



Units 3 and 4 Biology

Practice Exam Question and Answer Booklet

Duration: 15 minutes reading time, 2 hours and 30 minutes writing time

Structure of book:

Section	Number of questions	Number of questions to be answered	Number of marks
A	40	40	40
B	10	10	70
Total			110

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers and rulers.
- Students are not permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is allowed in this examination.

Materials supplied:

- This question and answer booklet of 27 pages.

Instructions:

- You must complete all questions of the examination.
- Write all your answers in the spaces provided in this booklet.

Section A – Multiple-choice questions

Instructions

Answer all questions by circling your choice.

Choose the response that is correct or that best answers the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will not be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Questions

Question 1

A red blood cell was left in concentrated salt solution for 24 hours. The cell would:

- A. Become turgid
- B. Lyse
- C. Crenate
- D. Plasmolise

Question 2

Pepsin is an enzyme that breaks down proteins in the stomach. It would be reasonable to assume that Pepsin is a:

- A. Fibrous protein
- B. Nucleic acid
- C. Nitrogenous base
- D. Globular protein

Question 3

The percentage of adenine in a sample of DNA was found to be 27 percent. The percentage of guanine in the same sample would thus be:

- A. 27 percent
- B. 73 percent
- C. 23 percent
- D. 32 percent

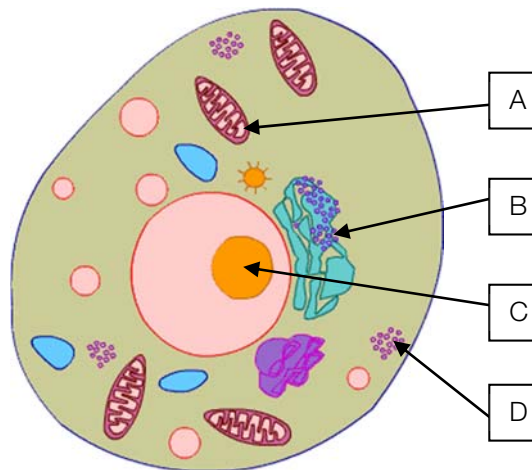
Question 4

The majority of synthesis of the protein receptors on the cell membrane takes place on:

- A. Golgi Apparatus
- B. Rough Endoplasmic reticulum
- C. Lysosomes
- D. Nucleus

Question 5

The conversion of three-carbon sugar molecules to ATP occurs in which organelle of the animal cell shown below?



- A. Organelle A
- B. Organelle B
- C. Organelle C
- D. Organelle D

Question 6

The final acceptor molecule of the electron transport chain in aerobic respiration is:

- A. Oxygen
- B. Carbon dioxide
- C. ATP
- D. NADP

Question 7

The outputs of the water splitting (light dependent) phase of photosynthesis are:

- A. 2 ATP, water, loaded acceptor molecules
- B. Water, oxygen, 2 ATP
- C. Loaded acceptor molecules, water, oxygen
- D. Oxygen, 2 ATP, loaded acceptor molecules

Question 8

The light dependent phase of photosynthesis occurs in the

- A. Grana
- B. Stroma
- C. Christae
- D. Matrix

Use the following information to answer questions 9 and 10:

The specific biological pathway for the synthesis of enzyme X is as follows:

Enzyme A catalyses the production of protein C, which binds onto the allosteric enzyme Y, which changes its active site to provide a platform for substrates B and D to join to synthesise enzyme X, which has an inhibitory effect on enzyme Y.

Question 9

If substrate D is unavailable within the cell, a build-up of which molecules would be observed?

- A. Substrate D and Enzyme Y
- B. Substrate B and Enzyme X
- C. Substrate B and Enzyme Y
- D. Substrate D and Enzyme X

Question 10

Enzyme Y is allosteric. An allosteric enzyme:

- A. Is an enzyme which requires another enzyme/protein to bind to its active site, which changes the shape of its allosteric site in order to fit the substrate
- B. Is an enzyme which requires another enzyme/protein to bind to its allosteric site, which changes the shape of its active site in order to fit the substrate
- C. Is an enzyme which requires another enzyme/protein to bind to its active site, which changes the shape of its active site in order to fit the substrate
- D. Is an enzyme which requires another carbohydrate to bind to its allosteric site, which changes the shape of its active site in order to fit the substrate

Question 11

An example of passive immunity is:

- A. Becoming ill with chicken pox only once in your life
- B. Obtaining a common cold and recovering from it without the use of antibiotics
- C. Pest flies on a food crop being resistant to a particular pesticide
- D. Receiving the anti-venom from a horse's blood for a snakebite

Question 12

A desert mouse would have:

- A. A shortened loop of Henle and dilute urine
- B. A lengthened loop of Henle and concentrated urine
- C. A shortened loop of Henle and concentrated urine
- D. A lengthened loop of Henle and dilute urine

Question 13

Fish kept in fish bowls without proper filtration inevitably die. This is because:

- A. The concentration of ammonia in the fish bowl becomes too concentrated
- B. The concentration of urea in the fish bowl becomes too concentrated
- C. The concentration of uric acid in the fish bowl becomes too concentrated
- D. All of the above

Question 14

The smooth endoplasmic reticulum is responsible for the

- A. Synthesis of proteins
- B. Packaging of proteins for export from the cell
- C. Synthesis of lipids
- D. Packaging of lipids for export from the cell

Question 15

The electron transport chain produces how many electrons?

- A. 32 or 34
- B. 36
- C. 36 or 38
- D. 32-34

Question 16

What are the products of anaerobic fermentation in plant cells?

- A. Ethanol and lactic acid
- B. Lactic acid and carbon dioxide
- C. Carbon dioxide and ethanol
- D. Ethanol

Question 17

What is the name of the molecule that enters the mitochondrion to initiate cellular respiration?

- A. Glucose
- B. Pyruvate
- C. Pyruvic fluid
- D. Glycogen

Question 18

If depolarisation along neurons is large enough, what is generated?

- A. Neurotransmitters
- B. An action potential
- C. Closing of all ion channels
- D. A synapse

Question 19

Schwann cells can be found on what part of a neuron?

- A. Axon
- B. Dendrite
- C. Neurotransmitters
- D. Axon terminal

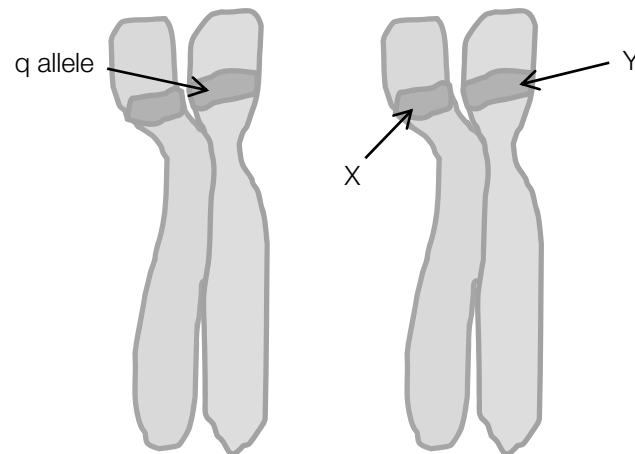
Question 20

B cells mature in the:

- A. Thymus
- B. Liver
- C. Bone marrow
- D. Blood stream

Question 21

Consider the following diagram of a homologous pair of chromosomes containing the gene for keratin content of finger/toe nails. Low keratin content (Q) is completely dominant to high keratin content (q).



The band represented by Y:

- A. Must contain a q allele
- B. Must contain a Q allele
- C. Must contain the same DNA sequence as X
- D. Must contain an alternative DNA sequence to X

Question 22

Which of the following is true of prokaryotic and eukaryotic nuclear organisation?

- A. Eukaryotes organise their genes on a chromosome, whereas prokaryotes lack a chromosome
- B. A eukaryote's linear chromosomes are contained within the nucleus, whereas DNA in prokaryotes exists free in the cell
- C. Eukaryotic nuclear division includes the splitting of homologous pairs whereas prokaryotic nuclear division only involves the splitting of chromosomes into chromatids
- D. Eukaryotic cells cannot take up foreign DNA while prokaryotic cells can take up and express foreign DNA

Question 23

Apoptosis is:

- A. A method of recycling the contents of a cell
- B. Used in order to silence DNA during gene regulation
- C. Only seen to be occurring during the onset of diseases such as cancer
- D. The regulated destruction of cells

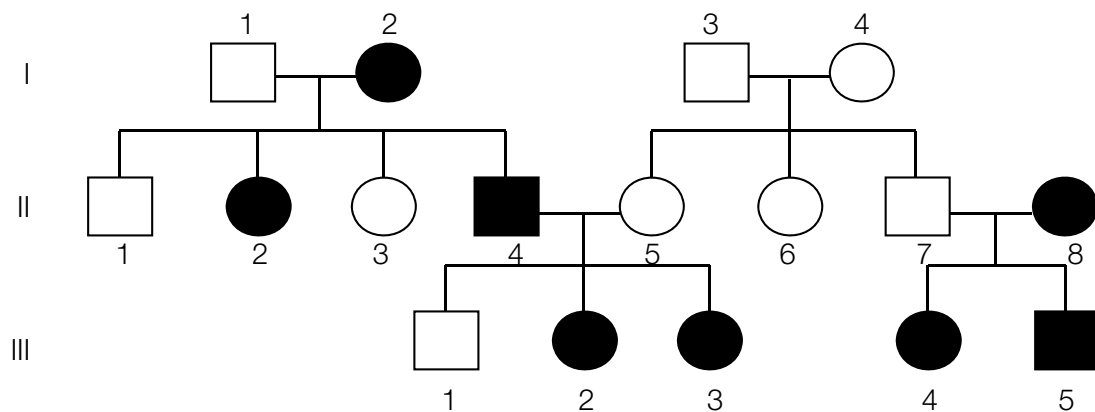
Use the following information to answer questions 24, 25 and 26:

Congenital hemidysplasia with ichthyosiform erythroderma and limb defects (also known as CHILD syndrome) is a disease associated with a mutation on the NSDHL gene. This gene codes for an enzyme, 3-beta-hydroxy sterol dehydrogenase, which is integral in the synthesis of cholesterol in the body from harmful substrates. The following sequence of DNA shows the mutation that leads to a slight alteration of the active site of 3-beta-hydroxy sterol dehydrogenase:

Normal gene: 3' – A T T C A G T A A A C G C C T A G C C A A – 5'

Mutated gene: 3' – A T T C A G T A A G C G C C T A G C C A A – 5'

Examine the following pedigree of a family containing some sufferers of CHILD syndrome:



Question 24

The mode of inheritance for CHILD syndrome is:

- A. Autosomal dominant
- B. Autosomal recessive
- C. X-linked dominant
- D. X-linked recessive

Question 25

For the NSDHL gene, individual III-2 is:

- A. Homozygous
- B. Heterozygous
- C. Hemizygous
- D. Nullizygous

Question 26

From the information, it is possible to conclude that type of mutation leading to misproduction of 3-beta-hydroxy sterol dehydrogenase is:

- A. A silent mutation
- B. A missense mutation
- C. A nonsense mutation
- D. A frameshift mutation

Question 27

The Principle of Independent Assortment states that:

- A. In mitosis, daughter cells receive a completely random combination of chromosomes
- B. In mitosis, daughter cells receive one chromosome from a homologous pair at random
- C. In meiosis, daughter cells receive a completely random combination of chromosomes
- D. In meiosis, daughter cells receive one chromosome from a homologous pair at random

Question 28

Hydrangea macrophylla is a type of flowering plant that is native to parts of Asia and the Americas. In this plant, the colour of the flower is under the control of one gene, in which white is completely dominant to blue. It is noticed that in particularly alkaline soils, the colour of the petals is seen to be pink.

The following table shows the number of individuals in a population of 200 expressing a particular phenotype, at different pH levels.

pH	White	Blue	Pink
2	143	51	6
5	152	35	13
7	92	20	88
11	62	12	126

It is reasonable to conclude that:

- A. Both the white and blue alleles are expressed and pink is the intermediate phenotype
- B. The phenotype of the plant is influenced by both the genotype and environment of the plant
- C. If two pink plants are crossed they will produce 100% pink offspring
- D. *H. macrophylla* produce diploid gametes

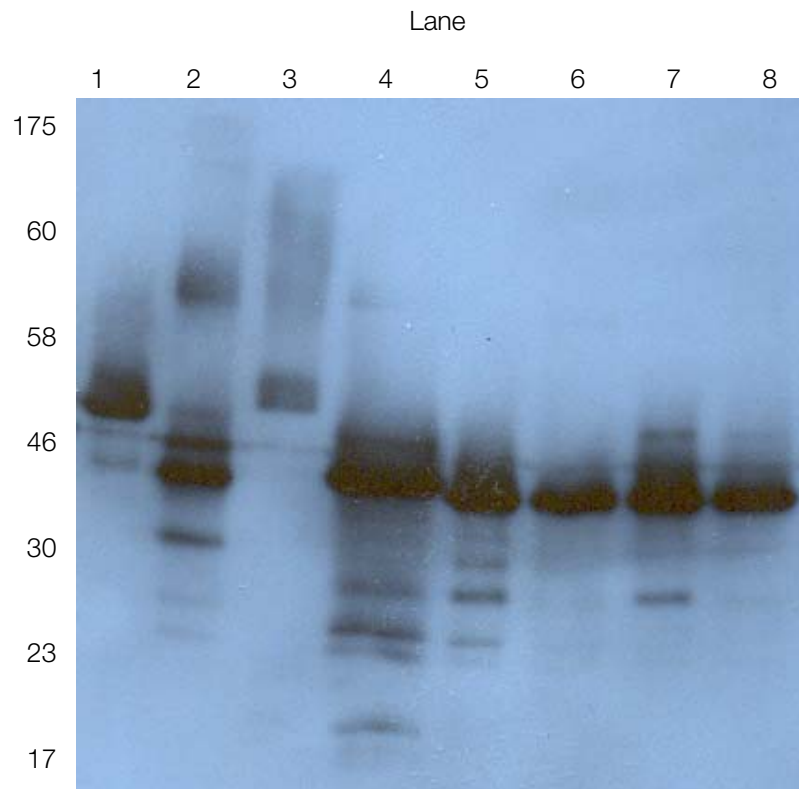
Question 29

DNA helicase:

- A. Is composed of repeating units of nucleotides
- B. Joins Okazaki fragments on the lagging strand during DNA replication
- C. Is most active during the S phase of the cell cycle
- D. Moves in one direction along a single-stranded DNA molecule

Question 30

Examine the following results resulting from the use of gel electrophoresis:



It is reasonable to conclude that:

- A. The DNA samples in lane 2 and 4 are identical
- B. The molecules of DNA in lane 1 have, on average, a larger molecular weight than those in lane 8
- C. Lane 7 contains one fragment of DNA
- D. Lanes 5 and 6 must contain DNA sourced from different individuals

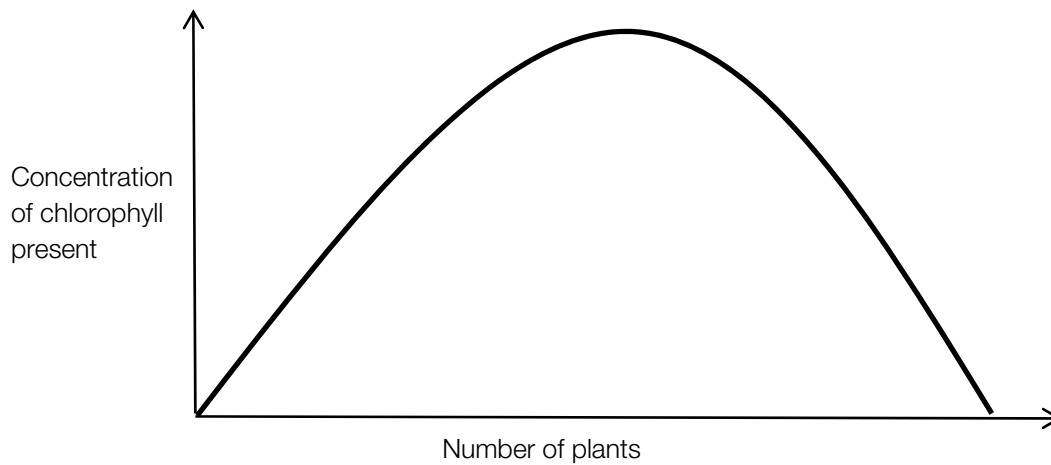
Question 31

Transgenic organisms:

- A. Are infertile
- B. Result from natural selection
- C. May result when foreign DNA is inserted into the nucleus of a fertilized embryo
- D. May rely on viral delivery systems in order to deliver foreign DNA to somatic tissue

Question 32

The following graph shows the variation in chlorophyll levels of plants samples from a rainforest.



From the information it can be concluded that concentration of chlorophyll in individual plants:

- A. Displays continuous inheritance
- B. Displays discontinuous inheritance
- C. Is under the control of one gene
- D. Is under the control of more than two alleles

Question 33

A fossilised mammalian skeleton is found. Using stratigraphy it is estimated that the fossil is 25, 000 years old. Which would be the best choice of isotope to test for in the fossil to support the hypothesis that the fossil is 25,000 years old?

- A. Carbon – 13
- B. Uranium – 235
- C. Lead – 207
- D. Carbon – 14

Question 34

An example of fossil evidence for human cultural evolution is:

- A. A fossilised jaw bone containing small, evenly sized teeth
- B. A fossilised rock tool found near human remains
- C. A skull containing a large brain case
- D. A skull with the position of the foramen magnum at the base of the skull, rather than at the back

Question 35

The species *Homo Neanderthalensis*:

- A. Were more closely related to apes than humans
- B. Had larger brains than modern humans
- C. Were disinterested in chasing large game, leading to their lack of survival when compared with *Homo Sapiens*
- D. Were slightly taller than modern humans

Question 36

Which of the following is an absolute technique to measure of the age of fossils?

- A. Carbon dating
- B. Comparative Embryology
- C. Stratigraphy
- D. Homologous features

Question 37

Which of the following is not an example of convergent evolution?

- A. The use of echolocation as a means of communication seen in both bats and dolphins
- B. Finger to toe membranes observed in the marsupial sugar glider and the flying squirrel
- C. The 'camera' eye design observed in both cephalopods (i.e. squid) and vertebrates (i.e. mammals)
- D. Opposable digits seen in both apes and humans

Question 38

A similar underlying bone structure is seen between the forearm of a man and a whale. This is an example of:

- A. Analogous features
- B. Homologous features
- C. Symmetrical features
- D. Convergence

Question 39

DNA Ligase:

- A. Separates the two parent DNA strands at the commencement of DNA replication
- B. Joins the DNA polymerase to the DNA so that new strands can be created in a semi conservative fashion
- C. Creates phosphodiester bonds between adjacent Okazaki Fragments
- D. Synthesises Okazaki Fragment on the lagging strand during DNA replication

Question 40

In the stratum of a sample of volcanic rock, the amount of ^{235}U (Uranium 235) is measured at 300 arbitrary units. The half-life of ^{235}U is 700 million years. In a newly formed rock of the same type of the sample, the amount of ^{235}U is measured at 1200 arbitrary units. How old is the volcanic rock sample?

- A. 700 million years
- B. 1.4 billion years
- C. 350 million years
- D. 2.1 billion years

Section B – Short-answer questions

Instructions

Answer all questions in the spaces provided.

Unless otherwise indicated, the diagrams in this book are not drawn to scale.

Questions

Question 1

- a. Explain the difference between saturated, monounsaturated and polyunsaturated fats, and why we are so regularly encouraged by health food experts to opt for the latter two in our diet. You may use a diagram in your answer.

2 marks

- b. Though one is a plant and the other is an animal, discuss the functional similarities of a potato and a liver.

2 marks

- c. What is the difference between a monosaccharide and a polysaccharide?

2 marks

- d. With the use of a diagram, illustrate how the Adenine Triphosphate (ATP), molecule provides energy for cellular processes.

2 marks

Total: 8 marks

Question 2

- a. What is an enzyme?

2 marks

A class of biology students sought to test the effect of very high and low pHs on the enzyme mythase. Mythase is involved in the reaction between substrate X and Y to form product Z (a gaseous product), which is a central reaction in the digestive system.

- b. Design an experiment to test the effect of pH upon mythase.

3 marks

- c. Through the experiment, the students discovered that the enzyme functioned much better at a very low pH, compared to a neutral or high pH. From this information, where in the digestive system might mythase be?

1 mark

- d. With reference to the structure of myxase, explain why it may function well at a low pH, but not at all at a high pH.

2 marks

- e. With the aid of a diagram, explain how two amino acids join to form a peptide bond.

2 marks

Total: 10 marks

Question 3

Anticodons in Transfer RNA join to codons in messenger RNA in a process known as translation; that is, the synthesis of polypeptides. Various anticodons and the amino acids they are associated with are shown below:

AAA- Phe
AAG- Phe
UAC- Met
AUU- stop
AUC- stop
ACU- Thr
UGG- Gly
GCG- Gly
GGU- Pro
AGA- Ser

- a. Explain why there is more than one anticodon associated with the single amino acid Glycine (gly).

1 mark

- b. Write out the DNA sequence of bases that would code for the complete polypeptide below. While there may be more than one acceptable answer, only one is required.

Met – Phe – Gly – Thr - Ser

1 mark

- c. Describe the process in which the messenger RNA is synthesised in the nucleus.

2 marks

Total: 4 marks

Question 4

While she was cooking in the kitchen, boiling water spilt on the bench where Christina's hand was resting. Before she realised, her hand retracted from the bench.

- a. What is a reflex arc?

1 mark

- b. What is the benefit of a reflex over the usual stimulus-response model in circumstances such as Christina's?

1 mark

- c. Complete the table below:

	Part of the central nervous system, peripheral nervous system, or both?	Brief description of function
Thermoreceptors on the skin		
Hypothalamus		

2 marks

Total: 4 marks

Question 5

Cytochrome C is a molecule that exists within mitochondria and usually aids the electron transport chain during aerobic respiration. However, when injury occurs to cells, cytochrome C is released into the cytoplasm, which triggers the assembly of apoptosomes which control the action of a class of enzymes known as caspase proteases. These proteases initiate apoptosis by digesting key cellular proteins, so that the cell may die in order to be replaced by healthy cells.

Multiple Appendageal Atrophy (MAA) is an autoimmune disease where the muscles in one's arms and legs are slowly broken down. In this condition, apoptosis in muscle cells is triggered through release of chemicals by T cells.

- a. What is an autoimmune disease?

1 mark

The average concentration of cytochrome C in the cytoplasm of fresh muscle cells from people affected by MAA was compared with that in healthy cells before and after they were subjected to excessive UV radiation.

	5 minutes before irradiation	1 minute before irradiation	1 minute after irradiation	5 minutes after irradiation	20 minutes after irradiation
Cytoplasmic concentration of cytochrome c in muscle cells of healthy individuals ($\mu\text{ mL}^{-1}$)	0.7	0.6	0.9	6.3	0.1
Cytoplasmic concentration of cytochrome c in muscle cells of MAA individuals ($\mu\text{ mL}^{-1}$)	4.8	2.1	0.3	0.1	0.2

- b. Account for the differing concentrations between the MAA and healthy individual's cells 5 minutes after irradiation.

2 marks

- c. Why does the cytoplasmic concentration of cytochrome c decrease between 5 and 20 minutes after irradiation in health individuals?

2 marks

Individuals may be genetically predisposed to developing MAA in later life; however it may also be triggered by infection of the MAA-inducing retrovirus.

- d. Outline the lifecycle of a typical virus.

2 marks

- e. What distinguishes retroviruses from normal viruses?

1 mark

- f. Viruses can be targeted to specific marker molecules on different cell types. With this knowledge, which type of cell in the body would the MAA-inducing retrovirus infect?

1 mark

Total: 9 marks

Question 6

- a. Draw the structure of two nucleotides connected in one strand of RNA, indicating the strand's direction.

3 marks

- b. The polymerase chain reaction (PCR) is a useful tool for amplifying samples of DNA so that they can be more easily analysed.

- i. In order to carry out PCR, what 'ingredients' are required?

1 mark

- ii. Summarise the main steps involved in PCR. You may use diagrams in your answer.

3 marks

- iii. Compare two fragments of DNA – One is made up of 40% cytosine – guanine pairs and the other is made up of 60% cytosine and guanine pairs. Which will require a greater temperature in order to separate the strands?

2 marks

The process of PCR is based upon the natural process of DNA replication.

- c. Outline how the leading and lagging strand are defined in DNA replication.

2 marks

Total: 11 marks

Question 7

Messenger RNA (mRNA), produced in transcription in the nucleus is able to migrate to ribosomes in the cytosol and provide the code for polypeptide formation.

- a. Name one other type of RNA.

1 mark

- b. Briefly describe the function of this RNA type.

1 mark

- c. Messenger RNA must be processed before it can leave the nucleus. Briefly describe the steps taken in this post transcriptional modification before the mRNA is ready to leave the nucleus.

3 marks

Total: 5 marks

Question 8

- a. Two pure breeding frogs are crossed together. Frog one is green and does not contain spots; whereas Frog two is yellow and does contain spots.

The F1 generation are all green and spotted.

The F1 are then crossed many times and the numbers of offspring in the F2 are shown below.

Phenotype	Number of individuals
Green and spotted	902
Yellow and spotted	298
Green and without spots	303
Yellow and without spots	105

- i. Which phenotypes are the dominant phenotypes? Assign allelic notation to Frog one, Frog two and the F1 frogs.

1 mark

- ii. Are the genes for colour and spots assorting independently or are they linked? How do you know?

1 mark

- iii. If you answered that the genes are assorting independently, what phenotypic ratio would you have expected in the F2 if the genes were linked? If you answered that the genes were linked, what phenotypic ratio would you have expected if the genes were assorting independently?

1 mark

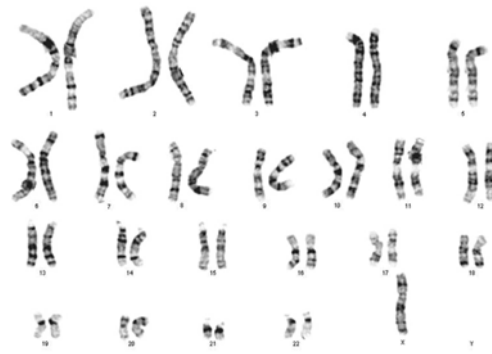
- b. Give an example of a phenotype produced by two co-dominant alleles, and compare it with an example of phenotype produced by two incompletely dominant alleles. What is the difference between co-dominance and incomplete dominance?

1 mark

- c. Explain the phenotypic ratio obtained when two F1 individuals are crossed for a gene that is lethal when homozygous dominant. Use a punnet square in your answer.

2 marks

Total: 6 marks

Question 9

The figure above shows the karyotype of an individual affected by Turner's syndrome. Individuals with Turner's syndrome contain a germline mutation meaning they have only one copy of the X chromosome and no copies of the Y chromosome.

- a. What are germline mutations?

1 mark

- b. Would a woman with Turner's syndrome be able to reproduce? Why/Why not?

2 marks

- c. What type of germline mutation has produced the Turner's syndrome? Make sure you include the stage of meiosis as which the mutation occurred in your answer.

2 marks

Total: 5 marks

Question 10

Many species use bright colours as a means to attract mates in the wild. Biologists have noticed that certain species of insect, frog, and caterpillar are also brightly coloured, though this adaptation appears to be a warning system that they are either poisonous or taste unpleasant.

- a. What is the selective advantage of having bright colouration as a warning signal to predatory species, rather than simply relying on an unpleasant taste?

1 mark

- b. Biologists working in the field have also noticed that a species of caterpillar, *C. calensis*, that are not poisonous are brightly coloured.

- i. This is an example of mimicry. What is the benefit of this mimicry?

1 mark

- ii. Explain how *C. calensis* developed their bright colours.

[illegible]

3 marks

- c. Give an example of how genetic drift that can lead to speciation.

2 marks

- d. What is the criterion for two different populations to be considered different species?

1 mark

Total: 8 marks

End of Booklet

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