ASI School ID:

2012 AUSTRALIAN SCIENCE OLYMPIAD EXAMINATION

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 2013).

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

Please note - students in Yr12 in 2012 are not eligible to attend the 2013 Australian Science Olympiad Summer School.

Signature: …… Date: ……

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Examiners Use Only:

BIOLOGY

2012 Australian Science Olympiad Examination

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	36 multiple choice questions	36 marks
SECTION B	12 short answer questions	15 marks
SECTION C	8 written answer questions	64 marks
	Total marks for the paper	115 marks

SECTION C: WRITE YOUR ANSWERS IN THIS BOOKLET

1. The table below refers to biological chemicals. Mark a tick in the box if the statement about the chemical is correct. The first one is completed for you. **(5 marks)**

	Biological chemical			
	RNA	**Starch**	**Protein**	**Lipid**
Used for growth and repair			√	
Contains nitrogen				
Contains carbon, oxygen and hydrogen				
Made from amino acids				
Reacts with iodine to form a blue black complex				
Insoluble in water				
Contains uracil				

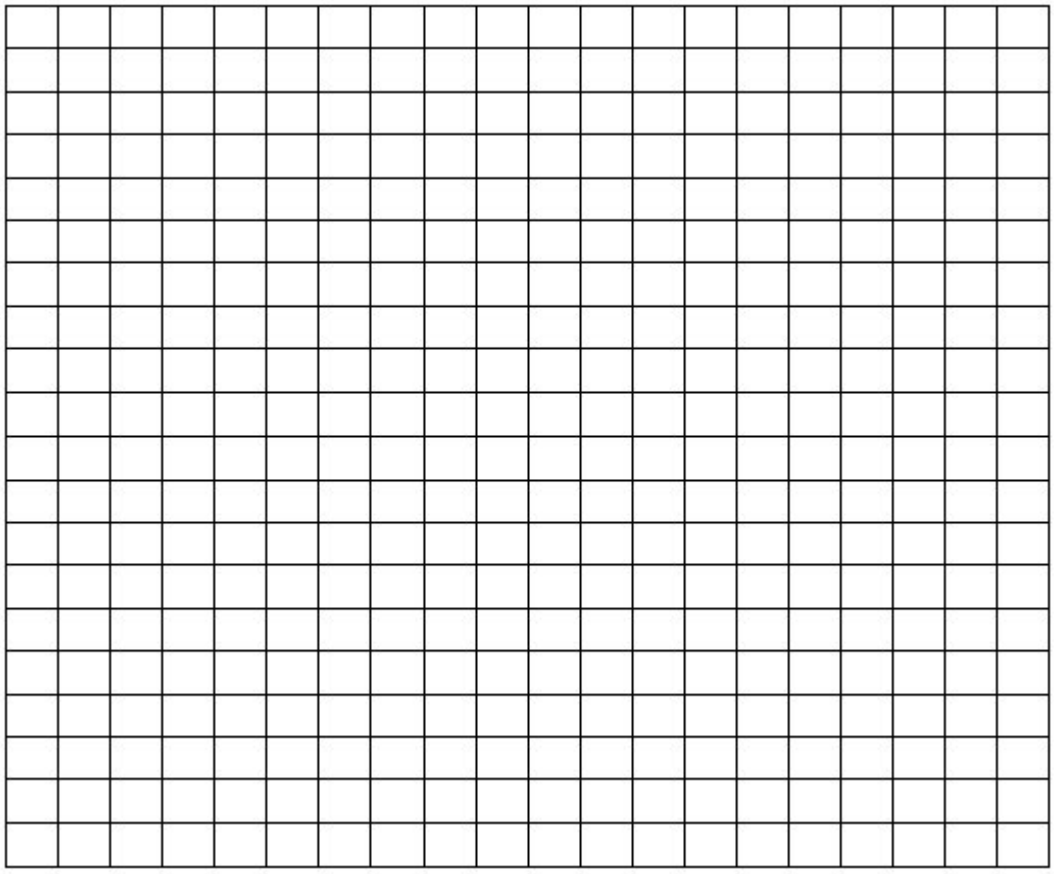
2. Absorbance spectroscopy is a technique that uses the linear relationship between the concentration of a substance in solution and its absorbance of a specific wavelength of light to estimate concentration.

This is done by first determining the absorbance of known concentrations of the substance and making a standard curve (a graph which shows the relationship of absorbance and concentration). The concentration of unknowns of the same substance can then be determined by finding where their absorbance values fall on the standard curve.

The absorbance of known concentrations of substance x at 280nm are shown below.

Concentration (mg/ml)	**Absorbance at 280 nm (arbitrary units)**
0	0
0.11	0.07
0.17	0.12
0.24	0.14
0.31	0.17
0.34	0.23
0.41	0.25
0.5	0.33

a. Use these values to construct a standard curve of absorbance of substance x at 280nm on the grid provided. Make sure to label your axes appropriately. **(5 marks)**



b. Use your standard curve to estimate the concentration of a solution of substance x that has an absorbance of 0.25 (answer to 1 decimal place). **(2 marks)**

_____

c. Both the solutions used to generate the standard curve and the solution of unknown concentration of substance x were dissolved in the same buffer. Another solution of substance x was dissolved in a different buffer. However this standard curve could not be used to estimate its concentration. Why not? **(2 marks)**

_____

_____

d. The wavelength chosen for the standard curve and the solution of absorbance of a particular substance is generally the wavelength of light it absorbs best (i.e. the wavelength of maximal absorbance). Why would it be preferable to perform absorbance readings at a wavelength that is absorbed well by a substance versus one that it absorbs minimally? **(2 marks)**

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_____

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3. In corn, a 'starchy' seed phenotype is described as being **dominant** to the 'sugary' seed phenotype. The starchy variety is grown in Australia to provide corn flour meal whilst the sugary variety is marketed as the vegetable sweet corn.

A Queensland farmer crossed a pure-breeding 'starchy' plant with a pure-breeding 'sugary' plant (pure-breeds are individuals that will give rise to progeny all of the same phenotype when crossed with other pure-breeds of the same phenotype).

a. What would be the phenotype of the F_1 seeds? **(1 mark)**

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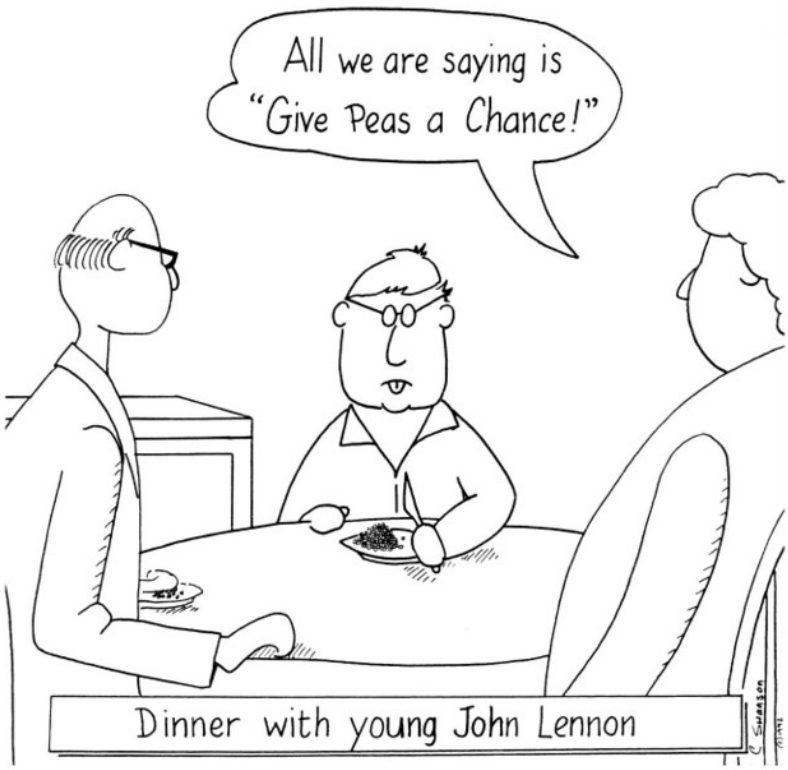
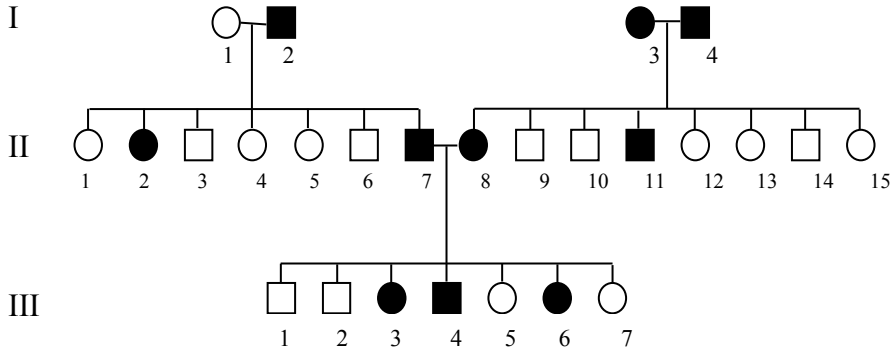
b. The F_1 seeds were allowed to mature, self fertilise and set seed. What is the expected ratio of starchy to sugary seeds in the cobs borne on the F_1 plants? **(2 marks)**



From the website of Craig Swanson at http://content.perspicuity.com/?q=node/31

4. The following pedigree refers to the ability to taste phenylthiourea, a bitter chemical, in three generations. Individual I2, a male, can taste phenylthiourea but individual I1, a female, cannot.



a. Is the ability to tasted phenylthiourea a dominant or recessive trait? **(1 mark)**

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b. What is / are **all** the possible genotype/s for the individual II7. (Use the symbols **T** for the dominant allele and **t** for the recessive allele? **(1 mark)**

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c. What is the genotype of II12? **(1 mark)**

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d. How many male non-tasters are there in the third generation? **(1 mark)**

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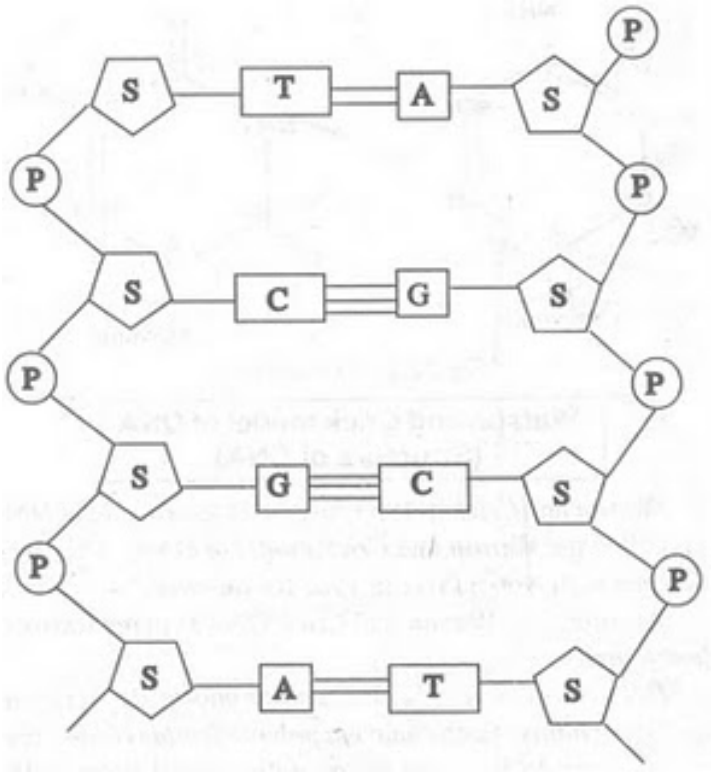
5. The diagram below shows one artist's representation part of a nucleic acid. **(4 marks)**



From http://dnanotes.nowlix.com/2011/01/download-dna-nucleotide-structures-and.html

a. Where in a **prokaryote** where would you see this molecule? **(1 mark)**

_____

b. The diagram is labelled with A, C, G, P, S and T. What is represented by the lines drawn between C, G, A and T? **(1 mark)**

_____

c. Analysis of this molecule shows that 23% of its nitrogenous bases are A. What percentage of G would you expect to find? **(2 marks)**

_____

6. Budgerigars are the only species in the Australian genus *Melopsittacus* (means melodious parrot) and are related to loris and lorikeets. In the wild they are a generally light green in colour with yellow heads. In 1879, a Belgian fancier reported a new mutation, *Ino*, in budgerigars and since then various mutations have been described. Some of these mutations give rise to different phenotypes, many of which are desirable to breeders (or fanciers) of captive birds.

One gene locus controls the general colour of the feathers (***G***) and another gene controls the intensity (***I***) of the colour, with the allele ***I*** giving the most intense colour. The intensity of the heterozygous individuals (***Ii***) show a colour intensity intermediate between the homozygotes (either ***II*** or ***ii***). Six possible phenotypes are shown in the table below.

		Intensity of colour	
General colour	**Pale**	**Mid**	**Dark**
Green	Light green	Dark green	Olive
Blue	Sky blue	Cobalt	Mauve

Work out the possible phenotypes and genotypes of the F_1 for the following three crosses (**a - c)**. Show your working and use the symbols given in this question to represent the alleles. Calculate the expected ratios from the crosses for all the phenotypes.

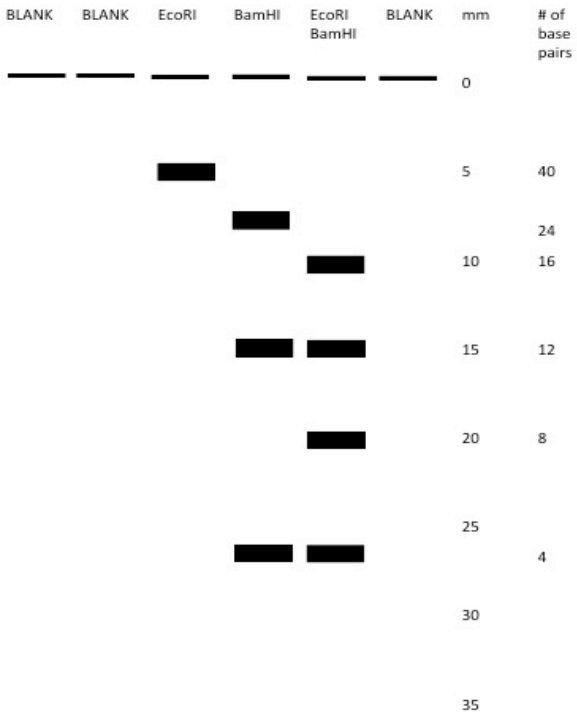
a. Sky blue X mauve **(2 marks)**
b. Homozygous olive X heterozygous olive **(2 marks)**
c. Heterozygous dark green X cobalt **(4 marks)**

7. A plasmid is a ring of double stranded DNA found mostly in prokaryotes and occasionally in some eukaryotes. Plasmids are inherited independently from the genomic DNA, are associated with antibiotic resistance, horizontal gene transfer and nitrogen fixation: quite a variety of functions occurring naturally in bacterial plasmids!

Restriction enzymes (such as EcorR1, BamH1) can be used to 'cut' plasmids at specific sites. These can then be inserted into other organisms carrying genes (in genetic engineering) to produce a variety of compounds such as antibiotics, insulin and toxins.

When a restriction enzyme cuts a plasmid once, the plasmid forms one length of DNA. If the enzyme cuts at 2 sites, then 2 pieces of DNA are formed. Different lengths of DNA can be separated by gel electrophoresis and we can determine the size (numbers of base pairs) of the plasmid. Using 2 or more different restriction enzymes, the size of a plasmid can be determined and the sites where restriction enzyme cuts the DNA allow the plasmid to be 'mapped'.

The digested DNA is loaded into wells at 0 mm and the gel is set to 'run' to separate the different lengths of DNA for about 90 minutes. In the example below, the restriction enzyme EcoR1 cuts the plasmid to give one length of DNA of 40 base pairs. With the restriction enzyme BamH1, the same plasmid is cut into three pieces.



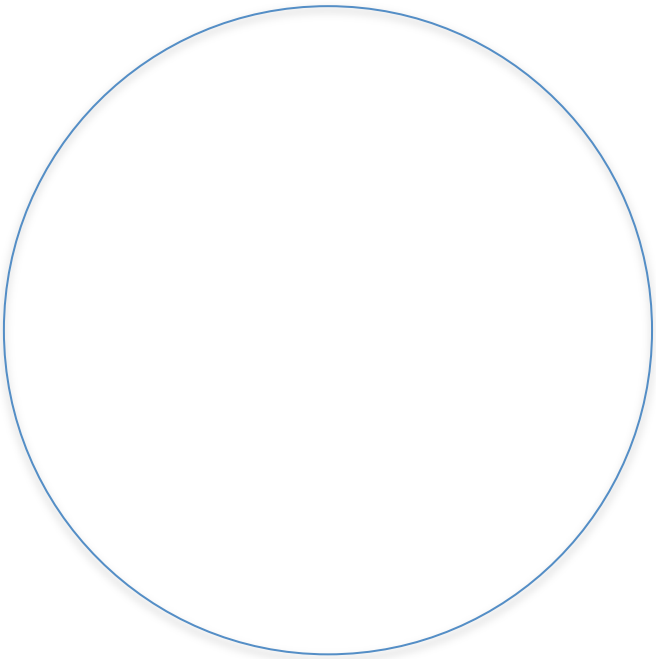
The student started recording the data from the gel at the end of the practical.

	Numbers of base pairs per band			
EcoR1	40			
BamH1	24			
EcoR1 and BamH1		12		

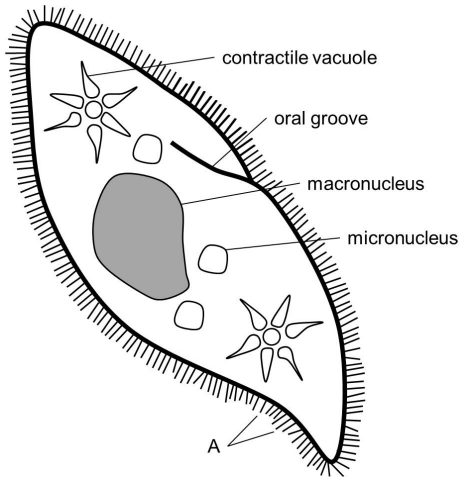
a. Complete the table above to show the experimental data from the gel. **(2.5 marks)**

b. How many base pairs was this plasmid? **(0.5 marks)**

c. Draw on the circle below a possible 'map' of the plasmid showing where the relative positions of the sites for the restriction enzymes are found. **(6 marks)**



8. A diagram of *Paramecium*, a unicellular aquatic organism, is shown below:



a. Is the *Paramecium* prokaryotic or eukaryotic? (**1 mark)**

_____

b. Name the structures labelled A in the diagram. What is their purpose? (**2 marks)**

_____

_____

c. The *Paramecium* regulates its water content using an organelle called a contractile vacuole. As water enters by osmosis, this organelle fills up and pumps water out into the external environment. As the salinity of the environment increases, predict how the rate of pumping would change. Explain why. (**3 marks)**

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_____

_____

_____

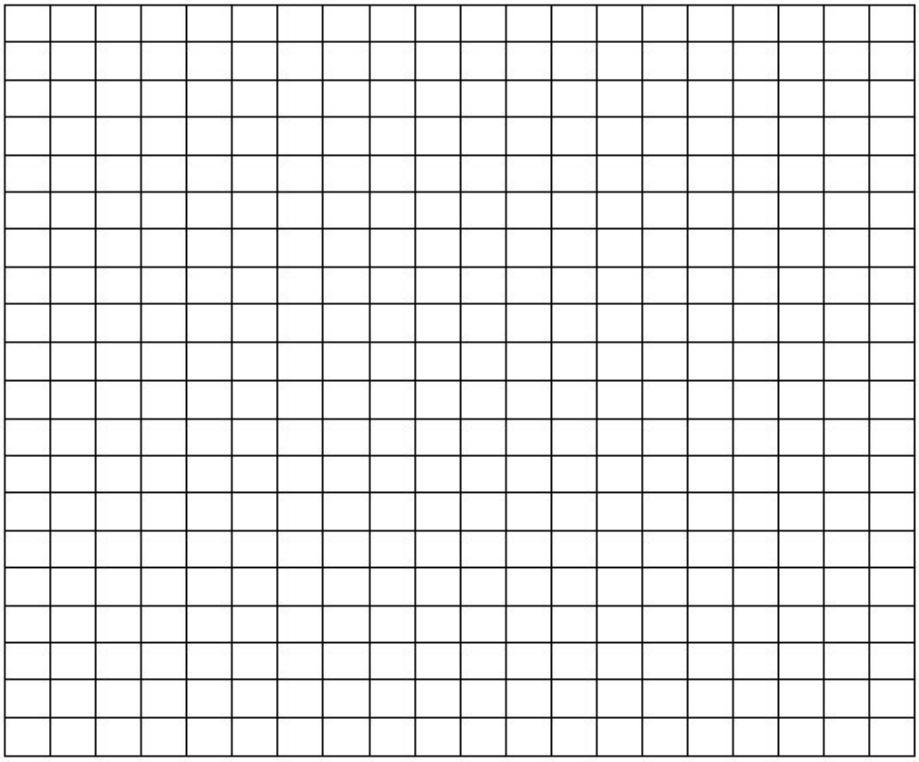
d. To investigate the reproductive rate of *Paramecium* at different population densities, a culture was set up containing 10 individuals / mL and the concentration of organisms was determined every 24 hours. Assume that the stock concentration of *Paramecium* was 100mL and contained 5200 individuals. What volume of water and what volume of stock solution would be required to set up 40mL of the initial culture? **(3 marks)**

The table below shows the concentration of *Paramecium* at each time point.

Number of hours after start of experiment	Concentration (number of individuals / mL)
0	10
24	12
48	15
72	28
96	**B**
120	41

e. After 96 hours, there were 8 individuals in 200 µL of the culture. What was the concentration of *Paramecium* at this time (shown in the table as B)? **(1 mark)**

f. Plot the data on the axes provided on the following page, remembering to give an appropriate title and label your axes. **(4 marks)**



g. Explain why the rate of growth is different between 0-24 hours and 48-72 hours. (**2 marks)**

h. Describe and explain what is happening between 96 and 120 hours? Suggest a way to prevent this from occurring. (**3 marks)**

Integrity of Competition

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