

2006
FORM VI
HSC TRIAL EXAMINATION

Biology

General Instructions

- Reading time 5 minutes
- Working time – 3 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- Write your Candidate Number at the top of each page of Part B

Total marks: 100

Section I Pages 2 – 23

This section has two parts, Part A and Part B

Part A

Total marks: 15

- Attempt Questions 1 to 15
- Allow about 25 minutes for this Part

Part B

Total marks: 60

- Attempt Questions 16 to 30
- Allow about 1 hour 50 minutes for this Part

Section II Pages 25 - 29

Total marks: 25

- Attempt ONE Question from Option Questions
- Allow about 45 minutes for this Section

CHECKLIST

Each boy should have the following:

1 Question Paper	
1 Multiple-choice Answer Sheet	
1 4-page Writing Booklet	

Part A**Total marks: 15****Attempt Questions 1 to 15****Allow about 25 minutes for this Part**

Use the multiple-choice Answer Sheet supplied.

Select the alternative A, B, C or D that best answers the question. Fill in the response circle completely.

Sample $2 + 4 =$

- (A) 2 (B) 6 (C) 8 (D) 9
- ☒ (A) ☒ (B) ☐ (C) ☐ (D)

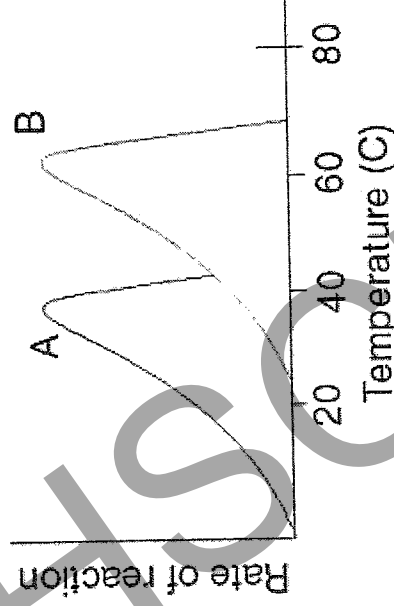
If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

- ☒ (A) ☒ (B) ☐ (C) ☐ (D)

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows.

- ☒ ☒ ☒ ☐ (D)
- correct* → ☒ ☐ (C)

- 1 The graph below shows the optimum temperature for two enzymes, enzyme A and enzyme B.



Which of the following statements is the most likely interpretation of these graphs?

- (A) Enzyme A is likely to be Amylase.
- (B) Enzymes A and B are likely to catalyse equal quantities of their substrates at their respective optimum temperatures.
- (C) Enzyme A is more likely to be a human enzyme than Enzyme B.
- (D) Enzyme B is more likely to be a human enzyme than Enzyme A.

- 2 Which of the following best describes the effect of very cold temperatures on the activity of an enzyme?

- (A) The enzyme structure is denatured.
- (B) The enzyme activity increases.
- (C) The enzyme structure is temporarily altered.
- (D) The enzyme activity is temporarily inhibited.

- 3 Which of the following most accurately describes the structure of veins?

- (A) Three layers thick; the muscle in the middle is elastic and very strong in order to withstand pressure from the heart; the inner layer is very smooth.
- (B) Only one epithelial cell thick; they are so thin that blood cells can only pass through them in single file.
- (C) Three layers thick; they contain valves that only allow blood to move in one direction.
- (D) Similar to arteries but thicker in order to withstand the higher pressure required to return blood to the heart.

- 4 During renal dialysis, many small molecules can easily diffuse through a synthetic membrane to allow the removal of excess wastes and water from the patient's blood. In what way does a cell membrane behave differently to a synthetic membrane?

- (A) Cell membranes can transport molecules by active transport.
- (B) Cell membranes prevent the movement of water against a concentration gradient.
- (C) Cell membranes allow the passage of red blood cells by facilitated diffusion.
- (D) Cell membranes maintain a permanent rigid structure with molecules locked into place.

- 5 Measurements were made of (i) the amount of water lost by leaves, and (ii) number of stomata, of several kinds of plants from different ecosystems. The measurements were made under the same controlled conditions. The results are shown in the table below.

Plant	Volume of water collected per minute per unit leaf area (mL)	Number of stomata per unit leaf area.
A	0.06	600
B	1.60	3000
C	0.80	600
D	0.16	3000

Using only this data, which plant is most likely to have evolved in a desert ecosystem?

- (A) A
- (B) B
- (C) C
- (D) D

- 6 Thomas Morgan's contribution to genetics is best described by which of the following statements?

- (A) He worked with the fruit fly (*Drosophila melanogaster*) and showed that some genes were sex-linked and located on the X-chromosome.
- (B) He worked on sea urchins and showed that a full set of chromosomes is necessary for normal function.
- (C) He worked on grasshoppers and established that chromosomes are distinct entities.
- (D) He worked on pea plants and is known as the Father of Modern Genetics.

- 7 Which of the following is evidence for punctuated equilibrium?
- (A) Transitional fossils
 - (B) The pentadactyl limb
 - (C) The gradual change in an organism over time as depicted by the fossil record.
 - (D) The sudden appearance of new species in the fossil record following mass extinctions.
- 8 Which of the following reproductive technologies is likely to produce an identical genetic copy of the parent?
- (A) Artificial insemination
 - (B) Artificial pollination
 - (C) Plants grown from cuttings
 - (D) Hybridisation
- 9 Biochemistry is an area of study which is useful when studying evolutionary relationships. Which of the following best describes its usefulness?
- (A) All members of the same species have the same DNA.
 - (B) Closely related species will have few proteins in common.
 - (C) Closely related species will have most of the sequence of amino acids of a particular protein in common.
 - (D) Members of the same species have different proteins.
- 10 When Charles Darwin visited the Galapagos Islands he was fascinated by the variety of finch species he observed. His study of them was very important to his final conclusions that led to his Theory of Evolution by Natural Selection. Which of the following best describes how the different species of finch are thought to have arisen?
- (A) Mutation
 - (B) Competition
 - (C) Divergent Evolution
 - (D) Convergent Evolution
- 11 Which of the following would be the best definition of someone who is in good health?
- (A) They are free from disease
 - (B) They are functioning well physiologically.
 - (C) They are functioning well both physiologically and mentally.
 - (D) They are not suffering from a disease caused by a microorganism.

- 12 Which of the following correctly distinguishes the microorganisms listed?

(A)	Viruses are composed only of nucleic acid molecules	Prions are composed only of protein molecules
(B)	Bacteria are unicellular prokaryotes	Protozoans are unicellular eukaryotes
(C)	Fungi are uni- or multicellular eukaryotes	Bacteria are uni- or multicellular prokaryotes
(D)	Viruses are acellular	Bacteria have membrane bound organelles

- 13 Which of the following is the best definition of an antigen?

- (A) A protein which attaches to invading pathogens.
 (B) A molecule that triggers an immune response.
 (C) An organism that triggers an immune response.
 (D) A molecule produced as part of the immune response.

- 14 Which of the following statements about the inflammatory response is correct?

- (A) Blood vessels constrict to reduce blood flow to the damaged area.
 (B) Chemicals are released to attract phagocytic cells.
 (C) Permeability of blood vessel walls decreases to prevent loss of protein.
 (D) Production of mucus increases to trap invading microbes.

- 15 Which of the following best describes Louis Pasteur's main contribution to our understanding of disease?

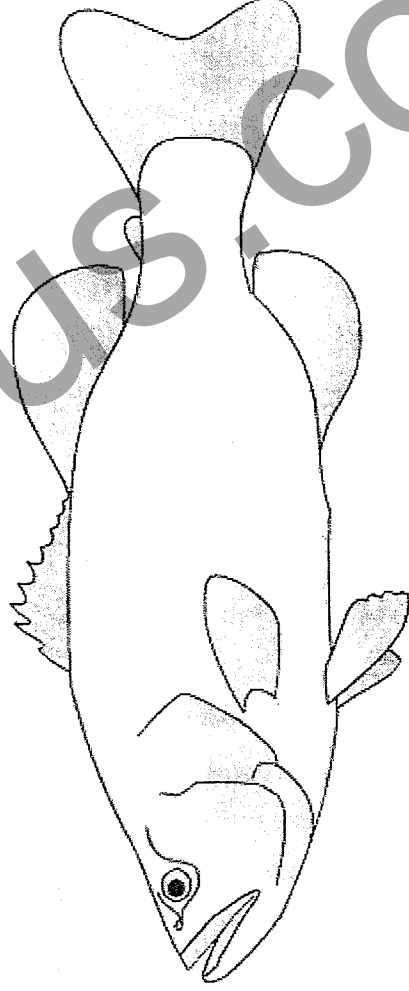
- (A) He isolated the bacterium that causes tuberculosis and cholera.
 (B) The discovery of antibiotics in controlling bacterial growth.
 (C) That microorganisms were responsible for the transmission of disease.
 (D) He showed that the theory of spontaneous generation was correct by using controlled experiments.

Part B**Total marks: 60****Attempt Questions 16 to 30****Allow about 1 hour 45 minutes for this Part**

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Marks**Question 16 (4 marks)**

Using the diagram below, outline the strategies used by a freshwater fish to cope with living in a hypotonic environment.

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Question 17 (3 marks)

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Harry Kewell missed round of 16 of the World Cup, with suspected gout. Although humans usually produce very little uric acid, gout is caused by a high content of uric acid in the blood which accumulates as crystals in the joints and causes acute pain.



From Doug Conway Kaiserslautern, Germany
June 27, 2006

Uric acid crystals are commonly found as a nitrogenous waste product in some types of animals. Compare the major forms of nitrogenous wastes produced in animals, including the types of animals producing each form and how they affect water conservation. You may draw a table.

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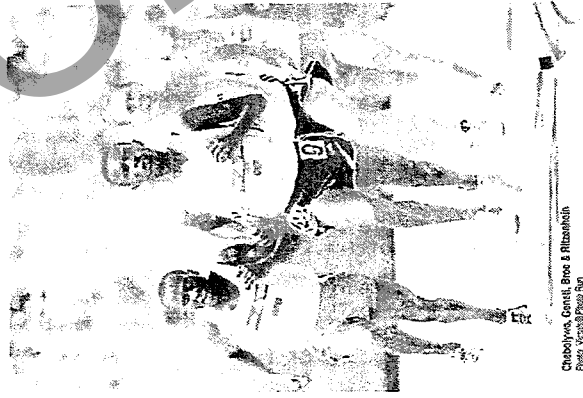
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Marks**Question 18 (2 marks)**

One method to improve an athlete's physical performance is to have them train at high altitude where the oxygen concentration of the air is reduced. Although initially there may not be sufficient oxygen available for normal tissue metabolism (hypoxia) the body can respond physiologically over time in several ways to compensate for this deficiency of oxygen. The rate of acclimatisation varies among individuals and depends on the change in altitude.



Chabolywa, Genet, Brice & Ritzeshain
Photo: Yacobi Photo Run

Suggest a mechanism by which an infusion of red blood cells taken from an athlete who has been training at high altitude (i.e. blood doping) may enhance athletic performance at sea level.

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Question 19 (5 marks)

You are an endocrinologist who diagnoses a patient with Addison's disease, which is a disease of the kidney. Some of the symptoms for this disease include loss of weight, low blood pressure and salt craving.

- (a) What is the cause of Addison's disease?

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- (b) Explain the physiology behind two of the above symptoms.

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Question 20 (6 marks)

- (a) Compare the responses of a named Australian ectotherm with a named Australian endotherm to a cold environment. 4

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- (b) Explain why such homeostatic responses are essential for the survival of organisms. 2

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Marks**Question 21** (5 marks)

Phenotypes are affected by the environment. Siamese cats are darker on their extremities, due to temperature effects on phenotypic expression. Expression of phenotype is a result of the interaction between genes and environment. Siamese cats and Himalayan rabbits both have dark coloured fur on their extremities, but not on the rest of their bodies.

- (a) Propose a mechanism by which the environment affects the phenotype of the above species. 2

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- (b) Outline a first-hand investigation you have carried out to demonstrate the effects of environment on phenotype. 3

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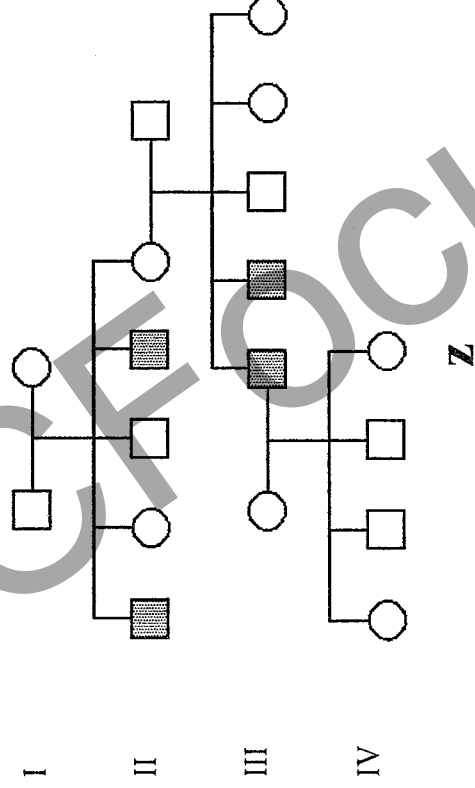
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Question 22 (4 marks)

Becker's muscular dystrophy is a sex-linked muscular disorder which occurs in approximately 5 in 100,000 male births. Symptoms usually appear in men about age 12, but may sometimes begin later. The average age of becoming unable to walk is 25-30. Women rarely develop symptoms. Below is a pedigree for the disorder.



- (a) Is the disorder likely to be dominant or recessive? Give an explanation for your choice. 1
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- (b) Predict the likely genotypic and phenotypic ratio of offspring of a mating between **Z** and a male that does not have the disease. 3
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Question 23 (5 marks)

Below is an mRNA sequence as it appears in the ribosome ready for translation and the universal code for translating this base sequence into an amino acid sequence.

AUGCUGCGUAAACUUUGGCCUGA

Nucleotide position in codon				
first	second			third
	U	C	A	G
U	UUU - Phe UUC - Phe UUA - Leu UUG - Leu	UCU - Ser UCC - Ser UCA - Ser UCG - Ser	UAU - Tyr UAC - Tyr UAA - Stop UAG - Stop	UGU - Cys UGC - Cys UGA - Stop UGG - Trp
C	CUU - Leu CUC - Leu CUA - Leu CUG - Leu	CCU - Pro CCC - Pro CCA - Pro CCG - Pro	CAU - His CAC - His CAA - Gln CAG - Gln	CGU - Arg CGC - Arg CGA - Arg CGG - Arg
A	AUU - Ile AUC - Ile AUA - Ile AUG - Start	ACU - Thr ACC - Thr ACA - Thr ACG - Thr	AAU - Asn AAC - Asn AAA - Lys AAG - Lys	AGU - Ser AGC - Ser AGA - Arg AGG - Arg
G	GUU - Val GUC - Val GUA - Val GUG - Val	GCU - Ala GCC - Ala GCA - Ala GCG - Ala	GAU - Asp GAC - Asp GAA - Glu GAG - Glu	GGU - Gly GGC - Gly GGA - Gly GGG - Gly
				U C A G U C A G U C A G U C A G

- (a) Using the universal code above, it can be seen that **AUG** is the start codon for this particular gene. What will be the amino acid sequence produced by the remainder of this particular base sequence?

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Question 23 continued on next page

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- (b) There are many different types of mutations. Insertions add one or more extra nucleotides into the DNA. Using the same sequence of RNA, predict the amino acid sequence produced by the insertion of the base C (Cytosine) at the position marked by the arrow.

AUGCUGC GUAACUUUGGCUGA



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- (c) Explain how mutations in DNA may lead to the generation of new alleles.

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Question 24 (2 marks)

The rhesus (Rh) factor is an antigen found on the surface of red blood cells. If you are Rh positive (Rh^+) your cells have the antigen and if you are Rh negative (Rh^-) your cells do not have the antigen.

A man who was Rh^+ marries a woman who is Rh^- . The man's father was Rh^- . Rh^+ is dominant to Rh^- . Predict the percentage chance of this couple having a Rh^- child.

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Question 25 (3 marks)

Discuss two reasons why Mendel's work was not recognised by the scientific community at the time he published his findings.

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Marks**Question 26** (6 marks)

No scientific theory is formulated in a social and political vacuum.

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Discuss this statement in relation to the historical development of theories of evolution.

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Marks**Question 27 (2 marks)**

Distinguish between non-infectious disease and infectious disease.

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Question 28 (3 marks)

After hurricane Katrina hit the Gulf Coast of the United States of America in August 2005, people were removed from flooded areas because the authorities were afraid that the water and sewage systems and the electricity supply were not working. As a result, the food and water supply and personal hygiene could not be maintained.

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Using hurricane Katrina as an example, explain how cleanliness in food, water and personal hygiene practices assist in the control of disease.

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Question 29 (5 marks)For a **named** infectious disease:

- (a) State how the disease is transmitted.

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- (b) State the major symptoms of the disease.

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- (c) Explain how the disease could be prevented.

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[illegible]

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Question 30 (5 marks)

A mysterious disease outbreak occurs in a colony of Koalas living in the forests around the Lucas Heights nuclear reactor. Ten sick animals are found to be suffering from the same symptoms; weight loss, skin lesions and foul breath. Radioactive contamination of the local environment is suspected. However, blood tests of the sick animals reveal that they have a type of bacterium in their blood. Describe the steps that you would undertake to prove that this particular bacterium is the cause of the disease.

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Section II**Total marks: 25****Attempt ONE question from Questions 31 - 34****Allow about 45 minutes for this section**

Answer the question in a writing booklet. Extra writing booklets are available.

	PAGES
Question 31	Communication27
Question 32	Biotechnology
Question 33	Genetics - The Code Broken?29
Question 34	The Human Story
Question 34	Biochemistry

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Question 31 – Communication (25 marks)

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| (a) | Identify the role of receptors in animals. | 1 |
| (b) | Depth perception is highly evolved in primates and many predators. Explain the processes involved in depth perception. | 2 |
| (c) | (i) Draw a detailed diagram to show how light is refracted in the mammalian eye onto the fovea. | 2 |
| | (ii) Compare the refractive power of the lens from rest to maximum accommodation. | 2 |
| (d) | Describe the condition known as cataracts and the ways technology can be used to overcome the effects of cataracts. | 5 |
| (e) | During your Biology course, you performed a first-hand investigation of a mammalian eye to gather first-hand data to relate structure to function. Describe the investigation you carried out and the conclusions that were reached. | 6 |
| (f) | Compare the nature and functioning of photoreceptor cells in mammals, insects and in one other animal. | 7 |

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Question 33 Genetics – The Code Broken? (25 marks)

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| (a) | If two genes are linked what does this mean? | 1 |
| (b) | Briefly describe how linkage will affect the inheritance of linked genes. | 2 |
| (c) | Explain why highly variable genes are used for paternity testing. | 2 |
| (d) | In guinea pigs the genes for coat colour and fur texture are independent genes. In this problem, coat colours are black and white and coat textures are rough and smooth. Predict the phenotypes, genotypes and corresponding ratios of a cross between a heterozygous black smooth guinea pig and a white heterozygous rough guinea pig. Show your working. | 4 |
| (e) | Multiple alleles are found in many organisms. Describe one example from a human and one example from another organism. Discuss the evolutionary advantage of multiple alleles. | 5 |
| (f) | Discuss the benefits and limitations of the Human Genome Project. | 5 |
| (g) | Gene therapy is a process by which it is hoped that genetic diseases such as Cystic Fibrosis could be cured. Evaluate the current application of gene therapy to a named disease you have studied. In your answer include an explanation of how recombinant DNA technology is used in gene therapy. | 6 |

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