. MRS.GREN is an acronym used to remember these characteristics:
  - M: Movement (organisms can move independently or exhibit internal movement)
  - R: Respiration (organisms can exchange gases to release energy from nutrients)
  - S: Sensitivity (organisms can detect and respond to stimuli from their environment)
  - G: Growth (organisms can increase in size or complexity through cell division and differentiation)
  - R: Reproduction (organisms can produce offspring to pass on genetic information)
  - E: Excretion (organisms can eliminate waste products of metabolism)
  - N: Nutrition (organisms can obtain and utilize nutrients for energy and growth)
- Examples include humans (MRS.GREN: movement, respiration, sensitivity, growth, reproduction, excretion, nutrition), plants (MRS.GREN: growth, reproduction, excretion, nutrition), and bacteria (MRS.GREN: movement, respiration, sensitivity, growth, reproduction, excretion, nutrition).

2. Describe the cell theory and its significance in understanding the nature of living organisms. How does the concept of cells as the smallest unit of life contribute to our knowledge of biology?
- The cell theory states that all living organisms are composed of cells, the cell is the smallest unit of life, and cells come from pre-existing cells. This theory revolutionized our understanding of biology by providing a unifying framework for the study of living organisms and their processes. By recognizing cells as the fundamental units of structure and function in all living organisms, the cell theory laid the foundation for modern biology and enabled scientists to investigate the complexities of life at the cellular level.

3. Using a dichotomous key, classify a set of organisms into different taxa based on observable characteristics. Discuss the importance of dichotomous keys in taxonomy and species identification.
- A dichotomous key is a tool used to identify organisms based on a series of paired statements or characteristics. By systematically narrowing down options, users can classify organisms into different taxa. For example, dichotomous keys may distinguish between plant species based on leaf shape, flower color, or stem structure. These keys are essential in taxonomy and species identification because they provide a standardized method for classifying and naming organisms, enabling researchers to accurately identify and classify species based on observable traits.

4. Compare and contrast eukaryotic and prokaryotic cells, highlighting their structural differences and functions. Provide examples of organisms belonging to each cell type.
- Eukaryotic cells are characterized by a membrane-bound nucleus and organelles, while prokaryotic cells lack a nucleus and membrane-bound organelles. Eukaryotic cells are typically larger and more complex, found in plants, animals, fungi, and protists, whereas prokaryotic cells are smaller and simpler, found in bacteria and archaea. Eukaryotic cells contain linear DNA organized into chromosomes within the nucleus, whereas prokaryotic cells contain circular DNA located in the nucleoid region. Eukaryotic cells also have membrane-bound organelles such as mitochondria, chloroplasts, and the endoplasmic reticulum, which are absent in prokaryotic cells.

5. Investigate the specialized structures and functions of various cell types, such as leaf cells, root hair cells, and nerve cells. How do these adaptations enable cells to perform specific functions within multicellular organisms?
- Specialized cells exhibit unique structures and functions that enable them to perform specific tasks within multicellular organisms. For example, leaf cells contain chloroplasts for photosynthesis, root hair cells have long extensions for absorbing water and nutrients from the soil, and nerve cells have long axons for transmitting electrical impulses. These adaptations optimize cellular efficiency and allow organisms to carry out essential physiological processes necessary for growth, development, and survival in diverse environments.

Unit 2: Green is the new black

1. Discuss the process of photosynthesis, including its overall chemical equation and the role of chloroplasts in plant cells. How does photosynthesis contribute to the production of oxygen and the conversion of solar energy into chemical energy?

- Photosynthesis is the process by which autotrophic organisms, such as plants, algae, and some bacteria, convert light energy from the sun into chemical energy in the form of glucose. The overall chemical equation for photosynthesis is:

  - $6CO_2 + 6H_2O + \text{Light energy} \rightarrow C_6H_{12}O_6 + 6O_2$

- Chloroplasts, specialized organelles found in plant cells, contain chlorophyll pigments that absorb light energy during the light-dependent reactions of photosynthesis. This energy is used to split water molecules into oxygen, protons, and electrons, releasing oxygen gas as a byproduct. In the light-independent reactions (Calvin cycle), carbon dioxide is fixed and reduced to form glucose, which serves as a source of chemical energy for the plant and other organisms in the food chain.

2. Explore the concept of tropism in plants, focusing on phototropism and gravitropism. How do plants respond to external stimuli, and what adaptive advantages do these responses confer?

- Tropism is the growth or movement of an organism in response to an external stimulus, such as light or gravity. Phototropism is the growth of plant organs (e.g., stems, leaves) towards light sources, enabling plants to optimize photosynthesis and maximize light absorption. Gravitropism, also known as geotropism, is the growth of plant roots downwards and stems upwards in response to gravity, facilitating anchorage, water, and nutrient absorption, and structural support. These tropic responses enable plants to adapt to their environment and optimize their growth and survival in diverse ecological niches.

3. Investigate the role of plant hormones in growth and development, including auxins, gibberellins, and cytokinins. How do these hormones regulate plant processes such as germination, flowering, and fruit ripening?

- Plant hormones, also known as phytohormones, regulate various physiological processes in plants, including growth, development, and responses to environmental stimuli. Auxins promote cell elongation, root formation, and apical dominance, while gibberellins stimulate stem elongation, seed germination, and flowering. Cytokinins promote cell division and differentiation, delaying senescence and promoting nutrient uptake. These hormones interact with each other and respond to environmental cues to coordinate plant growth and development throughout the plant life cycle, from seed germination to fruit ripening and senescence.

4. Compare and contrast aerobic and anaerobic respiration, including the products and energy yields of each process. How do cells generate ATP under different oxygen availability conditions?

- Aerobic respiration is a metabolic process that occurs in the presence of oxygen and produces ATP (adenosine triphosphate) through the oxidation of glucose to carbon dioxide and water. The overall chemical equation for aerobic respiration is:

  - $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$

- Anaerobic respiration, also known as fermentation, occurs in the absence of oxygen and produces ATP through glycolysis followed by fermentation pathways. Common fermentation products include lactic acid in animals and ethanol in yeast and some bacteria. Although anaerobic respiration produces less ATP than aerobic respiration, it enables cells to generate ATP in oxygen-deprived conditions, such as during intense exercise or in anaerobic environments.

5. Evaluate the importance of enzymes in biological systems, including their role in catalyzing biochemical reactions in humans. How do factors such as temperature and pH affect enzyme activity?

- Enzymes are biological catalysts that accelerate chemical reactions by lowering the activation energy required for reactions to occur. They are essential for various cellular processes, including metabolism, DNA replication, and protein synthesis. Enzymes are highly specific and catalyze specific reactions by binding to substrates at their active sites. Factors such as temperature and pH can affect enzyme activity by altering the enzyme's structure and stability. Optimal

enzyme activity typically occurs within a specific temperature and pH range, beyond which denaturation and loss of enzyme function may occur. Temperature and pH extremes can disrupt enzyme-substrate interactions and impair biological processes dependent on enzyme-mediated reactions.

Unit 3: Inside Out

1. Discuss the importance of balanced nutrition in maintaining human health, including the functions of essential biomolecules such as carbohydrates, proteins, and lipids. How does malnutrition impact physiological processes and overall well-being?
- Balanced nutrition is essential for maintaining human health and well-being by providing essential nutrients required for growth, energy production, and cellular function. Carbohydrates serve as the primary energy source, proteins are necessary for tissue repair and growth, and lipids play roles in cell membrane structure and hormone production. Malnutrition, resulting from inadequate or imbalanced nutrient intake, can lead to various health issues such as stunted growth, impaired immune function, and increased susceptibility to infections and chronic diseases. Micronutrient deficiencies, such as iron deficiency anaemia or vitamin A deficiency, can also have significant health implications and impact overall physiological processes.

2. Explore the processes of digestion and absorption in humans, including the roles of digestive enzymes and the structure of the digestive system. How do nutrients from food contribute to cellular metabolism and energy production?
- Digestion is the process of breaking down food into smaller molecules that can be absorbed and utilized by cells for energy and growth. It involves mechanical and chemical digestion in the gastrointestinal tract, facilitated by digestive enzymes such as amylase, lipase, and protease. Absorption occurs primarily in the small intestine, where nutrients are transported across the intestinal epithelium into the bloodstream and lymphatic system for distribution to cells throughout the body. Once inside cells, nutrients undergo cellular metabolism through processes such as glycolysis, the citric acid cycle, and oxidative phosphorylation, ultimately producing ATP for cellular energy needs.

3. Investigate the structure and function of the circulatory system in humans, including the roles of the heart, blood vessels, and blood components. How does the circulatory system facilitate the transport of oxygen, nutrients, and waste products throughout the body?
- The circulatory system, also known as the cardiovascular system, is responsible for transporting oxygen, nutrients, hormones, and waste products throughout the body to maintain cellular homeostasis. It consists of the heart, blood vessels (arteries, veins, and capillaries), and blood components (red blood cells, white blood cells, platelets, and plasma). The heart pumps oxygen-rich blood to tissues via arteries and returns oxygen-depleted blood to the heart via veins. Capillaries facilitate gas exchange and nutrient uptake in tissues. Oxygen and nutrients are transported by red blood cells bound to haemoglobin, while waste products such as carbon dioxide and metabolic byproducts are removed from tissues and transported to the lungs or kidneys for elimination.

4. Explain the process of gas exchange in humans, focusing on the mechanisms of pulmonary ventilation and diffusion across respiratory surfaces. How do respiratory adaptations enable organisms to efficiently exchange gases with their environment?
- Gas exchange in humans occurs through the process of respiration, which involves pulmonary ventilation (breathing) and diffusion of gases across respiratory surfaces (alveoli). During inhalation, the diaphragm and intercostal muscles contract, causing the chest cavity to expand and air to be drawn into the lungs. Oxygen diffuses across the respiratory membrane into the bloodstream, where it binds to hemoglobin in red blood cells for transport to tissues. Carbon dioxide produced by cellular metabolism is transported from tissues to the lungs, where it diffuses into alveoli and is exhaled during exhalation. Respiratory adaptations such as a large surface area, thin respiratory membranes, and a rich capillary network optimize gas exchange efficiency and enable organisms to meet their metabolic oxygen demands.
5. Analyze the structure and function of the nervous system, including the roles of neurons and neurotransmitters in transmitting electrical signals. How do sensory receptors and effectors contribute to sensory perception and motor responses in organisms?

- The nervous system is a complex network of cells and tissues that coordinates and regulates physiological processes and behavior in organisms. It consists of the central nervous system (brain and spinal cord) and the peripheral nervous system (nerves and ganglia). Neurons, specialized cells that transmit electrical impulses, form the basic functional unit of the nervous system. Neurotransmitters are chemical messengers that transmit signals between neurons and target cells, such as muscles or glands. Sensory receptors detect stimuli from the environment and transmit sensory information to the central nervous system for processing and interpretation. Effectors, such as muscles and glands, respond to motor signals from the nervous system by producing motor responses such as movement or secretion. Together, sensory receptors and effectors enable organisms to perceive and respond to changes in their internal and external environments, facilitating adaptation and survival.

Unit 4: Where do I stand?

1. Describe the components of an ecosystem and their interactions, including biotic and abiotic factors. How do energy flow and nutrient cycling sustain life within ecosystems?
- Ecosystems consist of biotic (living) and abiotic (non-living) components that interact within a defined geographical area. Biotic factors include organisms such as plants, animals, fungi, and bacteria, while abiotic factors include physical and chemical components such as sunlight, temperature, soil, water, and nutrients. Energy flows through ecosystems in the form of sunlight, which is converted into chemical energy by photosynthetic organisms and transferred through food chains and webs to consumers. Nutrient cycling involves the movement and transformation of essential elements such as carbon, nitrogen, phosphorus, and oxygen between living organisms and the environment. Decomposers play a crucial role in recycling nutrients by breaking down organic matter into simpler forms that can be utilized by producers, completing nutrient cycles and sustaining life within ecosystems.

2. Investigate the concept of population growth and the factors that influence population dynamics, such as birth rates, death rates, and migration. How do changes in population size and distribution impact ecosystem stability?
- Population growth refers to changes in the size, density, and distribution of populations over time. Population dynamics are influenced by factors such as birth rates, death rates, immigration, and emigration. High birth rates and low death rates contribute to population growth, while factors such as disease outbreaks, predation, and resource availability can limit population growth or cause population declines. Changes in population size and distribution can impact ecosystem stability by altering species interactions, resource availability, and ecosystem services. For example, overpopulation of certain species may lead to competition for resources or habitat destruction, disrupting ecosystem balance and biodiversity.

3. Analyze the concept of keystone species and their importance in maintaining ecosystem structure and function. How do interactions between keystone species and other organisms contribute to biodiversity and ecosystem resilience?
- Keystone species are species that have disproportionately large effects on ecosystem structure and function relative to their abundance or biomass. They play critical roles in maintaining ecosystem stability and biodiversity by exerting strong ecological influences on other species and community dynamics. Keystone species may regulate population sizes of other species through predation, herbivory, or habitat modification, thereby preventing dominance by competitively superior species and promoting species diversity. Their removal or decline can lead to cascading effects within ecosystems, disrupting trophic interactions and compromising ecosystem resilience to environmental changes or disturbances.

4. Discuss the significance of nutrient cycles, such as the carbon, oxygen, nitrogen, and phosphorus cycles, in ecosystem processes. How do human activities disrupt nutrient cycles and affect ecosystem health?
- Nutrient cycles are biogeochemical processes that involve the movement and transformation of essential elements between living organisms, the atmosphere, hydrosphere, lithosphere, and biosphere. Carbon, oxygen, nitrogen, and phosphorus cycles are fundamental to ecosystem functioning and support various biological processes such as photosynthesis, respiration, and nutrient cycling. Human activities, such as deforestation, fossil fuel combustion, agricultural practices, and industrial pollution, have significantly altered nutrient cycles, leading to environmental

degradation and ecosystem dysfunction. For example, deforestation and land conversion release carbon dioxide into the atmosphere, contributing to climate change, while nitrogen and phosphorus runoff from agriculture and urban areas contributes to the eutrophication of water bodies, causing algal blooms and oxygen depletion. These disruptions compromise ecosystem health and resilience, threatening biodiversity and human well-being.

5. Explore the concept of homeostasis and its importance in maintaining internal balance within organisms. How do feedback mechanisms regulate physiological processes and responses to external stimuli?
- Homeostasis is the ability of organisms to maintain internal stability and physiological equilibrium in response to changes in the external environment. It involves regulatory mechanisms that monitor and adjust internal conditions, such as body temperature, blood pH, and osmotic balance, to keep them within optimal ranges for cellular function. Feedback mechanisms, such as negative feedback loops, play a crucial role in maintaining homeostasis by detecting deviations from set points and initiating corrective responses to restore equilibrium. For example, thermoregulation mechanisms regulate body temperature through processes such as sweating, vasodilation, or shivering in response to changes in environmental temperature. By maintaining internal balance, homeostasis enables organisms to adapt and survive in diverse environmental conditions, enhancing their resilience to environmental fluctuations and stressors.

Eutrophication
Nutrient enrichment that occurs due to runoff from agricultural fields etc. Rapid growth of algae and other planktons resulting in an algal bloom. Dissolved oxygen depletion and toxin generation. Aquatic species die as a result of the loss of oxygen.
Unit 5: Life under the microscope

1. Describe the role of antibodies in the immune response, including their production and function within the body.
- Antibodies play a crucial role in the immune response by recognizing and neutralizing foreign substances called antigens. They are produced by specialized white blood cells called B cells, which undergo activation and differentiation upon encountering antigens. Antibodies bind to specific antigens, marking them for destruction by other immune cells or enhancing their clearance from the body through various mechanisms such as agglutination or neutralization.

2. Explain the concept of autoimmunity and how it relates to lifestyle and health disorders. Provide examples to support your explanation.
- Autoimmunity occurs when the immune system mistakenly attacks the body's own tissues and cells, leading to inflammation and tissue damage. This can result in autoimmune diseases such as rheumatoid arthritis, lupus, and type 1 diabetes. Lifestyle factors such as smoking, diet, and stress can influence autoimmunity by triggering immune dysregulation or exacerbating underlying genetic predispositions.

3. Discuss the importance of vaccination in preventing infectious diseases. What are the mechanisms by which vaccines confer immunity?
- Vaccination is a critical public health intervention that stimulates the immune system to produce a protective immune response against specific infectious agents, known as pathogens. Vaccines contain weakened or inactivated forms of pathogens or their antigens, which elicit an immune response without causing disease. Upon vaccination, the immune system generates memory cells that recognize and mount a rapid response upon subsequent exposure to the pathogen, thereby preventing infection or reducing its severity.

4. Compare and contrast DNA and RNA in terms of their structure, function, and roles in transcription and translation processes within cells.
- DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) are nucleic acids that play essential roles in the storage and expression of genetic information within cells. DNA consists of a double helix structure and serves as the blueprint for protein synthesis through the process of transcription and translation. RNA, including messenger RNA (mRNA), transfer

RNA (tRNA), and ribosomal RNA (rRNA), is involved in various cellular processes, such as carrying genetic instructions from DNA to the ribosomes, where proteins are synthesized.

5. Evaluate the ethical considerations associated with biotechnological practices such as genetic modification and genome mapping. How can these technologies impact society and the environment?
- Biotechnological practices such as genetic modification and genome mapping offer significant potential benefits in areas such as agriculture, medicine, and environmental conservation. However, they also raise ethical considerations regarding issues such as informed consent, genetic privacy, and environmental impacts. Genetic modification of organisms may have unintended consequences on ecosystems and biodiversity, while genome mapping raises concerns about genetic discrimination and the equitable distribution of benefits and risks.

Unit 6: Who would win?

1. Describe the hierarchical classification system used in taxonomy, providing examples of organisms at each level. How does understanding classification aid in the study of biodiversity and conservation?
- The hierarchical classification system used in taxonomy organizes organisms into progressively broader categories, including domain, kingdom, phylum, class, order, family, genus, and species. For example, humans belong to the domain Eukarya, kingdom Animalia, phylum Chordata, class Mammalia, order Primates, family Hominidae, genus Homo, and species sapiens. Understanding classification aids in the study of biodiversity and conservation by facilitating the identification and categorization of organisms, which allows researchers to assess species richness, distribution patterns, and evolutionary relationships within ecosystems.

2. Analyze the components and impacts of the HIPPO Effect on ecosystems. How do human influences on habitat change exacerbate biodiversity loss and environmental degradation?
- The HIPPO Effect refers to the main drivers of biodiversity loss and environmental degradation, including habitat destruction, invasive species, pollution, population growth, and overharvesting. Human influences on habitat change, such as deforestation, urbanization, and agricultural expansion, disrupt ecosystems and lead to habitat loss and fragmentation. This exacerbates biodiversity loss by reducing available habitat for species and increasing their vulnerability to extinction. Additionally, habitat alteration can facilitate the spread of invasive species and pollutants, further degrading ecosystem health and resilience.

3. Discuss the causes and consequences of pollution, including the greenhouse effect and global warming. What measures can be taken to mitigate the adverse effects of pollution on the environment?
- Pollution refers to the introduction of harmful or toxic substances into the environment, leading to adverse effects on living organisms and ecosystems. Causes of pollution include industrial emissions, vehicle exhaust, agricultural runoff, and improper waste disposal. Pollution contributes to the greenhouse effect and global warming by releasing greenhouse gases such as carbon dioxide and methane into the atmosphere, leading to climate change and associated impacts such as rising temperatures, altered weather patterns, and sea-level rise. Mitigation measures include transitioning to renewable energy sources, improving energy efficiency, reducing emissions from transportation and industry, and implementing pollution control technologies and regulations.

4. Explore the concept of sustainable living and its importance in conservation efforts. How can overexploitation of natural resources be addressed to ensure the preservation of ecosystems?
- Sustainable living involves meeting the needs of the present without compromising the ability of future generations to meet their own needs. It encompasses practices that minimize environmental impact, conserve natural resources, and promote social equity and economic viability. Addressing overexploitation of natural resources requires implementing sustainable resource management strategies such as sustainable forestry, fisheries management, and agriculture practices. This involves setting quotas, implementing regulations, and promoting ecosystem-based approaches to ensure the preservation of ecosystems and the services they provide.

5. Investigate the role of human activities in altering nutrient cycles, such as carbon, oxygen, nitrogen, and phosphorus cycles, within ecosystems. How do these alterations affect ecosystem dynamics and biodiversity?

- Human activities such as deforestation, fossil fuel combustion, and agricultural practices alter nutrient cycles within ecosystems, leading to nutrient imbalances and ecological disruptions. For example, deforestation reduces the carbon storage capacity of forests, leading to increased atmospheric carbon dioxide levels and climate change. Nitrogen and phosphorus runoff from agricultural fields and urban areas contributes to the eutrophication of water bodies, causing algal blooms and oxygen depletion, which can harm aquatic ecosystems. These alterations affect ecosystem dynamics by disrupting nutrient cycling, reducing biodiversity, and increasing the vulnerability of ecosystems to environmental stressors and disturbances.

WORKSHEET/ASSIGNMENT

NAME: .....

GRADE: ...MYP 5 SEC:.....

DATE:.....

Topic: Circle of life- Evolution

Key Concept: Relationships

Related Concept: Transformation, Forms, Consequences

Global Context: Orientation in space and time

Statement of inquiry:

ATL: Thinking Skills

ATL strands: Critical Thinking Skills

Criterion: A

Task- Answer the questions in the worksheet.

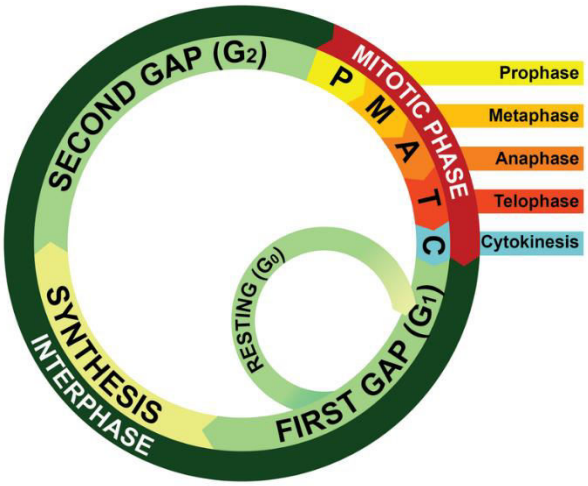
Task Clarification Statement- The worksheet will help the students comprehend and assess their own understanding of the topic.

The Cell Cycle

Cell division is just one of several stages that a cell goes through during its lifetime. The **cell cycle** is a repeating series of events, including growth, DNA synthesis, and cell division. The cell cycle in prokaryotes is quite simple: the cell grows, its DNA replicates, and the cell divides. In eukaryotes, the cell cycle is more complicated.

Eukaryotic Cell Cycle

The diagram in the figure below represents the cell cycle of a eukaryotic cell. As you can see, the eukaryotic cell cycle has several phases. The mitosis phase (M) actually includes both mitosis and cytokinesis. This is when the nucleus and then the cytoplasm divide. The other three phases (G1, S, and G2) are generally grouped together as **interphase**. During interphase, the cell grows, performs routine life processes, and prepares to divide. These phases are discussed below.



Eukaryotic Cell Cycle. This diagram represents the cell cycle in eukaryotes. The G1, S, and G2 phases make up interphase (I). The M (mitotic) phase includes mitosis and cytokinesis. After the M phase, two cells result.

Interphase

Interphase of the eukaryotic cell cycle can be subdivided into the following three phases, which are represented in the figure above:

- **Growth Phase 1 (G1):** During this phase, the cell grows rapidly, while performing routine metabolic processes. It also makes proteins needed for DNA replication and copies some of its organelles in preparation for cell division. A cell typically spends most of its life in this phase.

- **Synthesis Phase (S):** During this phase, the cell's DNA is copied in the process of DNA replication.
- **Growth Phase 2 (G2):** During this phase, the cell makes final preparations to divide. For example, it makes additional proteins and organelles.

Cancer and the Cell Cycle

Cancer is a disease that occurs when the cell cycle is no longer regulated. This may happen because a cell's DNA becomes damaged. Damage can occur because of exposure to hazards such as radiation or toxic chemicals. Cancerous cells generally divide much faster than normal cells. They may form a mass of abnormal cells called a **tumor**. The rapidly dividing cells take up nutrients and space that normal cells need. This can damage tissues and organs and eventually lead to death.

Questions

1. What is the cell cycle?

2. What are the phases of the eukaryotic cell cycle?

3. In which phase does a cell spend most of its life? What happens during this phase?

4. What is cancer? What may cause cancer to occur?

5. What is the S phase? What happens during this phase?

Write true if the statement is true or false if the statement is false.

_____ 1. A chromatid is made of two identical chromosomes.

_____ 2. There may be thousands of genes on a single chromosome.

_____ 3. Prophase is the first phase of mitosis.

_____ 4. Female human cells have 23 pairs of homologous chromosomes.

_____ 5. Mitosis occurs in the following order: prophase - metaphase - telophase - anaphase.

_____ 6. The process in which the cell divides is called mitosis.

_____ 7. During mitosis, DNA exists as chromatin.

_____ 8. A gene contains the instructions to make a protein.

_____ 9. Chromosomes form during metaphase.

_____ 10. Mitosis is the phase of the eukaryotic cell cycle that occurs between DNA replication and the second growth phase.

_____ 11. Sister chromatids are identical.

_____ 12. Chromatids separate during anaphase.

_____ 13. Chromosomes are coiled structures made of DNA and proteins.

_____ 14. Human cells have 64 chromosomes.

_____ 15. Cytokinesis is the final stage of cell division.

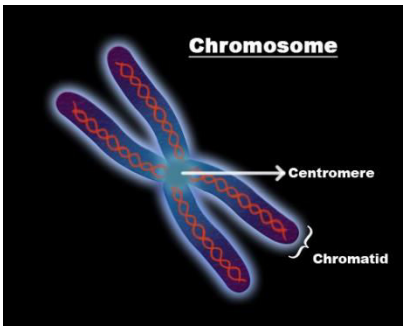
Read these passages from the text and answer the questions that follow.

Chromosomes

Chromosomes are coiled structures made of DNA and proteins. Chromosomes are the form of the genetic material of a cell during cell division. During other phases of the cell cycle, DNA is not coiled into chromosomes. Instead, it exists as a grainy material called **chromatin**.

Chromatids and the Centromere

DNA condenses and coils into the familiar X-shaped form of a chromosome only after it has replicated, as seen in the figure below. Because DNA has already replicated, each chromosome actually consists of two identical copies. The two copies are called sister **chromatids**. They are attached to one another at a region called the **centromere**.



Chromosome. After DNA replicates, it forms chromosomes like the one shown here.

Chromosomes and Genes

The DNA of a chromosome is encoded with genetic instructions for making proteins. These instructions are organized into units called **genes**. Most genes contain the instructions for a single protein. There may be hundreds or even thousands of genes on a single chromosome.

Human Chromosomes

Human cells normally have two sets of chromosomes, one set inherited from each parent. There are 23 chromosomes in each set, for a total of 46 chromosomes per cell. Each chromosome in one set is matched by a chromosome of the same type in the other set, so there are actually 23 pairs of chromosomes per cell. Each pair consists of chromosomes of the

same size and shape that also contain the same genes. The chromosomes in a pair are known as **homologous chromosomes**.

Questions

1. What is a chromosome? What is it made out of?

2. What are homologous chromosomes? How many homologous pairs are in a human cell?

3. What is the main difference between chromatin and chromosomes?

4. Why do chromosomes look like an "X"?

5. What is a gene?

Circle the letter of the correct choice.

1. Why is it necessary for the DNA to replicate prior to cell division?
   a. so that each daughter cell will have 23 chromosomes
   b. so that each daughter cell will have a complete copy of the genetic material
   c. so that each daughter cell will have 46 homologous chromosomes
   d. so that each daughter cell will have 2 sister chromatids
2. Why do chromosomes have an X-shape?
   a. because they are made of two sister chromatins
   b. because they are made of two sister centromeres
   c. because they are made of two sister chromosomes
   d. because they are made of two sister chromatids
3. Chromosomes form during what part of the cell cycle?
   a. prophase of mitosis
   b. the end of the G2 phase
   c. right after S phase and DNA replication
   d. during cytokinesis
4. The correct order of phases during mitosis is

a. telophase→prophase→metaphase→anaphase

b. prophase→anaphase→metaphase→telophase

c. prophase→metaphase→telophase→anaphase

d. prophase→metaphase→anaphase→telophase

5. How many chromosomes are in a normal human cell?

a. 23

b. 32

c. 46

d. 64

6. When do the sister chromatids line up at the equator of the cell?

a. metaphase

b. anaphase

c. prophase

d. telophase

7. Which of the following statements concerning cytokinesis is correct? (1) cytokinesis occurs in both prokaryotes and eukaryotes, (2) cytokinesis is when the cytoplasm splits in two, (3) in plant cells, cytokinesis involves the formation of a cell plate.

a. 1 only

b. 2 only

c. 1 and 2

d. 1, 2, and 3

8. During which phase of mitosis do the sister chromatids separate?

a. prophase

b. telophase

c. anaphase

d. metaphase

Match the vocabulary word with the proper definition.

Definitions

_____ 1. division of the nucleus

_____ 2. region of the chromosome where sister chromatids are attached

_____ 3. division of the cytoplasm

_____ 4. phase of mitosis in which spindle fibers attach to the centromere of each pair of sister chromatids

_____ 5. coiled structures made of DNA and proteins

_____ 6. phase of mitosis in which sister chromatids separate and the centromeres divide

_____ 7. a segment of DNA with the genetic instructions to make a protein

_____ 8. two copies of replicated DNA that make a chromosome

_____ 9. the first and longest phase of mitosis

_____ 10. uncoiled DNA

_____ 11. a pair of the same chromosome

_____ 12. phase of mitosis in which the chromosomes begin to uncoil and form chromatin

Fill in the blank with the appropriate term.

1. Chromosomes are coiled structures made of _____ and proteins.

2. _____ is the division of the nucleus.

3. During _____, sister chromatids line up at the equator, or center, of the cell.

4. _____ is the division of the cytoplasm.

5. There may be hundreds or even thousands of genes on a single _____.

6. A _____ contains genetic the instructions for making proteins.

7. During anaphase, sister _____ separate and the centromeres divide.

8. The four phases of mitosis, in order, are _____, _____, _____, _____.

9. Human cells normally have _____ chromosomes.

10. A new nuclear membrane forms during _____.

11. The _____ fibers ensure that sister chromatids will separate when the cell divides.

12. When a chromosome first forms, it actually consists of two sister _____.

Answer the question below. Use appropriate academic vocabulary and clear and complete sentences.

Describe the structure of a chromosome, using proper vocabulary. Discuss when and why a chromosome forms.

Levels of Organization

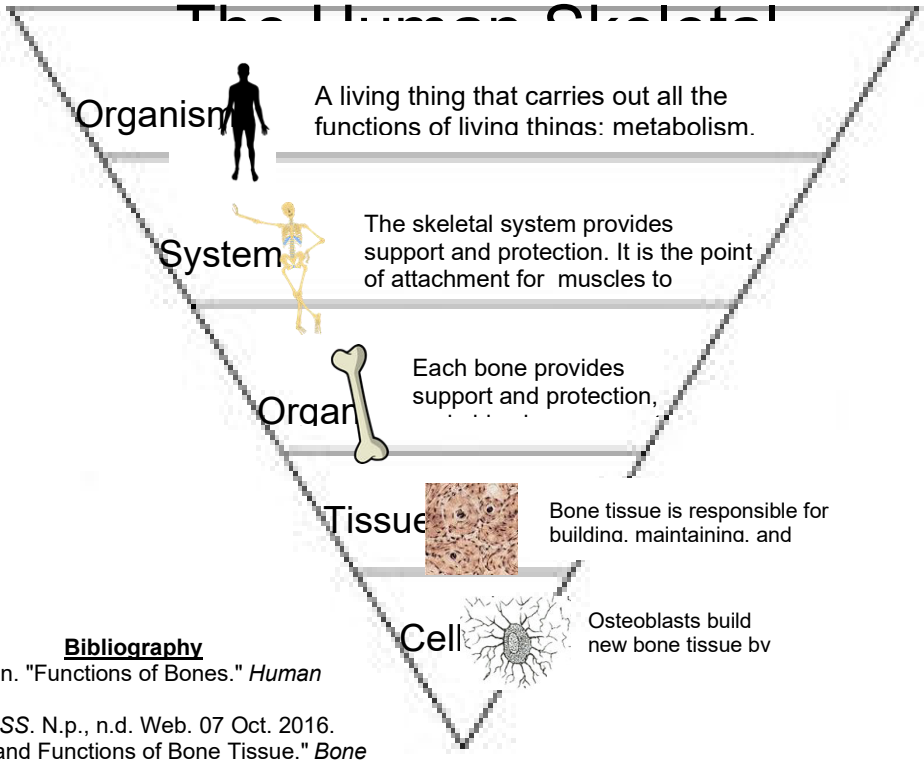
Goal: To demonstrate understanding of the levels of organization
Role: Researcher and Reporter
Audience: Biology Students
Product: Poster
Standard:Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Scenario: You are challenged with teaching a group of younger students about the levels of organization in living things, or within an organism. However, you want to make sure that this group of students understands how each level is related to each other. In groups of three, you will develop a basic model that outlines the structure and function of each level, using one human organ system as an example. You will also create a presentation for your system to teach your class.

To make a complete, clear, and concise poster for this assessment, you must include the following components:

- The names of the levels of organization
- An named example from your body system for each level
- A definition of the function of your named example
- A picture of your example
- Bibliography of all sources used

For example:



Bibliography

Iqbal, Ahsan. "Functions of Bones." *Human Anatomy*
RSS. N.p., n.d. Web. 07 Oct. 2016.
"Structure and Functions of Bone Tissue." *Bone Tissue*.
Ivy Rose Ltd., n.d. Web. 07 Oct. 2016.
"Three Types of Bone Cells: Osteoblasts, Osteoclasts,
and Osteocytes."*Different*

For your presentation, you will continue working in your small group with your assigned/chosen body system. Information presented during the presentation will be used to fill in a chart that will be used as a study guide for the quimester exam.

- What to research for your assigned body system:
  - List and explain the functions of the organ system.
  - Identify the major organs and their functions.
  - Describe the basic structure of at least one major organ in assigned body system (*i.e. lungs: bronchi, bronchioles, and alveoli*).
  - Each member must describe a disease associated with their body system.
    - Name of disease
    - Description of disease/mode of action
- Presentation Slide Visuals
  - Title Slide, with group members names and parallel
  - Outline of the human body
  - Diagram of major organs in anatomically correct locations
  - Labels on major organs
  - Neat, easy to understand, colorful, creative
- Presentation
  - Present all required information (see above).
  - Organized and easy to follow.
  - All group members participate equally in the presentation.
  - Spoken clearly and eye contact with audience.
  - Bibliography slide

Presentation Rubric

	EXCELLENT (4)	**GOOD (3)**	**FAIR (2)**	**POOR (1)**
CONTENT	All required information is presented.	Most of the required information is presented.	Some of the required information is presented.	Hardly any required information is presented.
ORGANIZATION	Presentation is well organized and easy to follow. Transition between topics is smooth.	Presentation is organized and easy to follow but transition between topics is not smooth.	Presentation is somewhat organized but hard to follow.	Presentation is very unorganized and difficult to follow.
EYE CONTACT	Eye contact is made throughout the entire presentation. No part of the presentation is read.	Eye contact is made throughout most of the presentation. Some of the presentation is read.	Eye contact is made only during some of the presentation. Most of the presentation is read.	No eye contact is made throughout the entire presentation and all of it is read.
VISUAL AID	Visual aid is creative, colorful, easy to read, and used effectively.	Visual aid is colorful, readable and used somewhat effectively.	Visual aid is lacking color, difficult to read, and not used effectively.	Visual aid is not used at all in the presentation.
VOICE	Presentation is loud and given at a slow pace that's easy to follow.	Presentation is audible and given at a good pace.	Presentation is barely audible and given at a fast pace.	Presentation is inaudible and given at a pace too fast to follow.
INDIVIDUAL PARTICIPATION	Individual participated and worked well in his/her group	Individual participated but did not work well in the group	Individual did not present information on topic, but did work well in group	Individual did not participate and did not work well in the group

Poster Rubric

Submission: You will submit a word doc/pdf of your levels of organization.
Due Date: Friday, July 30th 2021

Criterion A: Knowing and understanding

Achievement level	Level descriptor	Task Specific Clarification
0	The student does not reach a standard identified by any of the descriptors below.	
1–2	The student is able to: i. state scientific knowledge ii. apply scientific knowledge and understanding to suggest solutions to problems set in familiar situations iii. interpret information to make judgments.	Your poster includes the names of each level of organization, includes an example of each level, and a picture. The use of the model is not clear. Few or no sources used are included in a bibliography.
3–4	The student is able to: i. outline scientific knowledge ii. apply scientific knowledge and understanding to solve problems set in familiar situations iii. interpret information to make scientifically supported judgments.	Your poster is constructed to model the levels of organization. Each level provides an example in the human body. A picture and general function of the example is provided. A function of the named example is included. Some sources used are included in a bibliography. The poster shows misconceptions of the levels.
5–6	The student is able to: i. describe scientific knowledge ii. apply scientific knowledge and understanding to solve problems set in familiar situations and suggest solutions to problems set in unfamiliar situations iii. analyse information to make scientifically supported judgments.	Your poster is correctly constructed to model the relative sizes of each level of organization. Each level is labelled, including a named example from a specific body system. A picture is included to represent the named example of that level. A function of the named example is included. Some sources used are included in a bibliography.
7–8	The student is able to: i. explain scientific knowledge ii. apply scientific knowledge and understanding to solve problems set in familiar and unfamiliar situations iii. analyse and evaluate information to make scientifically supported judgments.	Your poster is correctly constructed to model the relative sizes of each level of organization. Each level is clearly labelled, including a named example from a specific body system. A picture is included to represent the named example of that level. An explanation of the function of the structure(s) at each level is provided. Sources used are included in a bibliography.

WORKSHEET/ASSIGNMENT

NAME: .....

GRADE: ...MYP.....SEC: .....

DATE:.....

Topic: Circle Of Life- Evolution
Key Concept: Relationships
Related Concept: Forms, Transformation
Global Context: Orientation In Space And Time

Statement of inquiry: The relationships between forms and functions lead to transformations in said space and time.

ATL: Thinking

ATL strands: Critical Thinking

Criterion: A

Task- Self Learning on the topic by reading and answering the questions.

Task Clarification Statement-
The task requires the learner to read and annotate the text given and solve the questions.

1. What is mitosis?
2. Why is mitosis important?
3. What would happen if mitosis didn't take place?
4. Suggest one advantage and one disadvantage of asexual reproduction.
5. What is meant by a diploid cell?

6. What cells in the body do you think are **not** diploid?
7. How many parents does a cell that reproduces by sexual reproduction have?
8. How many parents does a cell that reproduces by asexual reproduction have?

Can you give an example of what happens when mitosis goes wrong?

Key words:

Diploid, haploid, chromosome, identical, DNA

(Challenge: do you know what DNA stands for?)

Stretch and challenge: research what 'meiosis' is and produce a table to compare and contrast the two types of cell division

Mitosis	Meiosis

1. What is mitosis?
2. Why is mitosis important?

Think back to the uses of mitosis.

3. What would happen if mitosis didn't take place?
4. Suggest one advantage and one disadvantage of asexual reproduction.
5. What is meant by a diploid cell?
6. What cells in the body do you think are **not** diploid?
7. How many parents does a cell that reproduces by sexual reproduction have?
8. How many parents does a cell that reproduces by asexual reproduction have?
9. Can you give an example of what happens when mitosis goes wrong?

Key words:

Diploid, haploid, chromosome, identical, DNA

(remember haploid = half!)

Stretch and challenge: research what 'meiosis' is and produce a table to compare and contrast the two types of cell division

E.g.	Mitosis	Meiosis
Number of cell divisions		

Crossing over		
Number of daughter cells produced		
Homologous chromosomes		