



2021 Trial Examination



STUDENT
NUMBER

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Letter

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BIOLOGY

Unit 2 – Written examination

Reading time: 15 minutes

Writing time: 1 hour and 30 minutes

QUESTION & ANSWER BOOK

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	25	25	25
B	7	7	75
			Total 100

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners 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 permitted in this examination.

Materials supplied

- Question and answer book of 25 pages.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the examination room.

SECTION A –Multiple-choice questions

Instructions for Section A

Circle the response that is **correct** for the question.

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

Marks are not deducted for incorrect answers.

If more than 1 answer is completed for any question, no mark will be given to that question.

Question 1

During S Phase of the Cell Cycle:

- A. The number of chromatids doubles and the number of chromosomes doubles
- B. The number of chromatids doubles and the number of chromosomes stays the same
- C. The number of chromatids stays the same and the number of chromosomes doubles
- D. The number of chromatids stays the same and the number of chromosomes stays the same

Question 2

A key feature of budding is _____, and it is performed by organisms such as _____.

- A. Unequal division of the cytoplasm; yeast
- B. Equal division of the cytoplasm; hydra
- C. Producing many offspring at once; yeast
- D. The creation of hard self-contained capsules; hydra

Question 3

Linked traits are those which are on the same chromosome and are usually inherited together. However, sometimes these traits can be separated by the process of crossing over. What is the name given to gametes which are produced where the linked genes have been separated?

- A. Parental gametes
- B. Polygenic gametes
- C. Recombinant gametes
- D. Synaptic gametes

Question 4

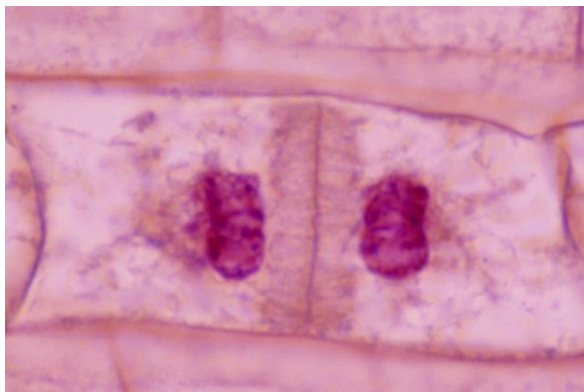
When a child is first conceived, it is considered to be a/an _____; after the first cell division it is considered to be a/an _____.

- A. Foetus; Embryo
- B. Foetus; Zygote
- C. Embryo; Foetus
- D. Zygote; Embryo

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Question 5

The diagram below shows a cell undergoing mitosis. Which stage of mitosis does the cell appear to be in?



- A. Telophase
- B. Metaphase
- C. Anaphase
- D. Prophase

Question 6

Which of the following processes would NOT be performed by eukaryotes?

- A. Mitosis
- B. Meiosis
- C. Binary fission
- D. Apoptosis

Question 7

Farmer Brock was diagnosed with lung cancer later in life. After undergoing testing, specialists believe that the cancer occurred largely due to a certain type of gene in his lungs being blocked. What is this type of gene most likely to be?

- A. Proto-Oncogene
- B. Tumour-Suppressor Gene
- C. Mutagen
- D. Oncogene

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Question 8

Justin has Incontinentiapigmenti, a rare X-linked dominant trait. Which of the following statements about Justin's family must also be true?

- A. Justin's mother has Incontinentiapigmenti
- B. Justin's father has Incontinentiapigmenti
- C. Justin's maternal grandmother has Incontinentiapigmenti
- D. Justin's paternal grandmother has Incontinentiapigmenti

Question 9

In corn, kernel colour is controlled by one gene, with purple colour P being dominant over yellow colour p . Kernel texture is controlled by another gene, where smooth texture S is dominant over wrinkled texture s .

Farmer Brock finds a wrinkled purple corn plant in his paddock. He is aware that this corn was produced from a cross between a smooth purple plant and a smooth yellow plant. Which is a possible genotype of the discovered plant?

- A. $ssPP$
- B. $sspp$
- C. $ssPp$
- D. $SsPp$

Question 10

Which of the following best describes the relationship between genes and alleles?

- A. An allele is a specific variant of a gene
- B. A gene is a specific variant of an allele
- C. An allele is a mutated gene
- D. An allele is a gene with an unknown function

Question 11

Usually, chromosomes separate completely when gametes are forming. However, sometimes things can go wrong, leading to a non-disjunction. If non-disjunction occurs during Meiosis I, how many chromosomes would each of the four resulting gametes have?

- A. All four gametes will have $n+1$ chromosomes
- B. All four gametes will have $n-1$ chromosomes
- C. Two of the gametes will be $n+1$, two of the gametes will have n chromosomes
- D. Two of the gametes will be $n+1$, two of the gametes will have $n-1$ chromosomes

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Question 12

What is the function of the M checkpoint?

- A. To ensure that DNA replication successfully occurred
- B. To ensure that growth patterns of the cell are normal
- C. To ensure that the chromosomes have been correctly attached to the spindle
- D. To ensure there are no errors in the DNA before it is replicated

Question 13

In dragonflies, green colour *G* is completely dominant over brown colour *g*. Bug Catcher Jonny has a box of dragonflies, some which are green and some which are brown. He finds a green one that he wishes to know the genotype of, so he performs a test cross. If the green dragonfly is homozygous, what phenotype ratio would you expect in the offspring of the test cross?

- A. 1 Green : 1 Purple
- B. 3 Green: 1 Purple
- C. All green
- D. All purple

Question 14

One of the most important events during meiosis is independent assortment. This process re-shuffles the genetic material and increases the amount of variation in the gametes. Which of the following best describes the process of independent assortment?

- A. All of the chromatids in the cell can be located anywhere during the cell
- B. Each chromosome lines up with its pair regardless of how the other pairs are lined up
- C. Non-sister chromatids swap genetic material
- D. Each spindle fibre connects to any chromosome, independent of what the other spindles fibres are doing

Question 15

Indian elephants have a diploid number of 56. How many chromatids would there be in a somatic cell from this species which has just completed S phase?

- A. 28
- B. 32
- C. 56
- D. 112

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Question 16

An exceptionally short individual came into Dr. Trueman's office, presenting with issues relating to a webbed neck. Dr. Trueman suspects that the individual has an abnormal set of sex chromosomes.

If Dr. Trueman is correct, what chromosome notation would likely be used for the patient?

- A. XYY
- B. YO
- C. XO
- D. XXY

Question 17

Mitosis and meiosis are both processes which take place in human cells. Which of the following is NOT a key difference between these processes?

- A. They produce different numbers of daughter cells
- B. Meiosis has two rounds of cell division, whereas mitosis only has one
- C. They are used for different purposes
- D. They start with different amounts of chromosomes

Question 18

In recent decades, scientists have discovered that certain species can be created via cloning. Cloning typically involves:

- A. Creating a haploid organism from a diploid organism
- B. Creating a haploid organism from a haploid organism
- C. Creating a diploid organism from a diploid organism
- D. Creating a diploid organism from a haploid organism

Question 19

Which of the following statements correctly describes the arrangement of base pairs in the DNA molecule?

- A. Thymine paired with adenine, joined by 3 hydrogen bonds
- B. Thymine paired with adenine, joined by 2 hydrogen bonds
- C. Thymine paired with cytosine, joined by 2 hydrogen bonds
- D. Guanine paired with cytosine, joined by 2 hydrogen bonds

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Question 20

Which of the following is an example of a genotype?

- A. Yy
- B. Y
- C. Tall
- D. 1:2:1

Question 21

There is a complex interaction between genotype, phenotype and environment. Which equation best represents this?

- A. Genotype = Environment - Phenotype
- B. Phenotype = Genotype + Environment
- C. Environment = Genotype + Phenotype
- D. Genotype = Environment + Phenotype

Question 22

In tree frogs, tongue length is a genetically-controlled trait. Long tongues are dominant to short tongues. If a frog that is homozygous for short tongue breeds with a heterozygous frog, what percentage of their offspring will have long tongues?

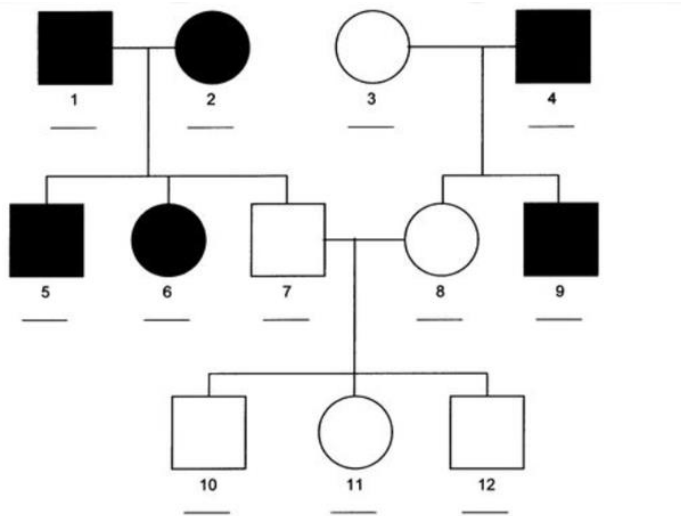
- A. 0%
- B. 25%
- C. 50%
- D. 100%

Question 23

'Centromere' 'Chromatid' and 'Chromosome' are words which are easily confused. What is the best description of the relationship between these terms?

- A. Chromatids in a chromatid combine together to form a centromere
- B. The centromere holds together two chromosomes from a chromatid
- C. Two chromatids are needed for a full chromosome, otherwise it is only a chromatid
- D. The centromere holds together two chromatids in a chromosome

Question 24



What mode of inheritance does this pedigree represent?

- A. X-linked Recessive
- B. Autosomal Recessive
- C. Autosomal Dominant
- D. X-linked Dominant

Question 25

During meiosis, in _____, the sister chromatids line up down the equator, whereas in _____, sister chromosomes are pulled apart.

- A. Metaphase II; Anaphase I
- B. Metaphase I, Anaphase II
- C. Metaphase II, Prophase I
- D. Anaphase II, Anaphase II

END OF SECTION A

SECTION B- Short-answer questions

Instructions for Section B

Answer all questions in the spaces provided.

Question 1

Scientists at *VicMed* Medical Laboratory are investigating what causes cells to become cancerous. They are doing a series of experiments on healthy cells, as well as examining cancerous cells under the microscope.

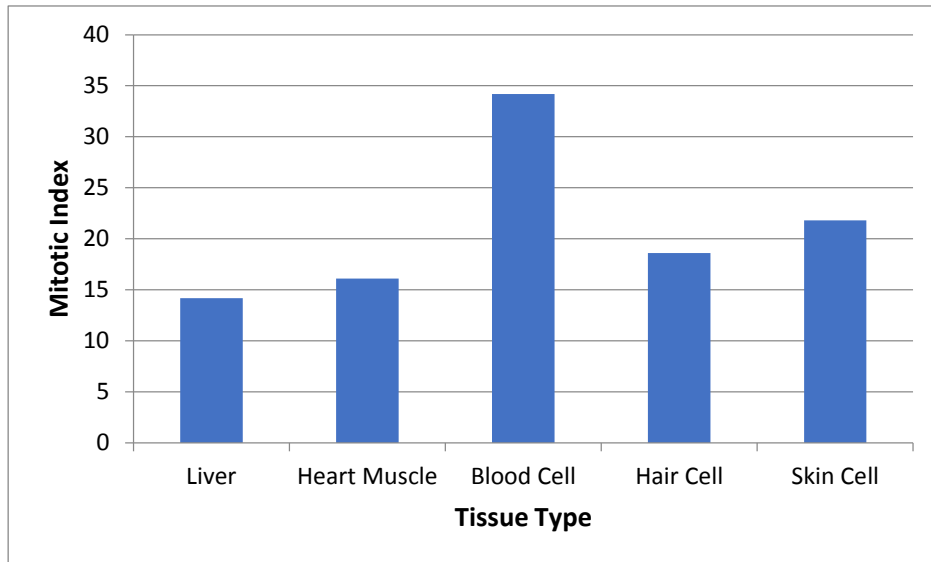
The scientists have chosen to use mitotic index as a measure for how quickly particular tissues are growing – the higher the mitotic index of a tissue, the more cells in the tissue are dividing.

- a. Mitosis occurs as part of the cell cycle, a process which repeats approximately every 24 hours in a typical eukaryotic cell. Draw a diagram below to represent the cell cycle, showing when mitosis occurs in the cycle, and clearly labelling its sub-phases.

4 marks

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After viewing a series of tissues under the microscope, the researchers produced the following graph:



b. Which of these tissue types is most likely to contain cancerous cells? Explain your answer.

3 marks

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c. The researchers are hoping to develop new treatments for cancer using stem cells. However, they need to be very careful in their experiments, as the use of some kinds of stem cells in treatment can increase the chance of cancer.

i. What are stem cells?

ii. What kind of stem cells can cause cancer in medical treatment, and why?

2 + 2 = 4 marks

Total 11 marks

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Question 2

As an embryo develops, it will eventually develop the three primary germ layers. Each of these three layers will then go on to give rise to specific tissues and organs.

a. In the table below, write the names of the three primary germ layers in the left-hand column. In the right-hand column, identify which of the primary germ layers each of the following body parts originates from:

- Kidneys
- Liver
- Brain
- Muscles
- Mouth

Name of Primary Germ Layer	Body parts given rise to by this Germ Layer

Total 8 marks

Question 3

Farmer Brock wishes to create the perfect wheat crop. He has found a single wheat plant that is very close to his ideal, and he wishes to make more of the plant. Farmer Brock is aware that in order to do that, he will need to have the plant reproduce asexually.



- a. Name the specific method of asexual reproduction which Farmer Brock is most likely to use with his plants, and explain how it works.

2 marks

- b. To make this asexual reproduction work, Farmer Brock must pick a particular part of the wheat plant to work with. What part of the plant would definitely NOT be appropriate to use for this purpose, and why?

2 marks

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- c. Name another method of asexual reproduction which some other plants can perform, and describe how it works.

2 marks

- d. Several years later, Farmer Brock's experiments have been very successful. He has been able to create large numbers of wheat clones, by growing the plants in special tissue culture and keeping these special crops isolated in large sheds. Describe 3 potential problems that Farmer Brock may face as a result of growing his plants this way.

3 marks

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- e. One day, Farmer Brock accidentally creates a mutant gigantic type of wheat, which he decides to call called *Wheatusmaximus*. It has 63 chromosomes. Farmer Brock attempts to create more of this crop both asexually and sexually, but he finds that he is unable to create more of the plant using sexual reproduction. Why would this be?

3 marks

Total 12 marks

Question 4

The study of genomics is a rapidly growing field in contemporary science. As genomic data is becoming more accessible and widespread, many people are becoming interested in what this data can teach us about human biology. In particular, the Human Genome Project, which occurred between 1990 and 2003, was a large-scale, systematic effort to sequence the entire human genetic code.

- a. What is a 'genome'?

1 mark

- b. Describe two different ways that genomic data from the Human Genome Project can be used in society today.

2 marks

- c. DNA is made up of a number of smaller subunits.

- i. What is the name given to these subunits?

- ii. Which component of this subunit is of most interest to scientists when undertaking genome sequencing?

1 + 1 = 2 marks

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- d. *VicMed*Laboratories has recently opened in central Victoria. It hopes to gather genomic data about a variety of species, particularly animals which are native to the area. Below is a sequence of bases from a sample of kookaburra DNA:

A G T G C T G A A C A T G A G T A A

- i. What is the sequence of the complementary DNA strand?

- ii. After sequencing a section of kookaburra DNA of 2000 base pairs in length, the scientists discover that 800 bases are guanine. How many bases in this section of DNA are adenine? Explain how you determined this answer.

1 + 3 = 4 marks

- e. Researchers have recently made some significant discoveries in relation to epigenetics.

- i. Define the term 'epigenetics.'

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ii. One type of epigenetics involves ‘DNA methylation.’ Describe how this process works and how it affects gene expression.

1 + 2 = 3 marks

Total 12 marks

Question 5

The walrus (*Odobenus rosmarus*) is a well-known species which can be seen in many nature documentaries. It is found in North Pole and grows to an average weight of 1000 kg.



- a. Walruses can have short, medium or long tusks. It is believed that this gene follows a co-dominant pattern of inheritance, where the medium tusks are a ‘halfway phenotype’ between the short and long tusks.
- i. Assign genotypes to represent each of the three phenotypes mentioned above.

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- ii. How does 'co-dominance' differ from 'complete dominance'?

- iii. Is it possible for medium tusks to be a pure-breeding trait? Explain your answer.

- iv. A short-tusked walrus and a medium-tusked walrus bred together. In the space below, create a Punnett Square showing this cross and the final genotype and phenotype ratio of the offspring.

- v. If 8 baby walruses were produced from the cross in iv, approximately how many of these babies would have medium tusks?

3 + 2 + 2 + 4 + 1 = 12 marks

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b. Although the average walrus weighs 1000kg, their weight is actually controlled by many genes, which produces continuous variation in the population.

i. Describe what is meant by the term ‘continuous variation’ and apply it to the scenario of walrus weight.

ii. In the space below, draw a graph representing polygenic inheritance, ensuring you label both axes appropriately.

2 + 2 = 4 marks

Total 16 marks

Question 6

Researchers have discovered that the way DNA is packaged is critical. Not only does the DNA packaging ensure that the DNA can fit into the nucleus of the cell, it can also change the way that genes are expressed.

- a. Describe how DNA is packaged in cells, ensuring you use the terms ‘histone,’ ‘nucleosome,’ ‘chromatin’ and ‘chromosome.’

4 marks

- b. Down’s Syndrome is a chromosomal disorder which affects a small proportion of the population. It can cause a variety of developmental problems, though most people with the condition live a happy life.

- i. Geneticists sometimes refer to Down’s Syndrome as ‘Trisomy 21.’ What does this term mean?

- ii. How many chromosomes will a person with Down’s Syndrome have in their skin cells?

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- iii. How many chromosomes will a person with Down's Syndrome have in their gametes?

1 + 1 + 1 = 3 marks

- c. Klinefelter's Syndrome is another condition which arises due to having an incorrect number of chromosomes. In this case, a male has an additional X chromosome.

Is Klinefelter's Syndrome a 'sex-linked' trait? Explain your answer.

2 marks

- d. Rachael suffers from haemophilia, an X-linked recessive disorder which causes blood clotting. Rachael's father shows the trait, but her mother does not. None of Rachael's grandparents suffer from the condition.

Assuming that X^h represents the allele for haemophilia, what is the genotype of:

- i. Rachael _____
- ii. Rachael's Father: _____
- iii. Rachael's Maternal Grandmother: _____

1 + 1 + 1 = 3 marks

Total 12 marks

Question 7

Kangaroos can be found throughout Australia. They are organisms which have a fascinating evolutionary history, and are in many ways an Australian icon.



- a. In kangaroos, fur type is controlled by a single autosomal gene. Coarse hair (C) is dominant over thin fur (c).
Nose length in kangaroos is controlled by another autosomal gene, where long nose (N) is dominant over short nose (n).

In the space below, perform a dihybrid cross between:

- A kangaroo which is heterozygous for fur type and homozygous recessive for nose length
- A kangaroo which is homozygous for coarse hair and heterozygous for nose length

Include the final genotype and phenotype ratio of the offspring.

Parent Genotypes:

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Genotype Ratio:

Phenotype Ratio:

Total 4 marks

END OF QUESTION AND ANSWER BOOK