**Previous IB Exam Essay Questions: Unit 10**

Use these model essay questions and responses to prepare for essay questions on your in-class tests, as well as the IB Examination, Paper 3. The questions below have appeared on IB HL Examinations over the past several years. The answers following the questions are the markscheme ideal responses used to evaluate student examination responses.

**1. Outline the experiments of Miller and Urey into the origin of organic compounds on Earth.** *6 marks*

* apparatus contructed in which chemicals could circulate
* gases of pre-biotic Earth`s atmosphere mixed inside
* methane (as a carbon source)
* ammonia water vapor and hydrogen
* sparks/ electric discharge (to simulate lightning)
* high temperature/ boiling water
* no free oxygen
* amino acids spontaneously formed
* example of other organic compound formed

**2. Outline the methods used by Miller and Urey in their experiments into the origin of organic compounds on Earth.** *2 marks*

* conditions on pre-biotic Earth were recreated in their apparatus
* mixture of ***any three of*** methane, ammonia, water vapor, and hydrogen
* water boiled and recondensed to simulate high temperature
* electrical discharge / sparks to simulate lightning

**3. Outline the conclusion that Miller and Urey drew from their experiments.** *2 marks*

* organic compounds / amino acids were formed from inorganic compounds
* organic compounds could have existed on pre-biotic Earth
* life might have arisen from non-living material

**4. Discuss the possible role of RNA in the origin of life on Earth.** *5 marks*

* short polymers of RNA have been produced abiotically
* from dilute solution of RNA nucleotide monomers in test tube experiments
* thus, RNA is capable of self-assembly
* when short RNA polytmers are added to a test-tube containing RNA nucleotide monomers
* copies are made from the template following base-pairing rules
* thus, RNA is capable of self-replication
* if zinc is added, RNA polymers up to 40 nucleotides are copied with less than 1% error
* RNA molecules are important catalysts in modern cells
* ribozymes remove introns from RNA
* ribozymes help catalyze the synthesis of new RNA
* thus, RNA is autocatalytic

**5. Answer the following questions concerning endosymbiotic theory.** *5 marks*

*a. Identify which* one *of the five kingdoms of living organisms was the first to appear on Earth.* *1 mark*

* Prokaryotes / Monera / Bacteria

*b. State* one *organelle, apart from chloroplasts, which is part of the endosymbiotic theory.* *1 mark*

* mitochondrion

*c. State* three *kingdoms in which this organelle is found.* *1 mark*

* any three of: fungi, protista, animals, plants

*d. State* two *characteristics of mitochondria which support the idea that they were once independent prokaryotes.* *2 marks*

* mitochondria have their own DNA and ribosomes / conduct their own protein synthesis
* mitochondrial DNA is circular
* mitochondrial DNA lacks histones
* mitochondrial DNA lacks introns
* mitochondria replicate independently of the host cell nucleus
* mitochondrial size is similar to prokaryotes
* mitochondrial ribosomes similar to prokaryoties in size / antibiotic sensitivity

**6. Discuss the definition of the term *species*.** *8 marks*

* 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 *D. 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

**7. Discuss how isolation can lead to speciation.** *7 marks*

(*Award 1 mark for each answer below up to 6 marks; Award 1 mark for some mention/'weighing up' of arguments/likelihood of isolation leading to speciation. 7 marks maximum.*)

* for speciation to occur populations of a species must beome isolated
* isolation can be geographical
* isolation of populations living together is less likely
* isolation may be ecological
* *e.g.* by different flowering times/pollinators/temporal/behavioral/mechanical
* new traits by chance mutations
* natural selection/selection pressures will alter population by favoring certain traits
* speciation can occur by divergent evolution
* *e.g.* by occypying different microhabitats/other example
* isolation prevents interbreeding
* gene pools become separated
* isolated populations can diverge by adapting to different conditions
* over a long period of time populations may diverge considerably
* with sufficient divergence, populations can no longer interbreed
* speciation has occurred when populations cannot interbreed

**8. Discuss how different types of isolation contribute to speciation.** *7 marks*

* any type of isolation can contribute if it prevents interbreeding/prevents gene flow
* geographical isolation is (probably) the commonest method
* physical barrier/long distance prevents interbreeding
* *e.g.* islands/mountain ranges/other barrier
* ecological isolation is harder to achieve
* *e.g.* populations occupy different habitats in the same area
* *e.g.* flower at different times/have different mating season
* other example of ecological isolation
* natural selection must act differently on the two populations
* populations must diverge sufficiently enough for interbreeding to be impossible
* behavioral isolation
* structural isolation
* a small gene pool so any mutations show more quickly

**9. Discuss the theory that evolution occurs by punctuated equilibrium.** *3 marks*

* long periods where there was no (apparent) change/stasis
* short periods of rapid evolution
* periods of mass extinctions leading to opportunities/caused by environmental disruption/rapid environmental change in short periods
* supported by lack of fossils showing gradual changes
* an example of such environmental disruption (meteors, earthquakes, volcanoes, *etc.*)
* alternative theory is gradualism
* punctuated equilibrium is based on fossil evidence rather than biochemical evidence

**10. Compare evolution by punctuated equilibrium with evolution by gradualism.** *3 marks*

* punctuated equilibrium involves faster mutation rates
* punctuated equlibrium involves more powerful natural selection
* punctuated equilibrium implies that the environment undergoes sudden changes
* punctuated equibrium involves discontinuous evolution
* gradualism implies continuous evolution
* punctuated equilibrium involves faster evolution rates (when it occurs)

**Previous IB Exam Essay Questions: Unit 11**

Use these model essay questions and responses to prepare for essay questions on your in-class tests, as well as the IB Examination, Paper 3. The questions below have appeared on IB HL Examinations over the past several years. The answers following the questions are the markscheme ideal responses used to evaluate student examination responses.

**1. Outline the method for the dating of rocks and fossils using radioisotopes, with reference to 14C and 40K.** *5 marks*

* accurate dating of fossils allows accurate sequencing of fossils
* select 14C for young samples / samples from 1,000 to 100,000 years old
* select 40K for older samples / samples over 100,000 years old
* extract isotopes from sample
* measure isotopes in sample as proportion of 14C / 40K relative to breakdown products 14N / 40Ar
* 14C/14N ratio decreases over time at a predictable rate / half-life = 5730 years
* 40K/40Ar ratio decreases over time at a predictable rate / half-life = 1,250,000 years
* compare 14C/14N / 40K/40Ar ratio with decay curve to determine age of sample

**2. Describe the major anatomical features that define humans as primates.** *3 marks*

* grasping limbs (with long fingers and a separated opposable thumb)
* mobile arm (with shoulder joints allowing movement in three planes and the bones of the shoulder girdle allowing weight to be transferred via the arms)
* stereoscopic vision / forward facing eyes on a flattened face / binocular vision / overlapping fields of view
* skull modified for upright posture / foramen magnum forward in base of skull

**3. Outline the trends illustrated by the fossils of *Ardipithecus*, *Australopithecus* and *Homo*.** *6 marks*

* all three genera are hominids
* increasing adaptation to bipedalism / forward movement of foramen magnum
* increasing brain size in relation to body size
* hominids originated in Africa and spread to other continents
* *Ardipithecus* / *Australopithecus* / *Homo* fossils found in Africa
* *Homo erectus* fossils found in Africa and in Asia
* *Homo neanderthalensis* fossils found in Europe
* *Homo sapiens* fossils found in all continents except Antarctica
* decreasing relative size of face / jaw / teeth / canines
* increasing relative size of brain case / forehead

**4. Discuss the incompleteness of the fossil record and the resulting uncertainties with respect to human evolution.** *5 marks*

* because the hominid fossil record is incomplete it is unclear how the various hominid species are related
* the fossil record for hominids is incomplete because it is difficult for remains of animals living in arid or semi-arid habitats to fossilize
* fossils only form when buried under sediment / before decomposition occurs
* animal bodies are usually easten by detritivores / decomposed by bacteria / broken down chemically
* therefore few fossils found of savanna-dwelling hominids
* most remains fossilized remain buried in sediment / remain unfound
* hominid fossils that have been found may not be representative of hominid history
* hominid fossils that have been found are usually partial / the remainder of the organism must be inferred / inferences may not be correct
* only hard parts of individuals fossilize leaving many questions concerning the rest of phenotype

**5. Discuss the the correlation between the change in diet and increase in brain size during hominid evolution.** *8 marks*

* early hominids / *Australopithecus* brain sizes were similar in size to those of apes
* early hominids / *Australopithecus* had powerful jaws / teeth indicate (mainly) vegetarian diet
* About 2.5 million years ago Africa became much cooler and drier
* About 2.5 million years ago savanna grassland replaced forest
* climate change may have prompted evolution of *Homo*
* climate change may have prompted better / more sophisticated tools
* climate change may have prompted change to hunting / killing large animals / increasing meat in diet
* change in diet corresponds to the start of increase in hominid brain size
* in apes and early hominids, brain growth slows after birth
* *Homo* has rapid brain growth after birth
* eating meat increases supply of protein / fat / energy making larger brain growth possible
* hunting / killing prey on savannas is more difficult than gathering plant foods
* natural selection possibly favored larger brains / greater intelligence

**6. Distinguish between *genetic* and *cultural* evolution.** *6 marks*

*genetic evolution: max 3 marks*

* genetic evolution is a product of selection for (adaptive) genes
* genetic evolution produces heritable traits
* genetic evolution is physically inherited as genes / coded within DNA
* genetic evolution is affected by random mutation
* natural selection determines likelihood of genetic inheritance
* acquired characteristics are not inherited
* genetic evolution occurs slowly / as gene pools alter gradually;

*cultural evolution: max 3 marks*

* cultural evolution is inherited from the environment
* cultural evolution is inherited independent of DNA
* cultural evolution is (specific) learning / learning done during one's lifetime
* cultural evolution can be directed
* selection determines likelihood of inheritance;
* cultural evolution can occur rapidly
* genetic evolution is nature whereas cultural evolution is nurture

**7. Discuss the relative importance of genetic and cultural evolution in the recent evolution of humans.** *2 marks*

* genetic evolution continues to produce the phenotype of humans
* cultural evolution has played an increasingly greater role in the lives of humans over time
* genetic change happens too slowly to produce the huge changes in human culture
* some cultural changes have reduced natural selection pressures

**8. Describe the adaptations for tree life which are found both in humans and in other primates.** *4 marks*

*If a* ***list*** *of adaptations only is given, award 3 marks maximum.*

* grasping limbs / fingerprints / fingerpads / nails
* needed for grasping / holding on to / climbing trees (branches)
* rotating forelimb / shoulder blade (scapula) on back of thorax / free wrist movement / well developed clavicle
* allows hanging from arms / arms support the weight of the body
* stereoscopic / binocular vision
* to judge distances

**9. Explain the Hardy-Weinberg equation and why it is used.** *6 marks*

* mathematical model for genetic equilibrium / from which predictions can be made
* used for sexually reproducing species / breeding must be random / population large / no migration / no selection / no mutation
* used to calculate allele / genotype frequency
* by sampling from a *population*
* allele frequencies / genotype frequencies remain constant through generations / no change
* if there is an observed change it suggests evolution is occurring (*do not accept just natural selection*) / population is no longer in equilibrium
* p and q represent the frequencies of two *alleles* of a gene
* frequency of alleles adds to 1 / (p + q)2
* (genotype frequencies) p2 + 2pq + q2 = 1
* p2 and q2 are the frequencies of the homozygotes
* 2pq is the frequency of the heterozygotes

**10. State *three* conditions under which the Hardy-Weinberg Principle does *not* operate.** *3 marks*

* natural selection
* non-random mating
* mutation
* migration / emigration / immigration / gene flow
* population(s) too small

**11. Outline the value of classifying organisms.** *4 marks*

* classification arranges organisms into groups
* classification allows identification of species / organisms
* classification allows prediction of related taxa / based on common characteristics
* classification reveals evolutionary links / shared derived characteristics / inherited from common ancestors
* classification allows effective communication / all scientists use same terminology
* classification avoids problem of convergence / ignores analogies
* classification emphasizes homologous structures / traits derived from common ancestry

**12. Explain the biochemical evidence for the common ancestry of living organisms.** *5 marks*

*details of biochemical evidence: 4 marks max*

* DNA structure is universal / same four nucleotides / adenine, guanine, cytosine, and thymine
* RNA composed of same four nucleotides / adenine, guanine, cytosine, and uracil
* ribosome structure is universal / composed of large and small subunits / proteins and rRNA / site for mRNA attachment / two sites for tRNA attachment
* protein structure is universal / composed of polymers / made of the same 20 amino acids
* genetic code is universal / same codons for determining amino acid sequence
* ATP is universal energy molecule / energy source for metabolism
* glycolysis is universal / biochemical pathway producing ATP from glucose
* membranes structure is universal / proteins and phospholipid bilayer

*conclusion: 1 mark max*

* biochemistry (near) identical in all organisms, therefore likely related by common ancestry

**13. Explain how variations in specific molecules can indicate phylogeny.** *4 marks*

* differences between molecules can be used to deduce phylogeny
* phylogeny is the evolutionary history of a (taxonomic) group
* mutation rates in DNA occur with predictable rates
* compare nucleotide sequences (of DNA) between taxa
* compare amino acid sequences (of proteins) between taxa
* differences can be used as a molecular clock
* to develop phylogeny
* to determine time since common ancestry

**14. Discuss how biochemical variations can be used as an evolutionary clock.** *5 marks*

*methods of using evolutionary clocks: 3 max*

* differences in nucleotide base sequences / DNA / amino acid sequences / proteins
* accumulate gradually over time
* differences accumulate at (roughly) predictable rates
* therefore the number of differences can be used as a clock
* to measure the time since two divergent groups shared a common ancestor
* example; e.g. amino acid sequences in globin genes

*problems with using evolutionary clocks: 2 max*

* however variations are partly due to mutations
* which are unpredictable chance events
* so there must be caution in interpreting data
* establish a variety of molecular clocks for reliability

**15. Distinguish, with examples, between *analogous* and *homologous* characterisitcs** *4 marks*

*analogous characteristics: 2 marks max*

* analogous characteristics are structures with a common function
* but a different evolutionary origin
* example: dolphin fins and shark fins

*homologous characteristics: 2 marks max*

* homologous characteristics are structures that have a common evolutionary origin
* even if they have different functions
* example: dolphin forelimbs and human arms

**16. Discuss the relationship between cladograms and the classification of living organisms.** *4 marks*

* cladograms (often) confirm existing classifications
* since both are based on phylogeny
* cladograms are (sometimes) different than traditional classifications
* because nodes can be placed at any point / arbitrary
* cladograms (sometimes) radically alter existing classifications
* example: birds grouped with dinosaurs
* strength of cladistics is that the comparisons are objective / rely on molecular homologies
* weakness of cladistics is that molecular differences are based on probabilities

**Previous IB Exam Essay Questions: Unit 12**

Use these model essay questions and responses to prepare for essay questions on your in-class tests, as well as the IB Examination, Paper 2. The questions below have appeared on IB HL Examinations over the past several years. The answers following the questions are the mark-scheme ideal responses used to evaluate student examination responses.

**1. Draw a labeled diagram of the human digestive system.** *5 marks* **SL**

*Award one mark for every* ***two*** *of the following structures clearly drawn and labeled correctly. Connections between organs must be correct for full marks*

* mouth/ teeth/ tongue
* esophagus
* stomach
* small intestine
* large intestine/colon
* anus
* rectum
* sphincters
* salivary glands
* liver
* pancreas
* gall bladder

**2. Describe the role of enzymes in the digestion of proteins, carbohydrates and lipids in humans.** *6 marks* **SL**

*Award one mark per role.* *Examples of specific enzymes:*

* protease/trypsin/pepsin/chumotrypsin/other named protease digest proteins into polypeptides/ dipeptides/ amino acids/ peptides
* lipase digest lipids into glycerol/ fatty acids
* amylase digest polysaccharides into disaccharides/ monosaccharides

*Enzymes must match products.*

* speed up/ catalyze reactions/ increased efficiency
* lower the (activation) energy required for digestive reactions to occur
* occurs at body temperature
* require optimum pH
* enzymes are specific
* digestive enzymes carry out hydrolytic processes

**3. Draw a diagram of a villus in vertical section.** *5 marks* **SL**

*Award one mark for each of the following structures clearly drawn and labeled correctly.*

* lymph vessel
* arteriole
* venule
* (central) lacteal
* capillary network
* epithelial layer/ lining/ epithelium
* microvilli
* goblet cells

**4. State the sources, substrate, product, and optimum pH conditions for the enzyme amylase.** **SL**

* *source*:

salivary glands

pancreas

* *substrate*: starch/ glycogen (*do not accept carbohydrate*)
* *product*: maltose/ disaccharide
* *optimum pH*: 7-8/ neutral - slightly alkaline

**5. Explain how the structure of the villi in the small intestine are related to absorption of digested food.** *3 marks* **SL**

*Award marks for a clearly drawn and correctly labelled diagram.*

* large surface area by microvilli / protrusion of exposed parts
* epithelium only one layer thick
* protein channels allow facilitated diffusion and active transport
* mitochondria provide ATP
* blood capillaries close to epithelium/ surface
* absorption of glucose/ amino acids
* lacteal / lymphatic vessel in center to absorb fats
* tight junctions assist in controlling absorption

**6. Describe the role of enzymes in digestion with reference to two named examples.** *5 marks* **SL**

* large food molecules must be broken down
* such as carbohydrates/ proteins, *etc.*
* by hydrolysis of bonds / to form monomers
* in preparation for absorption
* rate of reaction at body temperature too slow
* enzymes increase the of breakdown / act as catalysts
* first enzyme example - name, substrate and product
* second enzyme example - name, substrate and product

*Award* ***3 max*** *if no examples given*

**7. Draw a labelled diagram to show the internal structure of the heart.** *6 marks* **SL**

*Award one mark for each of the following structures clearly drawn and labelled correctly in a diagram of the heart*

* left and right ventricles
* left and right atria
* atrioventricular valves / bicuspid / mitral and tricuspid valves
* semilunar valves
* aorta and vena cava
* pulmonary artery and pulmonary vein
* ventricle thicker than atria
* left ventricle wall thicker than right ventricle wall

*Do not award marks for a diagram with only the ventricles* ***or*** *atria. However, it is not necessary to show the cordae tendinae.*

**8. Draw a labelled diagram of the heart showing all four chambers, associated blood vessels and valves.** *5 marks* **SL**

*Award one mark for* ***any two*** *of the following clearly drawn and correctly labelled.*

* vena cava
* inferior and superior vena cava distinguished
* aorta
* pulmonary artery
* pulmonary vein
* left ventricle
* right ventricle
* left ventricle shown with thicker wall than right ventricle
* septum
* left atrium
* right atrium
* coronary artery
* two semi-lunar valves
* AV valves
* bicuspid and tricuspid valves distinguished

**9. Outline the events that occur within the heart, which cause blood to move around the body.** *6 marks* **SL**

* blood is collectred in the atria
* blood is pumped from the atria to the ventricles
* opened atrio-ventricular valves allow flow from the atria to the ventricles
* closed semi-lunar valves prevent backflow from the arteries to the ventricles
* blood is pumped out from the ventricles to the arteries
* open semi-lunar valves allow flow from ventricles to arteries
* closed atrio-ventricular valves prevent backflow to the atria
* pressure generated by the heart causes blood to move around the body
* pacemaker (SAN) initiates each heartbeat

**10. Explain the relationship between the structure and function of arteries, capillaries and veins.** *9 marks* **SL**

(*3 marks maximum for information on arteries.*)

* carry blood away from the heart
* have thick walls to withstand high pressure / prevent bursting
* have muslce fibers to generate the pulse / help pump blood / even out blood flow
* have elastic fibers to help generate pulse / allow artery wall to stretch / recoil

(*3 marks maximum for information on capillaries.*)

* allow exchange of oxygen/carbon dioxide/ nutrients/waste products from tissues/cells
* have a thin wall to allow (rapid) diffusion / movement in / out
* have pores / porous walls to allow phagocytes / tissue fluid to leave
* are narrow so can penetrate all parts of tissues / bigger total surface area

(*3 marks maximum for information on veins.*)

* carry blood back to the heart / from the tissues
* have thinner walls because the pressure is low / to allow them to be squeezed
* have fewer muscle / elastic fibers because there is no pulse / because pressure is low
* have valves to prevent backflow

**11. Draw a simple diagram of the gas exchange system in humans.** *5 marks* **SL**

*For a diagram of the whole gas exchange system, award 1 mark for each of the following structures clearly drawn and labeled correctly.*

* trachea
* lungs
* bronchi
* bronchioles
* lungs (2 must be shown)
* intercostal muscles between ribs
* diaphragm

*For a diagram of an alveolus only, award 1 mark for each of the following structures clearly drawn and labeled correctly.*

* alveolus
* bronchiole

**12. Describe the mechanism of ventilation in the human lung.** *5 marks* **SL**

* consists of inhaling and exhaling air / exchanging stale air with fresh air (with the environment)
* external intercostal muscles contract moving the rib cage up/out
* diaphragm contracts
* increaes volume of thorax / lowers lung pressure relative to air pressure / pulls air in
* diaphragm relaxes
* abdominal muscles contract
* internal intercostal muscles contract moving the rib cage down/in
* force air out / decreases volume of thorax / raise lung pressure relative to air pressure

**13. Describe the need for a ventilation system.** *6 marks* **SL**

* (small) animals obtain oxygen (by diffusion) through skin / in humans (large) animals skin is ineffective for ventilation
* humans are large / have a small ratio of surface area:volume
* so need ventilation system to increase surface area
* to maintain a concentration gradient in alveoli
* as oxygen is used in respiration (and carbon dioxide is produced)
* gaseous exchange occurs between air in alveoli and blood capillaries
* alveoli have high ratio of surface area:volume (to facilitate ventilation)
* to bring in fresh air (and remove stale air)

**14. Explain the need for, and mechanism of, ventillation of the lungs in humans.** *8 marks* **SL**

* draws fresh air / oxygen into the lungs
* removal / excretion of carbon dioxide
* maintains concentration gradient of oxygen / carbon dioxide / respiratory gases
* diaphragm contracts
* (external) intercostal muscles contract
* increased volume (of thorax / thoracic cavity)
* decreasing air pressure in lungs
* air rushes in down air pressure gradient
* converse of the above causes exhalation
* abdominal muscles contract during active exhalation
* elastic recoil of lungs helps exhalation

**15. Many processes in living organisms, including ventilation and gas exchange, involve moving materials. State the differences between ventilation and gas exchange in humans.** *4 marks* **SL**

*ventiallation:* *2 max*

* movement of air
* movement in and out of the lungs
* caused by muscles
* an active process
* involves mass flow / involves flow along air passages

*gas exchange* *2 max*

* movement of carbon dioxide and oxygen
* (occurs when) oxygen moves from lungs / alveoli to red blood cells / carbon dioxide moves to lungs / alveoli from red blood cells
* (occurs when) oxygen moves from red blood cells to tissues / carbon cioxide moves to red blood cells from tissues
* a passive process / diffusion
* takes place across a surface

**16. Describe homeostasis in relation to blood glucose concentration in humans.** *6 marks* **SL**

* homeostasis is maintaining internal environment at constant levels/within narrow limits
* homeostasis involves both nervous and endocrine systems
* low blood glucose triggers glucagon release
* glucagon is produced å-islet cells in pancreas
* glycogen is converted to glucose
* high blood glucose concentration triggers insulin release
* insulin produced by ß-islet cells in pancreas
* glucose taken up by (liver/muscle) cells
* glucose converted to glyocgen
* blood gluose levels controlled by negative feedback
* correct reference to lowering or raising blood glucose levels

**17. Define, with examples, the term homeostasis.** *4 marks* **SL**

* keeping conditions constant/ within narrow limits
* within the body/ internal environment
* *e.g.*, temperature in humans kept at 37 degrees C/ other example
* *e.g.*, blood sugar/ glucose in humans kept within limits/ other example

**18. Explain how blood glucose concentration is controlled in humans.** *9 marks* **SL**

* homeostasis maintains the internal blood glucose levels between narrow limits
* 70-110 mg glucose per 100 ml blood
* blood glucose level is maintained by negative feedback
* islets in pancreas monitor blood glucose levels
* after meal blood glucose increases
* high blood glucose stimulates release of insulin
* (release of insulin) by pancreatic islets/ by ß-cells
* causes muscles/ adipose tissue and liver to store glycogen
* glucose stored in the form of glycogen (in muscle/ liver)
* storage lowers blood glucose levels
* if blood glucose levels drops glucagon secreted
* secrete glucagon by pancreatic islets/ by å-cells
* this causes liver to break down glycogen (to glucose)
* glycogen breakdown causes blood glucose level increase

**19. Describe the response of the human body to low external temperatures.** *4 marks* **SL**

* thermoreceptors/ sensory input
* hypothalamus acts as a thermostat
* metabolic rate increases
* shivering / goose bumps / hairs raising / swet glands inactive
* vasoconstriction of skin arterioles
* blood flow from extremities is reduced / blood flow to internal organs is increased
* increased activity
* heat is transferred in blood

Use these model essay questions and responses to prepare for essay questions on your in-class tests, as well as the IB Examination, Paper 2. The questions below have appeared on IB HL Examinations over the past several years. The answers following the questions are the mark-scheme ideal responses used to evaluate student examination responses.

**1. Outline how the skin and mucous membranes prevent entry of pathogens into the body.** *5 marks*

*To receive full marks, responses must have* ***two*** *answers for each.*

*skin: 3 max*

* lower pH/ acid to keep bactgeria from growing/ chemical barrier
* fatty acids/ waxes antimicrobial
* physical barrier to prevent entry/ dry skin inhibits bacterial growths
* bacteria on skin/ mucous membranes prevent other bacteria from growing
* antimicrobial/ lysozyme in sweat and saliva (mucous membrane) to keep bacterial growth in check

*mucous membranes: 3 max*

* mucous traps bacteria/ sticky/ mucous slightly acidic *e.g. vagina*
* cilia sweep mucous up to be swallowed to kill bacteria
* contain macrophages/ phagocytes

**2. Discuss the benefits and dangers of vaccinations against bacterial and viral infections.** *8 marks*

*general statements: 3 max*

* vaccinations stimulate antibody production/immunity
* against/resistance to specific pathogens/artificial immunity
* use either weakened pathogens or specfic antibodies
* primary response to first vaccination/secondary response to second vaccination
* memory cells (are cloned) maintain long-term immunity

*benefits: 3 max*

* eradicated some diseases *e.g.* smallpox/ polio
* decrease child mortality
* MMR/mumps, measles and rubella prevent long-term health problems
* *e.g.* deafness/ blindness/ heart damage from rubella/ male infertility from mumps
* prevent epidemics/ pandemics

*dangers: 3 max*

* too many vaccinations may lower body's immunity to new diseases
* immunity may not be life-long/ may have severe version as adults *e.g.* measles
* some vaccines may cause serious side effects
* *e.g.* whooping cough vaccine may cause encephalitis/ toxic effects (Hg) in some vaccines/ allergic reactions
* may contract disease from vaccine

**3. Explain the principle of immunization against bacterial or viral diseases.** *3 marks*

* **vaccine** injected / ingested / vaccination given
* contains weak / killed form of the bacterium /virus
* antibody production (by white blood cells) stimulated
* antibodies / memory cells persist
* refer to booster shots / repeated vaccination

**4. Define the terms active and passive immunity.** *2 marks*

* active immunity - production of antibodies by the organism itself
* passive immunity - acquisition of antibodies from another organism / from elsewhere

**5. Explain the role of antibody production with regard to vaccinations.** *8 marks*

* vaccine injected into body / ingested
* containing killed / weakened pathogen / fragments of pathogen / toxins
* macrophages ingest antigen / antigen presenting cells ingest antigen
* T-helper cells bind to macrophages
* T-helper cells stimulated / activated
* antigen binds to B-cells
* activated T-helper cells then bind to B-cells
* activation of B-cells
* which divide / undergo mitosis to form clones of (plasma) cells
* B-cells / plasma cells produce antibodies
* memory cells produced
* second / booster shot sometimes given
* more antibodies and faster response / graph to show this
* antibodies are specific to antigen

**6. Explain the production of antibodies against a pathogen.** *8 marks*

* antigen/pathogen engulfed by macrophage (by endocytosis)
* presentation of antigen by macrophage on membrane/MHC protein
* helper T-cell binds to macrophage
* helper T-cell activated
* activated helper T-cell binds to (inactive) B-cell
* B-cell is activated by helper T-cell
* B-cells start to divide/clone
* plasma cells formed/grow
* plasma cell increaes numbers of rough ER/Golgi apparatus
* B cells/ clone / plasma cells begin to produce antibodies to the specific antigen
* antibodies secreted/ pass out through membrane (by exocytosis)
* memory cells give long-term immunity/ allow rapid antibody production

**7. Explain why antibotics are used to treat bacterial but not viral diseases.** *2 marks*

*No credit for answers that state antibiotic means against life nor for the statement that viruses are not alive.*

* antibiotics block metabolic pathways in bacteria / inhibit cell wall formation / protein synthesis
* viruses use host cell metabolic pathways / do not possess a cell wall and so are not affected by antibiotics
* antibiotics are not used to treat viral diseases because they are ineffective and may harm helpful bacteria

**8. Describe the production of monoclonal antibodies.** *2 marks*

* (B) lymphocyte obtained that produces the desired antibody
* (B) lymphocyte fused with myeloma / tumor cells
* (hybridoma) cells formed in this way are cultured to produce antibodies

**9. Outline the role of fibrinogen.** *2 marks*

* soluble substance that can be converted to insoluble substance
* converted to fibrin (in cuts)
* helps to form a **clot**
* to seal a cut / prevent more blood loss / prevent entry of infection

**10. Describe the process of clotting.** *5 marks*

* blood vessel damaged
* clotting factors released from damaged cells / platelets / blood plasma
* clotting factors include Ca2+ and vitamin K
* thrombin produced
* clotting factors cause production of thrombin / conversion of prothrombin to thrombin
* thrombin converts fibrinogen into insoluble fibrin
* fibrin traps cells to form a clot

**11. Explain the role of antibody production and the principle of vaccination in immunity.** *8 marks*

*antibody production:*

* exposure to antigen
* leads to activation of (helper) T-cells
* leads to clonal selection / activation of specific type of B-cell
* production of plasma cells
* specific antibody produced
* memory cells produced which provide long lasting immunity

*principle of vaccination:*

* artificial exposure to antigen / artificial active immunity
* use dead / attenuated pathogen / protein material
* first vaccination produces lymphocytes specific to antigen
* booster shot causes more intense response / graph to show this
* immunity to disease before actually contracting the disease

**12. Polio is a viral disease which affects the nervous system. Describe the different ways in which the body could acquire immunity to this disease.** *6marks*

* natural immunity by catching the dieases
* antigen presentation by macrophages/MHC proteins
* helper T-cells activated
* lymphocytes/ B-cells react forming antibodies
* clonal selection/ multiply when they encounter antigen
* polyclonal if more than one clone formed
* memory cells formed
* natural passive immunity by placenta/ breast feeding
* artificial active by vaccination/ Sabin vaccine/ Salk vaccine
* artificial passive by injection of antibodies

**13. Discuss the cause, transmission and social implication of AIDS** *8 marks*

*the answer must include at least one reference to cause, transmission, and social implications in order to receive full marks*

*cause:*

* acquired immunodeficiency syndrome
* caused by HIV/ human immunodeficiency virus
* retrovirus/ RNA to DNA
* enters (and lowers number of) T-helper cells
* less antibodies produced/ immune system disabled/ weakened
* body vulnerable to pathogens (opportunistic infections)

*transmission*

* transmission through body fluids/ does not live long outside the body
* through sexual intercourse
* sharing of infected needles
* mother to fetus/ across placenta
* blood transfusions
* blood products/ factor VIII used to treat hemophiliacs

*social implications*

* families and friends sugger grief
* great costs/ reduction in workforce/ economic implications
* discrimination/social stigma
* increase in number of orphans/ family structure/ stability affected
* reduces promiscuity/ encourages use of condoms

**14. Tuberculosis is a disease of the ventilation system. Explain how white blood cells attack the pathogens that cause this disease.** *8 marks*

* B-cells/ lymphocytes produce antibodies
* antigen recognized
* antigen can be protein in cell wall of pathogen
* macrophage presentation of antigen
* clone formed/ division of cells
* T-helper cells assist
* formation of antigen-antibody complex (neutralization/agglutination/precipitation)
* phagocytes engulf
* engest by endocytosis
* pathogen kills
* digested by lysosomes
* formation of memory cells

**15. Blood vessels carry blood to and from the kidney. Draw a labelled diagram to show the internal structure of the kidney, including the vessels that are connected to it.** *5 marks*

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

* cortex, shown at the edge of kidney
* medulla, shown inside the cortex (with pyramids)
* pelvis, whown on the concave side of the kidney
* ureter, shown connecting with the pelvis/; on concave side/ hilum
* renal artery, shown connected to the concave/ pelvis side/ away from cortex
* renal vein, shown connected to the concave/ pelvis side/ away from cortex

**16. Explain briefly the function of the loop of Henle in the human kidney.** *2 marks*

* makes the medulla hypertonic / have higher solute concentration / more negative water/ solute potential
* by raising the sodium / mineral ion concentration / release of sodium ions into medulla / out of the ascending limb
* allows the production of hypertonic / concentrated urine / urine with less water / more water absorption in collecting duct

**17. Compare the composition of the blood arriving at the kidney via the renal artery with the composition of the blood carried away from it in the renal vein.** *4 marks*

* more oxygen in the renal artery/ less in the renal vein/ oxygenated versus deoxygenated
* less carbon dioxide in the renal artery/ more in the renal vein
* more urea in the renal artery/ less in the renal vein
* more ammonia/ ethanol/ toxins/ hormones in the renal artery/ less in the renal vein

*reject answers for the points above if "none" instead of "less" is indicated*

* more salt/NaCl/ Na+/ Cl-/ ions (in total) in renal artery than in renal vein
* more water (in total) in renal artery than in renal vein
* with ADH, lower salt concentration/ higher water concentration in vein than in artery

**18. Define excretion and osmoregulation.** *4 marks*

* removal of toxins / waste products from an organism
* waste products of metabolism
* control of water potential / level / content in a cell / organism
* and control of solute / osmotic potential / concentration

**19. explain how hypertonic urine is produced in the medulla of the human kidney.** *4 marks*

* water reabsorbed from urine / filtrate
* as it passes down the collecting ducts / last part of nephron
* by osmosis
* because water potential of medulla is lower / solute concentration is higher
* high salt / sodium ion / urea concentration in the medulla
* generated by the loop of Henle
* sodium passes from filtrate in the loop of Henle to the medulla
* in the ascending limb
* by active transport
* water in the medulla carried away by the blood system
* ADH makes the collecting duct wall permeable to water

**Previous IB Exam Essay Questions: Unit 14**

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. Outline the general organization of the nervous system.** *4 marks*

* formed of central nervous system
* brain and spinal cord
* peripheral nervous system divdided into volumtary and autonomic nervous systems
* autonomic nervous system consists of sympathetic and parasympathetic nervous system
* voluntary nervous system has motor and sensory neurons

**2. Draw a diagram to show the structure of a motor neuron.** *5 marks*

* cell body drawn and labelled with a nucleus shown inside *(reject if cell body not drawn at end of axon)*
* axon drawn at least three times as long as the diameter of the cell body and labelled
* Schwann cells / mylin sheath drawn and labelled
* gaps in the myelin sheath drawn and labeled
* at least five dendrites drawn leading to the cell body labelled
* at least two motor end plates / boutons / synaptic knobs / synaptic terminals drawn and labelled

**3. Outline the changes that lead to the depolarization of an axon as an action potential travels along a neuron.** *5 marks*

* local currents / ions diffuse from adjacent depolarised section of axon
* resting / membrane potential reduced
* voltage-gated ion channels affected
* sodium channels open
* sodium diffuses in / moves in rapidly
* therefore fewer positive charges outside and more inside / inside becomes positive relative to outside / membrane polarity reversed
* before depolarisation outside was positive relative to inside
* when some sodium gates open entry of Na+ causes more sodium gates to open
* membrane potential rises from -70mV to +40 mV ( -+ 10 mV)

*(Award no marks for statements about potassium movement and repolarisation)*

**4. Explain how the nerve impulse passes along a neuron.** *8 marks*

* in resting potential
* sodium is pumped out by the active transport and potassium in
* a concentration gradient builds up electrical potential / voltage
* negative inside compared to outside
* when impulse passes / action potential
* must pass threshold level
* sodium channels open and ions diffuse into neuron
* membrane depolarized
* potassium diffuse out across membrane through ion channels
* active transport of ions once more
* slower in un-myelinated neuron than in myelinated
* an action potential in one part of the neuron causes the action potential to develop in the next section

**5. Explain how a non-mylenated neuron can maintain a resting potential and undergo an action potential.** *9 marks*

*(Award 1 mark for each point below; up to 9 marks max.)*

* resting potential is a charge difference across the membrane / -70mV
* inside negative compared to the outside
* active transport of ions across the membrane / pumps using ATP
* positively charged sodium ions / Na2 are pumped out
* fewer K+ are pumped in / 2 K+ compared to 3 Na+
* neurone contains negatively charged organic ions
* membrane allows little / no diffusion of ions
* to create action potential sodium ion channels open
* sodium ions move into the neurone
* therefore there is depolarisation / membrane polarisation is reversed
* this causes similar changes further on along the neurone
* reference to diffusion of ions / local currents
* potassium ion channels open after the sodium ion channels
* potassium diffuses out causing some repolarisation

**6. Explain how a nerve impulse is transmitted from a neuron to a muscle.** *8 marks*

* impulse reaches the motor end plates / synaptice knobs / boutons / synaptic terminals
* synaptic vesicles contain neurotransmitter / acetylcholine
* calcium enters through the presynaptic membrane
* calcium causes the vesicle to move to and fuse with the membrane / causes exocytosis
* neurotransmitter / acetycholine released into the synaptic cleft
* crosses / diffuses across the synoptic cleft to the muscle fibre membrane / postsynaptic membrane
* binds to receptor sites
* causes depolarisation of the muscle fibre membrane / postsynaptic membrane
* by opening sodium gates
* threshold of stimulation must be reached / all or nothing effect
* enzyme / acetylcholinesterase breaks down the neurotransmitter / acetylcholine
* depolarisation causes sarcoplasmic reticulum to release calcium ions
* calcium ions cause / enable muscle contraction

**7. Describe the principles of synaptic transmission in the nervous system.** *6 marks*

* nerve impulse reaches pre-synaptic knob / membrane
* calcium ions / Ca+2 enter pre-synaptic neuron / knob
* vesicles with neurotransmitter / acetylcholine release contents
* neurotransmitter diffuses across synapse / synaptic cleft
* binds to receptors on post-synaptic neuron / membrane
* sodium ions / Na+ enter post-synaptic neuron / sodium channels open
* depolarization / action potential / nerve impulse (in post synaptic neuron)
* calcium ions / Ca+2 pumped back into synaptic cleft / synapse
* neurotransmitter broken down

**8. Explain the process of synaptic transmission.** *7 marks*

* presynaptic neurons pass stimulus / potential to postsynaptic neurons
* presynaptic neuron releases neurotransmitter into synaptic cleft
* process involves exocytosis
* exocytosis requires Ca+2 entry into presynaptic neuron
* neurotransmitter binds with postsynaptic membrane receptor
* neurotransmitter binding can cause postsynaptic membrane ion channel to open / increase / change permeability of post-synaptic membrane
* increase / change permeability of post-synatic membrane
* open channel allows specific ions to enter / exit post-synaptic membrane
* depolarization / hyperpolarization can result in / initiate action potential
* outcome depends on type of postsynaptic receptor and type of channel opened ; reference to excitatory and inhibitory synapses
* Na+ passing to the inside of the post-synaptic neuron (usually) causes depolarization
* Cl- passing to the outside of the post-synaptic neuron (usually) causes hyperpolarization
* (some) neurotransmitters are destroyed by enzymes

*Accept any of the above points if accurately illustrated in a diagram.*

**9. Draw a labelled diagram of the human elbow joint.** *4 marks*

*Award* ***1*** *for every two of the following structures clearly drawn and labelled correctly.*

* humerus
* radius
* ulna
* cartilage (on ends of bones)
* ligaments (connecting humerus with radiuus / ulna)
* capsule (sealing joint)
* synovial fluid
* biceps (attached to radius)
* triceps (attached to ulna)
* tendons (connecting muscle to bone correctly)

**10. Describe the roles of structures at the elbow joint, including nerves, muscles and bones, in movements of the human forearm.** *8 marks*

* labelled diagram showing, biceps, humerus, radius, ulna
* cartilage reduces friction
* synovial fluid lubricates the joint
* capsule / capsular ligament seals the joint
* ligaments prevent dislocation / restrict the range of movement / attach bones to one and another
* motor neurones stimulate muscles to contract
* bones provide a firm anchorage for muscles
* bones act as levers / change the torque / size / direction of forces
* tendons attach muscle to bone
* biceps and triceps are antagonistic
* biceps is the flexor / bends the elbow **and** triceps is the extensor / straightens the elbow joint
* biceps is attached to the radius and triceps is attached to the ulna

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

**11. Describe the roles of nerves, muscles and bones in producing movement.** *6 marks*

* motor neurones carry impulses / messages to muscle
* nerves / neurones stimulate muscles to contract
* neurones control the timing of muscle contraction
* muscles provide the force for / cause movement
* muscles are attached to bone by tendons
* bones act as levers
* joints between bones control the range of movement
* antagonistic muscles cause opposite movements

**12. Explain how a muscle fibre contracts, following depolarization of its plasma membrane.** *6 marks*

* calcium released from sarcoplasmic reticulum
* calcium binds to troponin
* troponin with calcium bound makes tropomyosin move
* movement of tropomyosin exposes binding sites (for myosin) on actin
* contraction of muscle fibres is due to the sliding of filaments (over each other)
* myosin heads bind to / form cross bridges with actin
* ATP binds to the myosin heads causing them to detach from the binding sites
* hydrolosis of ATP / conversion of ATP to ADP causes myosin heads to move
* myosin heads reattach to actin further along
* myosin pushes actin / actin pushed towards the centre of the sarcomere / shortening of sarcomere

**13. Explain how skeletal muscle contracts.** *9 marks*

* muscles / fibres / myofibrils contain (repeating) units called sarcomeres
* muscle / sarcomeres contain actin filaments and myosin filaments
* actin fibres are thin and myosin fibres are thick
* arriving action potential causes release of Ca+2
* Ca+2 binds troponin
* causing troponin and tropomyosin to move (on actin)
* ATP binds to myosin heads releasing them / breaking cross bridges
* ATP hydrolysed / split into ADP + P
* ATP / energy causes myosin heads to change shape / swivel / become cocked
* myosin heads bind / form cross bridges to (exposed) actin binding sites
* myosin heads swivel / move actin (releasing ADP+ P)
* myosin filaments move actin filaments towards centre of sarcomere

**14. Explain the process of muscle contraction.** *9 marks*

*(Award* ***1 mark*** *for each of the following, up to* ***9 marks****)*

* muscles contraction due to sliding filaments
* actin and myosin filaments slide over each other
* diagram / description of interdigitation of filaments
* action potential / stimulation causes calcium release in muscle fibres
* from the endoplasmic / sarcoplasmic reticulum
* calcium activates troponin
* troponin binds to tropomyosin / troponin and tropomyosin change shape
* tropomyosin moves exposing binding sites on actin
* myosin heads bind to actin / cross bridges formed between actin and myosin
* myosin heads / crossing bridges push actin filaments (inwards)
* myosin heads detach / cross bridges break
* myosin heads move back and reattach / ratchet mechanism
* ATP used (to break cross bridges)
* actin and myosin overlap more
* sarcomere becomes shorter
* myofibril / muscle fibre consists of many sarcomeres

**Unit 15 Previous IB Exam Essay Questions: Neurobiology**

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. Compare the sensitivities of rod and cones cells to differences in light.** *4 marks*

*maximum 1 mark for comparing sensitivity to light intensity: dim light* ***versus*** *bright light:*

* rods especially effective in dim light whereas cones insensitive to dim light
* rods effective under all conditions whereas cones especially effective in bright light

*maximum 1 mark for comparing sensitivity to light wavelength: all wavelengths* ***versus*** *specific wavelengths*

* rods have one type of pigment sensitive to all visible wavelength whereas cones sensitive to different wavelengths
* rods have one type of pigment whereas cones have pigments sensitive to either red, green or blue

*maximum 2 marks for comparing passage of impulse from photoreceptor to bipolar neuron:*

* rods dispersed throughout peripheral retina whereas cones are concentrated only in the fovea
* several rods synapse with a single bipolar neuron whereas each cone cell individually synapses with its own single bipolar neuron
* 3:1 ratio of rods to bipolar neurons whereas 1:1 ratio in cones
* rods have greater sensitivity to low light intensity whereas cones have lower sensitivity to low light intensity
* rods have poorer discrimination of detail whereas cones provide finer discriminatory sensitivity

**2. Draw a labelled diagram showing the main parts of the human brain. State one function for each of two structures labelled in your diagram.** *6 marks*

*Award one mark for up to four of the following structures clearly drawn and correctly labelled* *Award one mark for up to two of the following functions correctly matched with one of the structures clearly drawn and correctly labelled*

* cerebral hemispheres: complex thought / memory / learning / problem solving
* hypothalamus: controls secretion of hormones by the pituitary gland / hunger / thirst
* cerebellum: co-ordinates muscle movement / controls balance
* medulla oblongata: controls autonomic reflexes, *e.g.* breathing rate / heart rate / regulates blood pressure / coughing
* pituitary gland: secretes hormones that control many processes in the body

**3. Compare the roles of the parasympathetic and sympathetic nervous systems.** *4 marks*

* both are part of the autonomic nervous system
* antagonistic to each other / counteracts
* the sympathetic prepares the body for action while the parasympathetic returns the body functions to normal
* example of any effect comparing the action of the sympathetic and parasympathetic systems in a tissue or organ (*e.g.* heart: sympathetic increases output and parasympathetic returns it back to normal)
* a second example

**4. Compare the effects of the sympathetic and parasympathetic nervous systems with reference to the heart.** *6 marks*

*sympathetic and parasympathetic nervous systems*

* antagonistic / have opposite effects
* vagus nerve is parasympathetic
* accerator nerve is sympathetic
* vagus nerve and accerator nerve / both systems lead to the SA node / pacemaker
* vagus / parasympathetic slows the heart **and** accerator / sympathetic speeds it up
* vagus / parasympathetic secretes acetylcholine
* accerator / sympathetic secretes (nor) adrenaline / (nor) epinephrine
* rate of heartbeat depends on relative amounts of stimuli from sympathetic and parasympathetic

**5. Describe the effects of the sympathetic and parasympathetic systems on the control of the heart and the iris of the eye.** *6 marks*

* unconscious / involuntary control
* antagonistic
* sympathetic system correlates with fight-flight responses / energy generation
* parasympathetic system is correlated with calming effect / emphasis on self-maintenance / return to normal state

*heart*

* sympathetic system: heart rate speeds up / more blood is pumped to muscles
* parasympathetic system: heart rate slows down / less blood is pumped to muscles

*iris*

* sympathetic system: radial muscles contract / pupil is dilated
* parasympathetic system: circular muscles contract / pupil constricts to protect retina

*Responses must include reference to both heart and iris to achieve full marks. Award 5 max if reference to heart or iris is omitted.*

**6. Outline the pathway of neurons connecting the retina of the eye to the muscles of the iris.** *3 marks*

* light received by retinal cells / neurons / bipolar neurons / photoreceptor
* passed to optic nerve / cranial nerve II
* to visual cortex / relay neurons / intermediary neurons
* out via motor neurons / cranial nerrve III / effector neurons / oculomotor nerve
* sympathetic neurons cause radial muscles to contract / pupil to enlarge
* parasympathetic neurons cause circular muscles to contract / pupil to reduce

**7. Discuss how the pupil reflex is used for brain death.** *2 marks*

* shine light in eye to see if pupil constricts
* pupil reflex is cranial reflex / ANS reflex / controlled by the brainstem
* (if pupil reflex is lost) patient is most likely brain dead
* some drugs (barbituates) / nerve damage may interfere with pupil reflex

*Credit annotated diagrams*

**8. Outline the role of endorphins in the body.** *4 marks*

* endorphins are produced by the brain
* they are neurotransmitters
* their action is inhibitory
* they act as pain killers
* they have specific receptor sites / receptor sites which accept opiates
* they are produced at times of stress (e.g. labour)
* they open K+ channels and close Ca2+ channels / cause a net positive outflow / prevent reaching threshold on post-synaptic membrane

**9. Outline the role of painkillers in the human body.** *4 marks*

* pain receptors located in skin / organs
* signal sent to brain / control center in CNS for conscious pain sensation
* natural pain killers are endorphins / enkephalins
* enkephalins block calcium channels of pre-synaptic neurons
* block transmission of pain signals
* endorphins released by pituitary gland
* bind to receptors of membranes of neurons that send signal
* may block release of neurotransmitters / no signal sent

**10. Explain how pre-synaptic neurons can either encourage or inhibit post-synaptic neurons.** *6 marks*

* neurotransmitters released by pre-synaptic neurons
* diffuse across synapse
* bind to specific receptors on post-synaptic membranes
* some neurotransmitters increase permeability of post-synaptic membrane to positive ions
* causing localized depolarization
* which helps an action potential to form / raises membrane above threshold
* *e.g.* acetylcholine or other example
* other cause negatively charged chloride ions to move across post-synaptic membrane into the cell / K ions move out of the post-synaptic nerve cell
* *e.g.* GABA / other example
* leading to hyper-polarization
* which inhibits actions potentials

**11. Explain how presynaptic neurons can affect postsynaptic transmission of impulses.** *7 marks*

*(Note US names for transmitters, e.g. norepinephrine for noradrenaline)*

* pre-synaptic neurons are excitatory or inhibitory
* cholinergic neurons release acetylcholine
* found in neuromuscular junctions / most synapses in voluntary NS / many synapses in autonomic NS
* adrenergic neurons release noradrenaline
* found in sympathetic synapses (of ANS)
* both types of neuron can be excitatory
* attach to postsynaptic receptors
* make membrane permeable to Na+ which moves through / into / across postsynaptic membrane
* causes depolarisation
* monoamine oxidase 'destroys' noradrenaline
* acetylcholine esterase 'destroys' acetylcholine
* other excitatory transmitters in brain - serotonin / dopamine / glutamic acid
* inhibitory neurons release transmitters that make postsynaptic membrane less permeable to Na+
* cause hyperpolarisation of the membrane
* by allowing K+ to diffuse out of postsynaptic membrane
* examples include glycine / gamma-aminobutyric acid (GABA) / acetylcholine

**12. Explain with examples how psychoactive drugs affect the brain.** *6 marks*

* excitatory drugs increase synaptic transmission
* named example e.g. nicotine, caffeine, cocaine / crack, amphetamines / MDMA /ecstasy
* some drugs mimic the neurotransmitter
* some drugs inhibit the enzyme that breaks down the neurotransmitter
* inhibitory drugs decrease synaptic transmission
* named example e.g. Valium / Temazepam / benzodiazepines / cannabis
* some drugs block receptors preventing neurotransmitters binding to them
* some drugs inhibit release of neurotransmitters

**13. Discuss briefly the effects of inhibitory psychoactive drugs.** *4 marks*

* benzodiazepine / valium / diazepam / Temazepam is an inhibitory psychoactive drug
* it relaxes (skeletal) **muscle**
* by enhancing the action of GABA / enhancing inhibition at the level of the synapse
* cannabis causes relaxation / euphoria / enhanced awareness *(accept known alternatives to cannabis)*
* inhibitory psychoactive drugs may reduce anxiety / muscle tension
* inhibitory psychoactive drugs may be addictive

**14. Outline the behavior effects of tetrahydracannabinol (THC).** *4 marks*

* affects ability to concentrate
* loss of motor/ muscle control
* impairs perceptions / painkiller / loss of time sense
* memory loss
* relaxed attitude
* increased appetite
* depression

**15. Explain the effect of psychoactive drugs on synaptic transmission using two named examples.** *6 marks*

*effect of psychoactive drugs: 4 max*

* some psychoactive drugs act like neurotransmitters
* some psychoactive drugs act like neurotransmitters but are not broken down (at the receptors)
* some psychoactive drugs interfere with the breaking down of the neurotransmitters
* some psychoactive drugs interfere with the reuptake of neurotransmitters
* some psychoactive drugs compete with neurotransmitters for receptor binding sites
* some psychoactive drugs block the binding of neurotransmitters to receptors
* affect the transmission of optic signal in the thalamus / optical cortex

*examples: 2 max*

* amphetamines
* nicotine
* cocaine
* cannabis
* benzodiazepines
* alcohol

**16. Explain the effects of excitatory psychoactive drugs using a named example.** *4 marks*

* psychoactive drugs affect the mind / brain **and** personality
* change / increase synaptic transmission
* (drugs) can block / similar in structure / inhibit breakdown of neurotransmitter

*Award 2 max per example, e.g. cocaine / nicotine / amphetamines.*

* cocaine / crack
* stimulates synaptic transmission of adrenergic synapses
* increased energy / alertness / euphoria
* nicotine
* stimulates synaptic transmission of cholinergic synapses
* has a calming effect
* amphetamines / ecstasy
* stimulates synaptic transmission of adrenergic synapses
* similar effects to cocaine
* longer lasting effect / 2 to 4 hours

**17. Explain, using examples, how inhibitory psychoactive drugs affect brain physiology.** *6 marks*

* block / decrease synaptic transmission
* can be inhibitory to pain
* examples are benzodiazepines / cannabis / alcohol
* benzodiazepines increase effect of inhibitory neurotransmitter GABA
* causing less transfer of information to the brain
* cannabis can block cannabinoid receptors in the brain stopping transmission
* alcohol enhances effect of inhibitory neurotransmitter GABA
* also decreases activity of glutamate, an excitatory neurotransmitter
* use of psychoactive drugs can lead to dependence on them

**Unit 16 Previous IB Exam Essay Questions: Behavior**

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. Outline the pain withdrawal reflex in humans.** *6 marks*

* pain sensed by receptor cells or nerve endings in the **skin**
* impulse passed along **sensory** neuron / nerve
* to the spinal cord / CNS
* passage through association neuron / neurons *(accept alternative terms for association neuron)*
* in gray matter
* impulse passed along *motor* neuron / nerve
* to muscles / contraction of muscles
* pulls or moves limb away from source of pain

**2. Describe the migration of a named species of bird or mammal.** *6 marks*

* name of species
* first area inhabited
* during which part of year / times of migration to and from this area
* second area inhabited
* route taken
* method of navigation
* length of time taken
* method of food supply
* other detail of behaviour during migration

**3. Explain the role of natural selection in the development of migration in birds or mammals.** *4 marks*

* individuals that do not migrate are selected against / vice versa
* due to severe weather / food shortage / no mates / other selective agent
* second example of selective agent
* individuals that migrate unsuccessfully are selected against / vice versa
* arrival in unsuitable area

**4. Explain the role of natural selection in the development of behavior patterns.** *6 marks*

* innate behavior patterns are inherited
* animals show variation in their behavior
* behavior patterns are adapted to the environment / selected by the environment
* those animals with adaptive behavior more likely to survive
* animals which survive leave more offspring (than those less adapted) / change in allele frequency
* population / species starts to show more adaptive behavior
* population has evolved

**5. Outline how natural selection can influence the development of behavior patterns.** *4 marks*

* innate behavior patterns develop independently of the environment
* stereotyped responses to environmental stimuli
* are controlled by genes / inherited from parents
* some types of behavior are better suited / adapted to their environment
* behaviors (alleles for these) selected for
* increases the survival of those organisms
* leads to higher reproduction rate

**6. Define innate behavior, and suggest one example of the survival chances of an animal being increased by innate behavior.** *3 marks*

* behaviour shown in all members of a species
* despite any variation in environmental influences / due to heritable factors
* behaviour not learned / born with

*(Award 1 mark for any suitable example; up to 1 mark)*

* e.g. withdrawal reflex
* fight or flight mechanism / moth response to bats

**7. Define kinesis, and explain, using one example, how kinesis might improve an animal's chance of survival.** *4 marks*

* **non-directional** response of organism in response to a stimulus
* **rate** but not direction of movement affected by the **size** of stimulus

*(Award 2 marks maximum)*

* wood lice move more in dry conditions
* better chance of finding damp areas

**8. Discuss how learning may contribute to an organism's survival chances.** *3 marks*

* acquire information from past experiences to adapt to new situations
* can better obtain food / shelter / resources
* can increases mating chances
* learns to avoid dangerous situations
* cooperation between individuals may increase survival

**9. Outline Pavlov's experiments on the conditioning of dogs.** *3 marks*

* (unconditioned) stimulus of food / sight of food accompanied by bell ringing
* salivation is the (unconditioned) response
* (conditioned) stimulus of bell ringing given before / without unconditioned stimulus / sight of food
* salivation became the condititioned response (to the bell ringing)

**10. Describe the roles of different members of a colony of honey bees.** *6 marks*

* queen: reproduction
* drone / male: fertilize queen / reproduction
* workers / (sterile females): wax making
* worker / nurse : feed larvae / secrete royal jelly
* worker / forager: look for food / nectar / pollen
* worker: clean / ventilate hive
* worker / soldier: protect hive
* worker / scout: communicate location of food to rest of hive

**11. Describe the social organization of honey bee colonies.** *6 marks*

* caste system / division of labor
* cooperate to regulate internal temperature of hive
* colony contains one queen
* queen lays eggs
* queen produces pheromones to give instructions to the workers
* colony contains many workers
* swarming when there are more workers than the queen can control
* workers feed / nurse the brood / larvae
* workers forage for food / pollen / nectar
* workers communicate with each other by exchange of pheromones
* workers communicate with each other by dances
* colony contains fewer drones than workers
* drones mate with queens
* workers evict drones when they are not needed
* workers protect queen from invaders
* workers build / maintain / repair hive

**12. Discuss briefly the role of altruistic behavior in social organizations, other than human ones.** *4 marks*

* idea expressing doubt about the meaning / nature of altruism
* individuals help others that are not their offspring
* e.g. worker bees nursing offspring of queens and drones / other example
* altruistic acts may lead to the individual's own death
* e.g. bees stinging attackers / other example
* members of the organization are genetically related
* helping the organization to survive ensures survival of individual's genes

**13. Describe, giving an example, the role of altruistic behaviour in social organizations.** *4 marks*

* altruistic behaviour - behaviour of an animal that is (potentially) harmful to itself but beneficial to another animal
* specific example of an animal and its role in the social organization
* risk / possible harmful effect of behaviour
* benefit gained
* e.g. worker bee feeds larva and protects the colony
* worker bee may die in defense of colony
* queen bee / rest of colony are protected
* *Other examples can be used, but not human ones.*

**14. Courtship is an important form of behaviour in many species of bird and mammal.** *7 marks*

*(a) Describe the courtship behavior of either one species of bird or one species of non-human mammal. 3 marks*

* name of bird or mammal species and brief outline of courtship
* details of male behavior during courtship
* details of female behaviour during courtship

*(b) Explain the role of natural selection in the development of this courtship behavior. 3 marks*

* courtship behaviour allows members of a species to identify each other
* courtship helps to attract a mate
* individuals that do more than (vigorous) courtship displays are more successful
* genes for (vigorous) courtship displays are inherited by offspring

*(c) State one type of behavior, other than courtship that has developed by natural selection. 1 mark*

* reflexes / taxis / kinesis / mate selection / grooming / communication / other
* **Carefully draw and Clearly label (using a ruler or straight edge) all diagrams in PENCIL. Diagrams should be large and take up about half a side of paper. Include a title.**
* **The following is a list of required drawings**
* **-a generalized prokaryotic cell (1.2.1)**
* **-the ultrastructure of a generalized animal cell (1.3.1)**
* **-the fluid mosaic model of a membrane (1.4.1)**
* **-a generalized amino acid (2.2.2)**
* **-the ring structure of glucose and ribose (2.2.3)**
* **-the structure of glycerol and a fatty acid (2.2.4)**
* **-the structure of a generalized dipeptide showing the peptide linkage (2.2.6)**
* **-the simple molecular structure of DNA (2.4.5)**
* **-the carbon cycle and show the processes involved (4.1.14)**
* **-a sigmoid growth curve (4.2.2)**
* **-the digestive system (5.1.4)**
* **-the heart showing all four chambers, associated vessels and valves (5.2.1)**
* **-the ventilation system including trachea, bronchi, bronchioles, alveoli and lungs (5.5.4)**
* **-male and female reproductive systems (5.7.1)**
* **-the structure of a mitochondrion as seen in electron micrographs (7.1.3)**
* **-the structure of the chloroplast as seen in electron micrographs (7.2.1)**
* **-the action spectrum for photosynthesis (7.2.7)**
* **-the structure of the testis as seen in the light microscope (9.1.1)**
* **-the structure of the ovary as seen in the light microscope (9.1.4)**
* **-the structure of a mature sperm and egg (9.1.6)**
* **-the structure of a motor neuron (11.1.2)**
* **-the human elbow joint (11.2.3)**
* **-the structure of skeletal muscle fibers as seen in electron micrographs (11.2.5)**
* **-the structure of the kidney (12.2.1)**
* **-the structure of a glomerulus and associated nephron (12.2.2)**
* **-the external parts of a named dicotyledonous plant (13.1.2)**
* **-plan diagrams to show tissue distribution in stem, root and leaf of a generalized dicotyledonous plant (13.1.3)**
* **-the structure of a dicotyledonous animal pollinated flower as seen by the naked eye and hand lens (13.3.1)**
* **-the external and internal structure of a named dicotyledonous seed (13.3.4)**