HERITAGE COLLEGE
A CHRISTADELPHIAN SCHOOL
ADELAIDE, AUSTRALIA

Biology Mid-Year Trial Exam
ANSWERS

Question booklet 1

Section 1: Multiple choice questions (Questions 1-15) 15 marks

1	J	K	●	M	**9**	J	●	L	M
2	J	K	L	●	**10**	●	K	L	M
3	J	K	L	●	**11**	●	K	L	M
4	●	K	L	M	**12**	J	K	L	●
5	J	K	L	●	**13**	J	K	L	●
6	J	●	L	M	**14**	●	K	L	M
7	J	●	L	M	**15**	●	K	L	M
8	J	K	●	M					

Section 2: Part A (Questions 16 to 21) 49 marks

16 (a)

If the drug can prevent the attachment of the farnesyl group in the first place, then the prelamin A protein will be the same as it is in normal cells when the farnesyl group is eventually removed. This will preserve the normal lamin A and it will not anchor to the nuclear rim. Overall, this will keep the nucleus in the normal shape and allow it to perform it's normal function. This will give the nucleus more surface area and allow things like ribosomes and mRNA to exit more efficiently for cellular processes.

16 (b)

A guide RNA could be made to match the specific sequence of the mutated LMNA gene. This could then be associated with a Cas9 protein assembly that will be able to cut the DNA at the point mutation and replace the affected nucleotide base with the corrected one. This CRISPR/Cas9 tool could then be injected into affected persons in order to seek and repair all of their affected cells, and restore the normal shape of the nucleus.

16 (c)

I think that the most effective treatment would be the use of CRISPR technique. This is because the drug will have to be taken on an ongoing basis in order to continue to prevent malformed nucleus in new cells that arise that still have the point mutation. However, CRISPR could be performed once on an individual and fix all of their cells so that newly arising cells in their body will all have the point mutation corrected and therefore will not show symptoms. This is potentially a less costly process for the individual since it is a one-off treatment, and it will have less of an impact on the patient's lifestyle.

17 (a)

Any of the following:

- It is made of a double layer (bi-layer) of phospholipids
- The inside of the membrane is hydrophobic due to the fatty acid tails pointing in
- The outside of the membrane is hydrophilic due to the heads of the phospholipids
- It is not static – it can move freely due to the presence of cholesterol molecules embedded
- There are proteins that are embedded on the surface of the membrane that act as receptors – called peripheral proteins
- There are some proteins that span both layers of the bi-layer called integral proteins
- Glycolipids can be found on outside attached the lipid by-layer with different functions

17 (b)

The membrane has special transport proteins embedded into it that help to allow molecules move in and out of the cell with the concentration gradient. Channel proteins are integral and help with the diffusion of ions and other hydrophilic molecules that cannot simply diffuse through the lipid bi-layer. Carrier proteins bond to large substrate molecules on the outside of the cell and change shape. The change in shape releases the substrate into the cell. No energy is used with either of these facilitator proteins.

17 (c)

Examples may include:

- Golgi body
- Nuclear membrane
- ER
- Membrane of mitochondria or chloroplast

When describing the role of the membrane, make sure you are specific about what the membrane does as its function in the example you used. Be clear on how it is crucial for the cell and helps with important aspects of cellular activity. Eg. increase SA; protect DNA; control what comes in/out of organelle; site of chem reaction; allows attachment of cytoskeleton; etc.

18

Note: marks are given for clearly stated points and relevant information to the question

DNA Sequencing –

- Could describe taking sample from species in question, and how DNA is prepared using restriction enzymes and PCR ready for analysis
- Sequence DNA from fish species in question and compare to known species of fish from a data base of sequenced marine species. Use gel electrophoresis or capillary electrophoresis and electropherograms - as each species will have a unique sequence of DNA bases
- DNA sequencing could be used to identify different species by finding and using specific markers such as VNTRs. Several would need to be used when determining the species with certainty.

Ethical & economic –

- Various answers are possible –
- Should DNA sequences be collected and kept?
- Who controls this information?
- Privacy?
- What will it be used for? Who can access it? – equity issues
- Collecting is costly process

- Accessing it may cost money
- Could it have long term cost benefits for things like criminal investigations?
- Could it have benefits for long term health issues that may be fixed?
- DNA info in the hands of health insurance companies may mean more money for ppl applying for coverage due to genetic issues.

19 (a)

Write the balanced equation for photosynthesis

19 (b) (i) and (ii)

Two of any of these…

- Amount of the original source of CO2
- Size of leaves used
- Same genus used
- Same temperature conditions
- Same light source and intensity

19 (c)

Increased the sample size which increases the reliability of the experiment and reduces the effect of random error by allowing averages to be taken.

19 (d)

If the ratio is greater than 1:1 than it means the plants are using more CO_2 than they are producing. If this is the case than the implication would be that they are performing more photosynthesis than respiration (which uses CO_2). This would mean that the plants are making more glucose than they need for normal respiration and therefore there would be more available to the plant for storage and other purposes that will allow further growth and development.

20 (a) (i)

Cellular respiration (aerobic or fermentation)

The breakdown of glucose in this process releases energy that can be used to convert ADP + P_i into ATP.

20 (a) (ii)

In all living cells, ATP breaks down into ADP + P_i in the cell and as a result it releases energy that the cell can use. When this energy is released it enables a cell to transport substances against a concentration gradient, or to grow, or to synthesize molecules. Without this reaction the cell would not be able to perform any work and would not be able to maintain homeostasis or reproduce.

20 (b)

Heat

21 (a)

DNA replication or DNA synthesis

21 (b)

Because the original parent double stranded molecule is unzipped exposing bases to free floating nucleotides. Each half of the double strand forms a template for adding another copied strand. The result is two new molecules that are exact copies, but that have one strand conserved from the original parent strand, and one strand made from newly added nucleotides. So, the original parent strand is partially conserved in the new ones.

21 (c)

The key property is the base pairing rules that exist between the bases that compose DNA. If one side of the double stranded DNA has the base cytosine, it will only pair up with a guanine for the opposite strand. Cytosine always pairs with guanine and adenine always pairs with thymine. In this way if you have one side of the strand, then the other side will always be copied in the same way with corresponding pairs. This means that each strand of the DNA will be copied exactly with the matching other side.

21 (d)

One of…

- Ionizing radiation
- High temperatures
- Toxic chemical
- Virus

21 (e)

One of…

- Prokaryotic DNA is circular (loop), while eukaryotic DNA is linear
- Prokaryotic DNA does not form complex chromosomes with histones, while eukaryotic DNA does.

Question booklet 2

Section 2: Part B (Questions 22 to 28) 50 marks

22 (a)

Cytosine

22 (b)

It will reduce or stop the expression of this gene.

22 (c)

Normal expression of the CDNK1C gene helps to slow or stop cell division where needed in the body by preventing the formation of promoting factors in the cell cycle. When this gene is methylated and expression is altered, it could lead to an increase in cell division beyond what is needed or wanted. This would occur due to the fact that the cell would have less ability to stop the growth and division using CDNK1C. In this case the result could lead to the formation of a tumor and cancer as cells divide uncontrollably.

22 (d)

Explain one of the following methods of altering gene expression, giving two clear points for the one you choose:

- Acetylation of DNA leading to euchromatin or deacetylation leading to heterochromatin. Explain how each situation alters gene expression in human cells and why.
- Non-coding RNA (ncRNA) – explain how small RNA molecules can control gene expression in a cell by destroying mRNA or preventing translation (e.g. miRNA or siRNA, etc.)

23 (a)

If the nucleus of an egg was injected it would not produce a clone as it is haploid and would not have enough genetic information to create diploid somatic cells. A nucleus of a somatic cell must be used in order for the egg to then undergo mitosis and create daughter cells that are diploid to grow the cloned organism.

23 (b)

Mitosis

23 (c)

The following two features are the most obvious:

- They are genetically identical to each other
- They are both diploid

23 (d)

The clones of Celia will all be genetically identical and will have no genetic diversity. This will lead to high susceptibility to diseases and less ability to adapt to environmental changes.

23 (e)

Any two of the following:

- Sterile environment
- Anchorage where necessary for the type of cell
- Appropriate hormone and growth factors
- Stable and appropriate temperature
- Appropriate pH levels.
- Proper nutrient levels and availability

23 (f) (i)

Many possibilities here… for example growth of plant crops with desirable traits.

23 (f) (ii)

For the example above this would include to susceptibility to disease due to the lack of genetic diversity in the crops. Limitations could include possibility of contamination or ethical and cost issues as well, or even the lack of ability to know if testing in culturing conditions matches actual conditions in whole organisms.

24 (a)

312 bases

24 (b)

312 / 3 = <u>104</u>
[I will accept 102 if you subtracted two aa's from this due to start and stop codon. However, 104 is most correct here.]

24 (c)

Although all humans have the EF23A gene, just as Tim Badger does, each person will potentially have different variations in the introns found in the gene. These introns may contain variable number tandem repeat (VNTR) sections that are repeating patterns of bases in different quantities and sequence. This means that each person will have a unique pattern in their introns for a particular gene in question. If you compare the EF23A gene between individuals they will be different, and this means that you can search a known EF23A gene in a data base with collected EF23A genes from a population and find a matching individual.

25 (a)

Granum (made of a stack of thylakoid membranes)

25 (b)

This structure is made of a many folded thylakoid membranes, which greatly increase the surface area within the organelle. The increased surface area means more are for chemical reactions to take place and thus greatly increases efficiency.

25 (c)

Advantages:

- Can store the genes of the proteins needed to make the many enzymes required for the function of this organelle
- Allows more efficient reaction rates and quicker response to the need for certain enzymes
- It reduces energy use for the cell, as it does not have to transport the transcribed mRNA out of nucleus to the ribosome, and then transport the protein required into the organelle before it can be used.

Differs:

- It is circular in structure, whereas DNA in nucleus is linear
- It only contains a fraction of the genomic DNA, whereas the DNA in the nucleus is a complete set.

26 (a)

At point C.

This is when the net movement of oxygen out of the leaf is greatest, and this is only caused by the light dependent reaction of photosynthesis which produces oxygen.

26 (b)

At points B and D.

This is because the y axis indicates this is where there is no net movement of oxygen in or out of the cell. This could only be explained by photosynthesis producing exactly the among of oxygen that the process of respiration would use in order to take place. What photosynthesis is producing is used up perfectly by respiration as a reactant.

27 (a)

A probe is a single stranded piece of DNA that is designed to match part of a known sequence of the desired target gene of interest. Attached to the probe is a radioactive tag that allows it to be identified and isolated. The human DNA is mixed with restriction enzymes which cut the DNA into smaller fragments at given sequences (restriction sites). The probe is then added to the restriction fragments and will bind to an exposed matching sequence on the insulin gene if present. This is then run through electrophoresis and x-rayed to see if the probe has located and attached to the desired gene of interest, which in this case is the insulin gene.

27 (b)

The insulin gene can be incorporated into a bacterial plasmid, which is a small independently replicating loop of DNA of the bacteria. The plasmid can be cut with the same restriction enzyme that the insulin gene was cut out of the human DNA with. This leaves matching base sequence sticky ends on the plasmid and insulin gene allowing them to anneal together and the gene to be incorporated into the loop of bacterial DNA. Once in the plasmid, the plasmid is placed back into the bacteria and the bacteria will then use transcription and translation in order to express the incorporated gene as it does with the other genes in its own genome. This results in the gene product (insulin) being produced.

28

Choose one or more of the CCDIAL aspects and elaborate on how the article demonstrates these. For example:

Communication and collaboration –

- Scientists from different countries working together to develop results

Development –

- Development of new technology from the old to improve our study of the cell and ability to analyse; this can then lead to better and revised understandings of how the cell works (new perspectives on the cell)

Influence –

- Development in fields related to physics (lenses and mirrors, etc.) are influencing and other areas such as medicine
- The use of this technology could have implications for poverty areas and has economic related impacts of helping fight diseases.

Application and Limitation –

- Knowledge is being used to make discoveries and develop better solutions for fighting diseases where it was not possible before.