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## 2015 AUSTRALIAN SCIENCE OLYMPIAD EXAM BIOLOGY – SECTION C

TO BE COMPLETED BY THE STUDENT USE CAPITAL LETTERS

**Student Name:** .....

**Home Address:** .....

..... **Post Code:** .....

**Telephone:** (.....) ..... **Mobile:** .....

**E-Mail:** ..... **Date of Birth:** ...../...../.....

Male    Female                      **Year 10**  **Year 11**  **Other:** .....

**Name of School:** ..... **State:** .....

To be eligible for selection for the Australian Science Olympiad Summer School, students must be able to hold an Australian passport by the time of team selection (March 2016).

The Australian Olympiad teams in Biology, Chemistry, Earth and Environmental Science and Physics will be selected from students participating in the Science Summer School.

Please note - students in Year 12 in 2015 are not eligible to attend the 2016 Australian Science Olympiad Summer School.

**I am an Australian public high school student and would like to be considered for the Australian Science Olympiad Summer School Scholarship.**

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<b>Examiners Use Only:</b>									

## 2015 AUSTRALIAN SCIENCE OLYMPIAD EXAM

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*Time Allowed:*

*Reading Time: 10 minutes*

*Examination Time: 120 minutes*

### INSTRUCTIONS

- *Attempt all questions in ALL sections of this paper.*
- Permitted materials: Non-programmable, non-graphical calculator, pens, pencils, erasers and a ruler.
- Answer SECTIONS A and B on the MULTIPLE CHOICE ANSWER SHEET PROVIDED. Use a pencil.
- Answer SECTION C in the answer booklet provided. Write in pen and use pencil only for graphs.
- Ensure that your diagrams are clear and labelled.
- All numerical answers must have correct units.
- Marks will not be deducted for incorrect answers.

### MARKS

SECTION A	40 multiple choice questions	40 marks
SECTION B	10 sets of true/false questions	40 marks
SECTION C	6 written answer questions	45 marks
	Total marks for the paper	125 marks

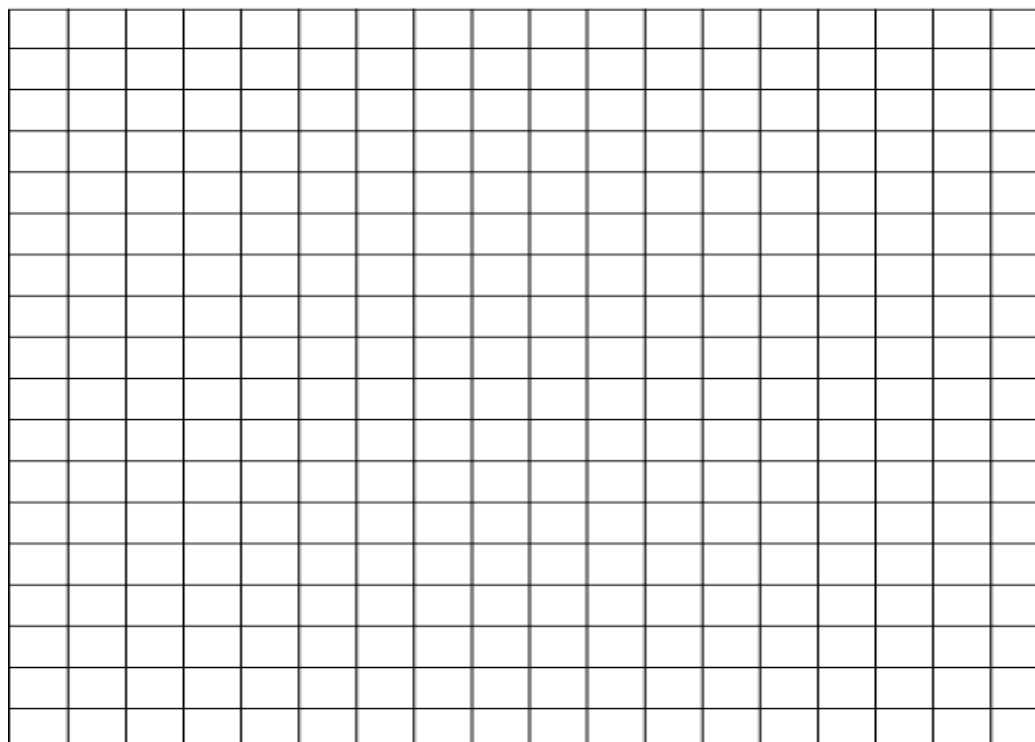
1. The activity of trypsin can be determined experimentally by measuring the rate at which amino acids are formed by the hydrolysis of a protein such as albumin. An experiment was carried out to investigate the effect of trypsin concentration on the activity of albumin. Two solutions of trypsin, A and B, of differing concentrations, were incubated with a dilute albumin solution. The concentration of amino acids produced was measured every two minutes for fourteen minutes. The results are shown in the table below.

Time/min	Concentration of amino acids produced /micromoles dm <sup>-3</sup>	
	Trypsin solution A	Trypsin solution B
0	0.2	0.2
2	1.2	0.4
4	2.3	0.7
6	3.4	1.0
8	4.4	1.2
10	5.3	1.3
12	6.2	1.4
14	7.1	1.5

From <http://www.resourcebank.curriculum.edu.au>

- A. Plot the results on graph paper below. (5 marks)

Title: \_\_\_\_\_



B. From your graph find the mean rate of amino acid production in A between 3 and 11 minutes. Show your working. (2 marks)

Answer \_\_\_\_\_

C. Which of the two solutions contained the highest concentration of trypsin? Explain your answer. (2 marks)

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D. State two conditions that should be kept constant in this experiment and in each case state how.

i) \_\_\_\_\_ (2 marks)

ii) \_\_\_\_\_ (2 marks)

E. State two commercial applications of the use of protease enzymes.

i) \_\_\_\_\_ (1 mark)

ii) \_\_\_\_\_ (1 mark)

2. DNA replication is semi conservative. This means that each replicated strand of DNA is made of half original DNA and half new DNA from free nucleotides.

A. Draw a diagram to explain this concept. (2 marks)

DNA is a polymer made of nucleotide monomers. Each nucleotide is composed of phosphate, a deoxyribose sugar and a nitrogenous base.

B. If a bacterium composed of nitrogen 14 was grown in culture that contained nitrogen 16, would newly synthesised DNA weigh more, less or the same as original bacterium DNA? Explain (2 marks)

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There are four different nitrogenous bases in DNA, guanine, cytosine, adenine and thymine. Within the double helix of DNA, guanine from one strand binds to cytosine while adenine binds to thymine.

C. A sequence of fifty base pairs of nucleotides contains 33 cytosine bases. How many adenine bases are there in the sequence? Show your working. (2 marks)

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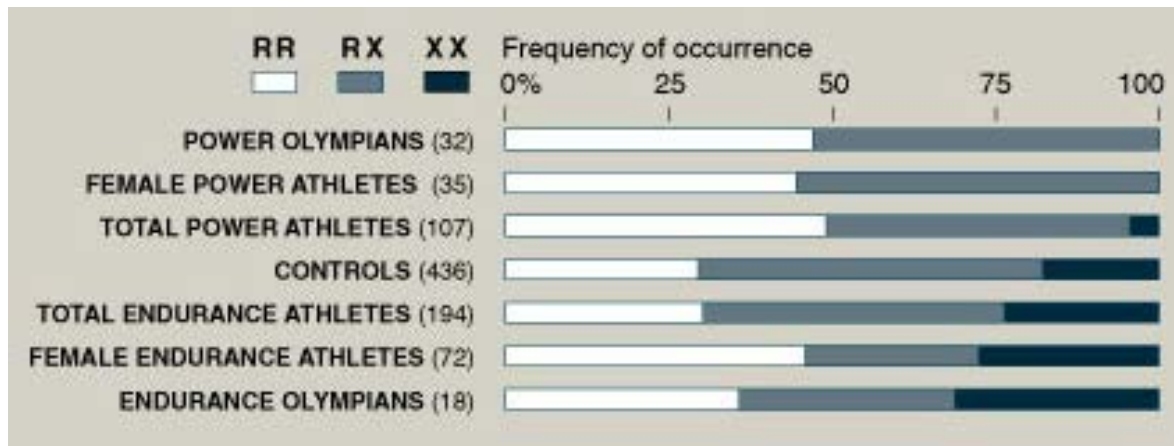
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3. A single nucleotide polymorphism (SNP) is a DNA sequence variation occurring within a group of the same species in which a single nucleotide differs between individual members. SNPs can be in coding or non-coding regions of DNA. There are many studies that look at how SNPs correlate with a person's phenotype. ACTN3 is a gene coding for muscle specific protein alpha-actinin-3. Three genotypes exist for this gene: RR, RX and XX. Lack of this protein (XX) is not associated with disease.



Source: Stephen M. Roth, Ph.D., University of Maryland; American Journal of Human Genetics

- A. Does the alpha-actinin-3 protein give an advantage in becoming an endurance athlete? Justify your answer (1.5 marks)

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- B. Does lack of the R allele prevent someone from becoming a power athlete? Justify your answer (1.5 marks)

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- C. Do you think this protein would be more likely to be involved in aerobic or anaerobic respiration and why? (2 marks)

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4. Atenolol is a drug that acts selectively at the heart. The following table shows the effect of increasing daily dose of atenolol on the heart rate of resting and exercising patients.

	25mg	50mg	100mg	200mg
Resting heart rate (beats/min)	$62.1 \pm 2.1$	$61.8 \pm 1.0$	$59.1 \pm 1.3$	$57.3 \pm 2.2$
Exercising heart rate (beats/min)	$100.1 \pm 3.6$	$96.7 \pm 3.1$	$89.5 \pm 2.1$	$87.1 \pm 2.3$

A. Describe the relationship between atenolol and heart rate. (1 mark)

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B. What would you expect the effect of atenolol on blood pressure is? (2 marks)

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5. One of the questions in biology that constantly needs to be answered is: Are the results of an experiment significant? To answer this question scientists use statistical calculations.

In one experiment biologists were trying to increase the success rate for infection with a certain virus. They set up several bacterial cell cultures and then infected them with a modified virus, which they hoped would infect a higher percentage of the bacteria.

The scientists know that the wild type virus infects 70% of the bacterial cells.

Cell Culture	% of Cells infected
1	75
2	68
3	85
4	72
5	63
6	70
7	79
8	81

The scientists are going to do a significance test to see if their results show a difference in the infection rate of the modified virus.

- A. What can the scientists use from their experiments to compare to the known infection rate?

\_\_\_\_\_ (1 mark)

- B. Calculate this value.

\_\_\_\_\_ (1 mark)

The scientists have calculated a critical value for their significance test to be 74.89. The critical value is the value where the probability that the value from the experiment is the same as the known value starts to get small enough that we can say that they are not the same.

If the value from our experiment does not reach the critical value we have not attained significant results and cannot infer anything based on the experiment.

- C. What can you say about the experiment and the infection rate based on the critical value? (2 marks)

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\_\_\_\_\_  
\_\_\_\_\_

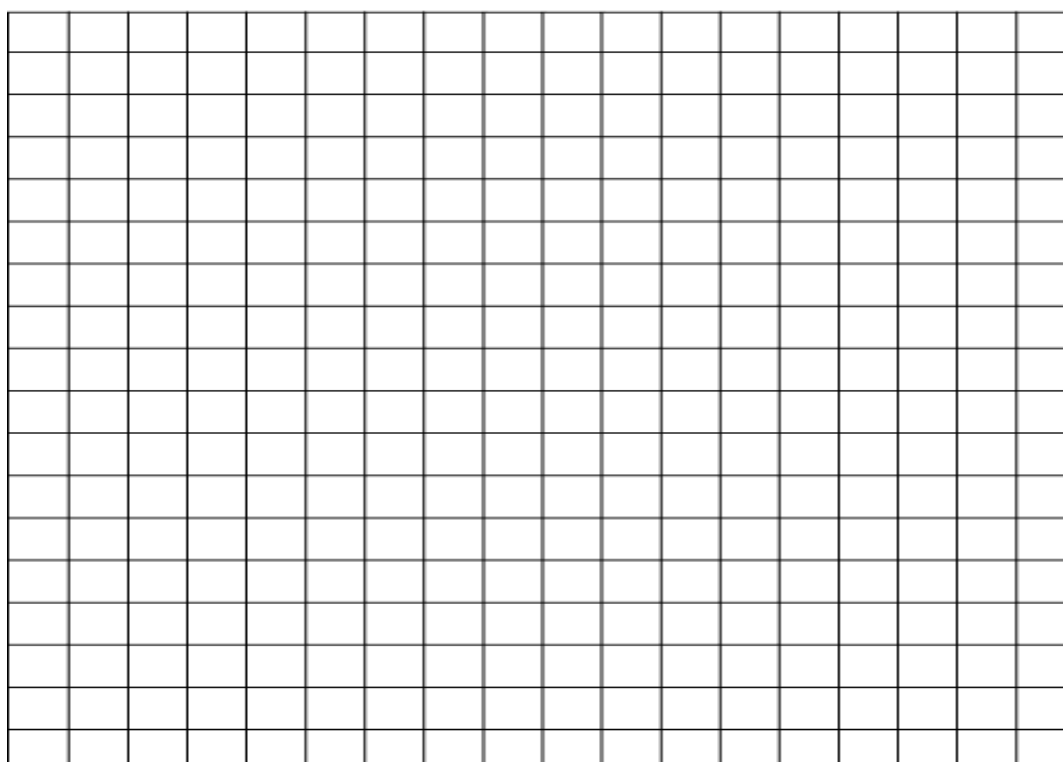


6. The disease cholera is caused by the bacteria *Vibrio cholerae* which infects the gut of humans after they drink contaminated water. The bacteria caused large amounts of watery diarrhea to be produced due to its production of a toxin, cholera toxin. The bacteria are commonly found in sewerage contaminated water, particularly in the developing world. After a hurricane in Haiti a team of scientists are monitoring water for Cholera bacteria and get the following data:

Days after Hurricane	Water sample volume (mL)	Number of <i>Vibrio cholerae</i> bacteria seen	Bacteria Per Litre of Water
3		5	20
6	50	25	
10	200		1000
12	320	384	
15	150	60	

- A. Complete the empty cells of the table (1 mark per cell 5 marks total).
- B. Graph the number of bacteria per Litre against time after the hurricane (connect all points with straight lines) (5 marks).

Title: \_\_\_\_\_



- C. The scientists were told to inform the World Health Organisation if the number of *Vibrio cholera* bacteria goes above 600 bacteria per Litre, as this indicates sewerage leakage into drinking water. If they had been monitoring drinking water daily what day would they have reached this notification threshold?

Days after Hurricane \_\_\_\_\_ (1 mark)

- D. Only certain strains of *Vibrio cholera* express the toxin required to cause severe disease, named cholera toxin. Name a technique that could be used to screen strains of *Vibrio cholera* for the presence of the gene for cholera toxin. (1 mark)
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*Integrity of Competition*

*If there is evidence of collusion or other academic dishonesty, students will be disqualified. Markers' decisions are final*

