

BIOLOGY

PRACTICE EXAM SOLUTIONS 2019

Section A – Multiple-choice questions

Question	Answer	Notes
1	C	Although polar, amino acids are too large to freely cross the plasma membrane
2	B	Enzymes do not increase the amount of energy available in the reaction system they simply decrease the required energy for the initiation of a specific reaction, the activation energy. Enzymes do not act as an alternative reagent, they themselves are not involved in the reaction. Enzymes do not function to lower the concentration of competitive inhibitors, competitive inhibitors bind to enzymes at the active site preventing the substrate from binding. Option B is the definition of the action of biological catalyst.
3	D	Some cellular processes occur on the surface of the smooth ER, more folding results in more surface area. A smooth ER means there will be no ribosomes
4	C	Option A, B, and D are all examples of supporting evidence of endosymbiosis theory. Option C is incorrect, mitochondria are unable to survive outside of a eukaryotic cell as some of the mitochondrial genome has been incorporated into the host cell genome. Resultingly the mitochondria are not able to produce all of the proteins necessary for its survival without the genes which have been incorporated into the host cell genome.
5	A	Condensation as water produced, polymerisation as polymer produced
6	B	Yeast undergo aerobic respiration the same as other eukaryotic cell types in the presence of oxygen, producing 36-38ATP. Alcohol and lactic acid fermentation occur in yeast and mammalian cells respectively.
7	C	Regulatory genes code for proteins that influence gene expression
8	A	If a key enzyme within the Krebs cycle is inhibited it is reasonable to assume that the entirety of the cycle would be unable to function. If the Krebs cycle is not functioning then the intermediates necessary for the electron transport chain are not produced, hence the cell will be forced to rely on glycolysis. As a result, the cell would only be producing 2 ATP per glucose molecule compared to the normal 36-38ATP, 34-36 ATP less than normal. Anaerobic respiration in mammalian cells produces lactic acid, not ethanol, and even if the concentration of Acetyl-CoA is increased greatly, the cell is unable to further metabolise Acetyl-CoA.
9	D	Contains uracil (U) therefore RNA, prokaryotes lack post-transcriptional modifications
10	B	The oxygen produced by photosynthesis arises from the light dependant phase, where water is an input. CO ₂ is an input in the light independent stage of photosynthesis, however the oxygen from CO ₂ is used in the production of glucose.
11	D	These hydrogen bonds form alpha helices and beta pleated sheets

12	B	Site A is a chlorophyll. Chlorophyll are the site of the light dependant stage of photosynthesis where light energy is absorbed and used to split water molecules into H and O and electrons are carried away by coenzymes NADP ⁺ . Light is not necessarily proportional to the temperature of the chlorophyll and Rubisco is an important photosynthetic enzyme but the reason why light is needed in photosynthesis is not that its inhibitors are inhibited by light. Hence A and C are incorrect.
13	C	Waxy cuticle physically prevents the invasion of pathogens into the plant
14	A	Penicillin, a competitive inhibitor that irreversibly binds to the active site of transpeptidase preventing its substrate from binding. This effectively decreases the amount of enzyme available to catalyse the reaction. Resulting in the reaction rate increasing as normal and then plateauing at a lower rate than without the inhibitor present as substrate concentration is increased.
15	C	Tricky question. Based on VCE Biology knowledge, at high temperatures penicillin may be denatured as it is a protein, penicillin may not bind if it is not complementary and a bacterial capsid may prevent penicillin action. All prokaryotes have a cell wall, so C is incorrect.
16	B	Phagocytes engulf and destroy pathogens, neutrophils lack MHC II markers
17	D	B and T lymphocytes are involved in the humoral response, this is the response that produces antibodies that combat pathogen invasion
18	B	Hydrophilic signalling molecules are not able to readily diffuse though the plasma membrane of the cell and as such bind to receptors located on the cell surface such as the transmembrane death receptor depicted. As TNF binds to a receptor on the cell surface it is most likely hydrophilic.
19	A	Provides heard immunity as friends/family less likely to become infected
20	A	Pheromones are an example of exocrine signalling molecules, used for communication and eliciting behavioural responses in other members of the same species.
21	B	Enhancing the allergic response would be problematic as allergy symptoms would be exacerbated causing harm to the individual
22	C	Insulin is an endocrine hormone that travels though the bloodstream to elicit differing responses in specific tissues. To respond to insulin a cell needs to be able to detect it, this detection is mediated via an insulin specific receptor that needs to be expressed on a cells surface for them to produce a cellular respond.
23	C	Antigen recognition occurs in the lymph nodes, dendritic cells are involved as they contain MCH II markers
24	C	This question measured the students understanding of the founder effect, C is the definition of this effect. A describes a genetic bottleneck, B describes genetic drift and D describes an aspect of natural selection.

25	B	Although all questions relate to potential issues, only option B refers to an environmental issue
26	A	Restriction enzymes are tools used by scientists used to cut DNA at phosphodiester bonds at a specific sequence, when this occurs they either create sticky or blunt ends. Sticky ends result in overhang between the strands of DNA at the cutting site, seen here. Blunt ends result in no overhang of DNA strands.
27	D	The black dot on the diagram refers to a common ancestor of all the species, including lemurs and orangutans
28	C	DNA gel electrophoresis separates DNA fragments based on size. Smaller DNA fragments will travel further as they experience less frictional force as they move through the pores in the agarose gel. It is more difficult for large DNA fragments to move through the gel, hence they travel a shorter distance through the gel.
29	A	Increased carrying angle is associated with bipedalism which is then associated with a more central foramen magnum
30	D	Inversions, duplications and translocations are all examples of block mutations; changes to segments of chromosomes leading to large scale shift of an organism's DNA. A frameshift mutation can be caused by a addition or deletion of a single base, a point mutation which leads to a change in the reading frame.
31	B	Epidemic is local to a region as shown in the map of Australia
32	C	Allopatric speciation is speciation as a result of geographic isolation, differing selective pressures and restricted gene flow. Selective breeding does not contribute to allopatric speciation.
33	C	Antivirals are used to treat viral infections
34	D	According to Darwin's theory of natural selection traits that are selected for will increase a species genetic contribution to the next generation. A trait that greatly increases a change of reproduction but results in subsequent death supports this theory.
35	D	BMP4 Expression has a linear relationship with beak depth in chicks, it can be inferred that the ratio between BMP4 and beak depth will remain constant between adult finches
36	D	After each PCR cycle the proportion of original genetic material is decreased by half. After 1 cycle, 50% of the DNA is original, 2 cycles 25% and 3 cycles 12.5%.
37	C	Autoimmune disease as self-cells are mistakenly destroyed by the body
38	D	Bacteria don't need to integrate the recombinant DNA directly into their nucleoid for it to be expressed. Bacteria can express genes encoded for on their nucleoid <u>and</u> on plasmids that they have up taken from the environment or conjugation.
39	B	The DNA extracted from a skin sample and a cheek swap would both contain the genome of the entire organism
40	B	Radiation therapy is a non-selective therapy – it kills cells indiscriminately. Due to this it does not follow the traditional concept of rational drug design. It fails to specifically target a particular aspect of the pathogens biology, and in doing so aim to avoid off target effects.

Section B – Short-answer questions

Question 1 a.

Answer:

Cholesterol

Question 1 b.

Answer:

No – although polar, glucose is **too large** to freely diffuse across the plasma membrane.

Question 1 c.

Answer:

No, **neutrophils lack MHC class II markers** so therefore are not antigen presenting cells.

Question 1 d.

Answer:

The bacterium lacks MHC class I markers and is thus recognised as non-self which prompts the phagocytosis of the bacterium by the neutrophil.

Question 1 e.

Answer:

Mast cells are triggered to release histamine prompting **vasodilation**.

Neutrophils and other phagocytes move to the site of damage/infection and **phagocytose debris and/or pathogens**.

Question 2 a.

Answer:

In the absence of lactose, the lacZ, lacY and lacA genes would still be expressed as **the repressor cannot prevent the process of transcription by RNA polymerase**.

Question 2 b.

Answer:

No introns would be present, **as the lac operon is a prokaryotic model and no post-transcriptional modifications occur in prokaryotic organisms**, thus no introns are present.

Question 2 c.

Answer:

- 5' Methyl-guanosine cap is added to the 5' end of the pre-mRNA – helps initiate process of translation/prevents damage to mRNA
- Poly-A-tail is added to the 3' end of the pre-mRNA molecule – assists export from nucleus/prevents damage to mRNA
- Introns are removed - They aren't involved in producing the desired protein

Notes:

Naming and describing any two of the three above would earn you full marks.

Question 2 d. i.

Answer:

Once it leaves the nucleus, the mRNA strand will migrate to a ribosome. A codon in the mRNA will pair up with the anticodon of a tRNA molecule carrying a specific amino acid within the ribosome. The process continues with more codons and anticodons pairing, resulting in the amino acids being carried by the tRNA molecules being added to the growing polypeptide chain via peptide bonding (also called condensation polymerisation reaction). Once a stop codon is reached, translation will cease, and the polypeptide chain will be released.

Question 2 d. ii.

Answer:

The likely role of the final product is to metabolise/ break down lactose molecules.

Question 3 a.

Answer:

Amphipathic/hydrophilic heads and hydrophobic tails

Notes:

These properties allow the phospholipid head which is hydrophilic to be attracted to water in the extra and intracellular fluid. The hydrophobic tails, attracted to non -polar molecules are attracted to the hydrophobic regions of other phospholipids, forming a bilayer.

Question 3 b.

Answer:

Secondary messengers

Notes:

These signalling molecules are part of the transduction cascade, lying in between the receptor and the effector protein, mTOR.

Question 3 c.

Answer:

Insulin is a hydrophobic molecule therefore cannot diffuse through the cell membrane. Hence it cannot bind to an intracellular receptor and instead must bind to a transmembrane receptor on the cell surface.

Notes:

Hydrophilic signalling molecules are not easily able to diffuse through the plasma membrane, hence bind to receptors on the cell surface. Whereas hydrophobic signalling molecules are able to passively diffuse through the plasma membrane and bind to intracellular receptors.

Question 3 d.

Answer:

Reception	The signalling molecule binds to the specific receptor on or in a target cell
Transduction	Change in conformation of insulin receptor activates a cascade of secondary messages which bring about a cellular response
Response	The effector proteins activate a/many biochemical, physical or physiological response(s)

Question 3 e.

Answer:

Increasing transcription and/or translation. The production of mRNA can be increased by upregulating the production or activity of relevant transcription factors or upregulating the translation of each mRNA i.e. increase the amount of times each strand of mRNA is translated.

Notes:

This one is a conceptual question. Protein synthesis may be increased wither at either the transcription or translation stage. Students could either have stated two separate process or described a specific example in detail to achieve full marks (i.e. to increase transcription, upregulate relevant transcription factors, and to increase translation, increase the length of the poly A tail).

Question 4 a.

Answer:

Booster vaccinations re-expose the immune system to the pathogen, prompting an immune response and further **increasing the amount of memory cells** to the specific antigen associated with that pathogen.

Question 4 b.

Answer:

Dendritic cell/macrophage phagocytoses *C. tetani* and destroys it, antigen presented on MHC class II marker. Antigen presenting cell then **activates specific T helper cell**, T helper cell then activates specific B cell which divides and proliferates into **plasma cells** which produce antibodies.

Question 4 c.

Answer:

An infection from *C. tetani* only occurs from when the bacterial spores enter an open wound, disease cannot be transmitted from person to person via ingestion/inhalation.

Question 4 d.

Answer:

Artificial passive

Question 5 a. i.

Answer:

Chloroplast

Question 5 a. ii.

Answer:

B

Notes:

The cell with a higher number of chloroplasts is likely to be in an environment where it is exposed to a lower level of sunlight and as a result needs to maximise photosynthesis. Where cell B has a low number of chloroplasts as it is in a high light environment and resultingly needs a decreased number of chloroplasts to have an adequate rate of photosynthesis occurring.

Question 5 b. i.

Answer:

The enzymes involved in photosynthesis (i.e. RuBisCo) denature after they exceed their optimal temperature, when these enzymes denature, they permanently deform and are no longer able to catalyse the specific reaction. Additionally, above a certain temperature the stomata of the plant close in order to prevent water loss. However, in doing so also CO₂ is unable to enter the leaves of the plant and photosynthesis unable to occur at the same rate.

Question 5 b. ii.

Answer:

The net rate of O₂ production is the result of the production of O₂ via photosynthesis but also the use of O₂ by cellular respiration. It tends to be days with minimal sunlight (or at night) which have the lowest temperatures, as a result the rate of photosynthesis and hence O₂ production decreases significantly, however the rate of cellular respiration, and O₂ consumption by the plant remains the same. Therefore, at low temperatures the rate of O₂ consumption exceeds that produced and results in a net negative O₂ balance.

Question 5 c.

Answer:

No. There is interdependence between the reactions occurring in the grana (D) and stroma (E). The products of the light dependant reactions at the grana (ATP and NADPH) are required as reactants at the stroma and vice versa. Therefore, if the reactions at one of these sites are unable to occur the reactions at the other cannot.

Question 6 a.

Answer:

NADH and FADH₂

Notes:

ATP is also produced but it is not fundamental for the reactions occurring at structure C (cristae).

Question 6 b.

Answer:

Electron transport chain.

Electron Carrier molecules give up electrons and Hydrogen at the cristae of the mitochondria. The electrons are accepted by and passed through a series of electron acceptors, on the cristae. The interaction between the electrons and protein complexes facilitates the production of ATP. Oxygen captures electrons after they are passed along which are combined with hydrogen to form water.

Notes:

It would be very easy for students to go into too much detail here. Make sure you only cover the key stages. Electrons being passed along a series of electron transporters leading to the production of ATP and Oxygen capturing electrons and combining with hydrogen to form water.

Question 6 c.

Answer:

The process is known as endosymbiosis, and is characterised by two outer membranes, the presence of mitochondrial DNA, and possessing 70s ribosomes similar to those found in bacteria.

Notes:

You could have chosen to mention any one of the above examples.

Question 6 d.

Answer:

No. The electron transport chain uses the products from glycolysis, B-oxidation and Krebs cycle to produce ATP at the cristae in the mitochondria. As this alternative pathway feeds into the Krebs cycle and does not produce a significantly different amount of ATP than glycolysis. If the electron transport chain is inhibited it would not provide a sufficient source of ATP.

Question 6 e.

Answer:

The researcher should place a sample of each organism in a sealed container with appropriate media for the organism's survival. The researcher should then place a pH indicator in both containers and extract the oxygen from each container and allow the organisms to respire anaerobically. Each container should contain the same amount of protozoa/yeast, be kept in the same temperature, humidity and amount of media etc. The container that contains the protozoa which as a result of anaerobic respiration produce lactic acid will cause the pH indicator to change colour, whereas the yeast will not. Repeat the experiment.

Notes:

Here, you would get 1 mark for stating the independent and dependant variables, 1 mark for a logical method, and 1 mark for supporting results. You also needed to state 2–3 controlled variables.

You may have also used alternative ways to measure the anaerobic respiration of each (e.g. a CO₂ detector, a pressure detector (for build-up of O₂), electronic pH meter etc.).

Question 7 a.

Answer:

Founder Effect

Notes:

A small group from the original population that has allele frequencies likely not representative of the original population has been introduced into a new environment. This also leads to a decrease in genetic diversity compared to the original population.

Question 7 b.

Answer:

After its introduction the new lizard population had a significantly decreased genetic diversity compared to the original population. Resultingly the population with reduced genetic variation has a significantly decreased ability to adapt in response to a change in environmental variables or selective pressures (e.g. introduction of a new disease).

Notes:

The prime example which students and teachers often use here is the introduction of a new disease to the population. If there is a high degree of genetic diversity in the population it is likely that the population may contain individuals that by chance have an allele that may provide some level of resistance to this new disease. If the population has low genetic diversity however there is a decreased chance that individuals might by chance possess alleles granting resistance to the disease. As a result, the population may be more susceptible to extinction due to inability of individuals to survive and evolve.

Question 7 c.

Answer:

Initially there was variation in the Italian wall lizard population head size and hence biting strength. On the island of Pod Mrcaru, there was decreased availability of insects for the lizards to feed on, hence a more plant-based diet was favoured. As a result the allele for a larger head (increased biting strength for vegetative diet) are more likely to be passed on to the next generation. Over time the lizard population adapted and evolved, now most lizards possess a large head size compared to the original population where these selective pressures did not act.

Notes:

Here, you needed to state that there was existing variation, explain what the selection pressure was, and acknowledging the effect of the selective pressure over time. You could have also mentioned that the lizards were competing with an indigenous lizard population, and an increased bite strength assists in conflict.

Question 8 a.

Answer:

Social implications: any well-thought implication that is distinct from an ethical implication, such as: early diagnosis may alter health care burden, may alter cost of treatment, alter family relations/situations.

Ethical implications: any well-thought implication that is distinct from a social implication, such as: burden of knowledge, potential for false positives/negatives, there is no cure but good survival rate if treated early compared to death within one year if there is no early treatment.

Question 8 b.

Notes:

Ensure a fluid, coherent discussion is made. Arguments from both sides should be considered. Then, a final conclusion must be made by weighing these arguments against each other. Some points to address:

Arguments for:

- Can treat before severe symptoms start to show
- Screening will mean that treatment can be started earlier, so increase survival rates and quality of life for child and parents/family
- Could prepare for complications so monitor condition more vigilantly, and see health care professionals accordingly
- Gives time to consider if a bone marrow transplant may be required
- Some symptoms may not show until 6 months, but 95% survival rate if treated within the first 3.5 months

Arguments against:

- Low incidence – is it a common enough condition to screen every newborn child?
- Expensive and may take away funds from other aspects of health care
- Potential for false positives or negatives could add stress to parents
- How many tests do we want to be doing on children as soon as they are born?

Question 8 c.

Answer:

During the first 6 months of age, the newborn is still protected by maternal antibodies that they acquire via breastfeeding.

Question 9 a.

Answer:

Primers bind to ssDNA and act as the site where Taq polymerase binds to. Primers are added and anneal to the single stranded DNA at 55 °C.

Question 9 b.

Answer:

Three: one cycle produces 4 µg, two cycles produce 8 µg and a third produces 16 µg.

Question 9 c. i.

Answer:

Hybrid DNA of early *H. sapiens* and *H. sapiens* has a lower abundance of single stranded DNA in comparison to the hybrid DNA of *H. sapiens* and *H. neanderthalensis* suggesting the DNA of *H. sapiens* and early *H. sapiens* have a closer match in DNA sequence.

Question 9 c. ii.

Answer:

The presence of Neanderthal DNA within the genome of modern humans with heritage in areas where early humans and Neanderthals coexisted would support interspecies breeding.

Question 9 d.

Answer:

Carbon-14 dating – used to date specimens from 0 to 50,000 years

Question 10 a.

Answer:

Although African elephants have a larger brain weight in comparison to humans, they require a larger brain to support their bodily functions, their **brain to body weight ratio is lower, relative size is important.**

Question 10 b.

Answer:

Opposable thumbs or stereoscopic vision

Notes:

Either of the above would be acceptable answers here.

Question 10 c.

Answer:

From quadrupedal to bipedal locomotion, the foramen magnum shifted from the back of the skull to the bottom in a more central position (more anteriorly). Bipedalism frees up the hands, meaning tools can be carried, and allows individual to be taller which helps them see predators or food from afar.

Question 10 d.

Answer:

Storytelling, belief in an afterlife and ceremonial rituals all could be used as examples of cultural evolution, **art (cave paintings) or individuals being buried with objects** could be possible evidence.

Question 10 e.

Answer:

The transition to eating cooked food/fire used for cooking food

Question 11 a.

Answer:

Taq Polymerase

Question 11 b.

Answer:

DNA samples are loaded into the well in the gel at the negative electrode. An electric charge is being run through the gel and the DNA moves towards the positive end as DNA has a negative overall charge. The agarose gel used is porous, and the DNA must move through these pores. Larger/longer segments of DNA move more slowly due to their mass and increased friction and appear closer to the origin than smaller pieces, allowing the segments to separate out based on size.

Question 11 c.

Answer:



Question 11 d.

Answer:

Frameshift mutation – a deletion of a single base has occurred resulting in a change in the reading frame.

Question 11 e.

Answer:

A frameshift mutation alters the reading frame of the DNA sequence, thereby potentially resulting in a completely different amino acid sequence to the original downstream from the mutation.