



Rewarding Learning

ADVANCED
General Certificate of Education
2012

Centre Number

71

Candidate Number

Biology

Assessment Unit A2 2

assessing

Biochemistry, Genetics and Evolutionary Trends

[AB221]

MONDAY 21 MAY, AFTERNOON



TIME

2 hours.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Write your answers in the spaces provided in this question paper.

There is an extra lined page at the end of the paper if required.

Answer **all eight** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 90.

Section A carries 72 marks. Section B carries 18 marks.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You are reminded of the need for good English and clear presentation in your answers.

Use accurate scientific terminology in all answers.

You should spend approximately **25 minutes** on Section B.

You are expected to answer Section B in continuous prose.

Quality of written communication will be assessed in **Section B**, and awarded a maximum of 2 marks.

Statistics sheets are provided for use with this paper.

**For Examiner's
use only**

Question Number	Marks
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**Total
Marks**

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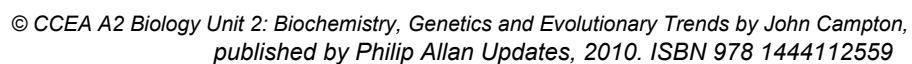
Examiner Only	
Marks	Remark

[1]

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1. _____
2. _____

4



- (i) Using the information provided, describe the process of transcription.

[4]7689

(c) DNA length is measured in base pairs. Analysis of a particular polypeptide shows that the gene involved in its synthesis is 330 base pairs long yet the polypeptide itself has only 84 amino acids in its primary sequence.

(i) How many base pairs would be required to code for 84 amino acids?

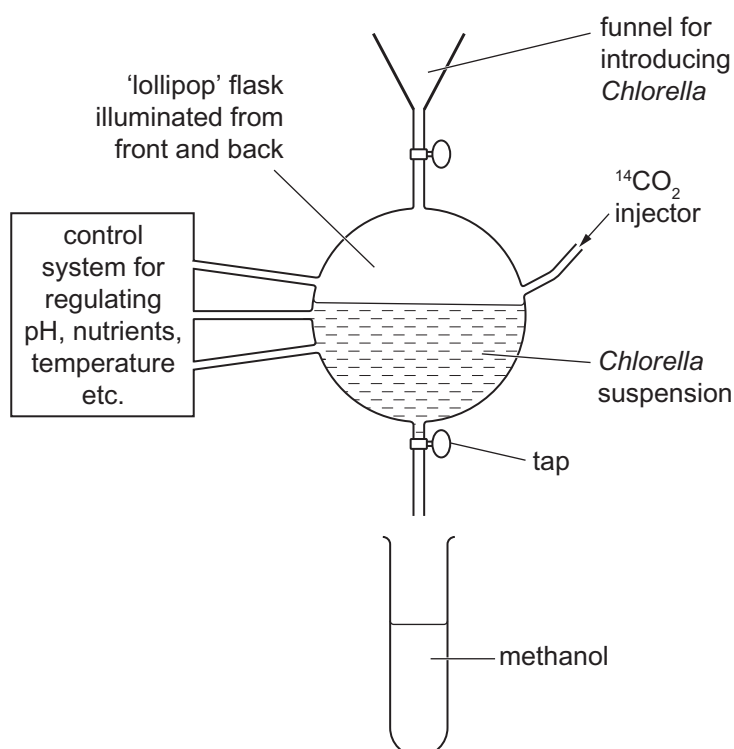
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(ii) Suggest why the gene contains 330 base pairs.

_____ [1]

Examiner Only	
Marks	Remark

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(Questions continue overleaf)



By gradually increasing the time interval between adding the radioactive carbon dioxide and killing the *Chlorella*, Calvin observed that the number of different compounds containing radioactive carbon in each successive sample increased up to a limit and then levelled off.

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Marks	Remark

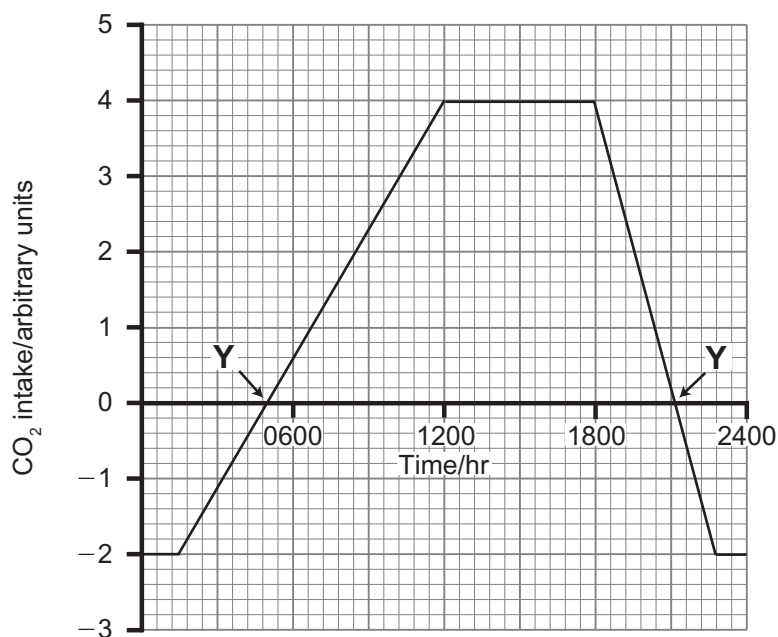
- (iii) The time that the *Chlorella* was exposed to radioactive carbon dioxide was increased by only a few seconds for consecutive samples. Suggest why.

 _____ [1]

- (iv) Suggest why Calvin used a specially flattened ('lollipop') flask in this investigation.

 _____ [1]

- (b) The graph below shows the rates of carbon dioxide intake by a commercial crop plant in a glasshouse over a 24-hour period.



- (i) State the term which is used to describe the situation indicated by the positions labelled Y.

_____ [1]

- 5 Bacterial plasmids may carry genes that provide resistance to naturally occurring antibiotics.

(a) (i) What is a plasmid?

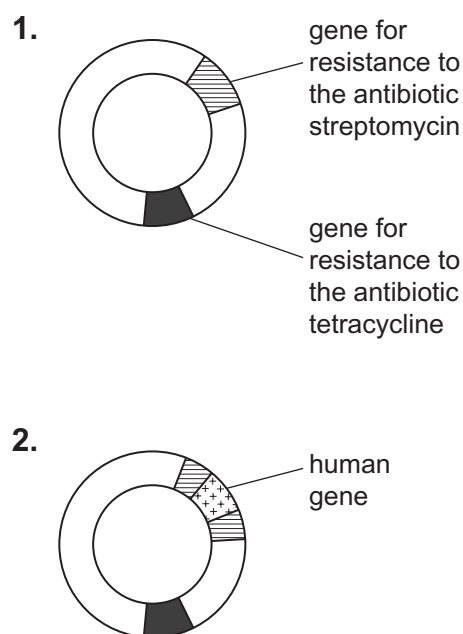
[1]

(ii) In recombinant DNA technology, plasmids are often used as vectors. Explain what is meant by the term 'vector' in this context.

[1]

Diagram 1 illustrates a naturally occurring plasmid that contains genes for resistance to two antibiotics. When this plasmid is not present in a particular bacterium, the bacterium would be killed in the presence of either of these antibiotics.

Diagram 2 illustrates a recombinant plasmid, which has had a human gene inserted at the point shown.



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- [1]

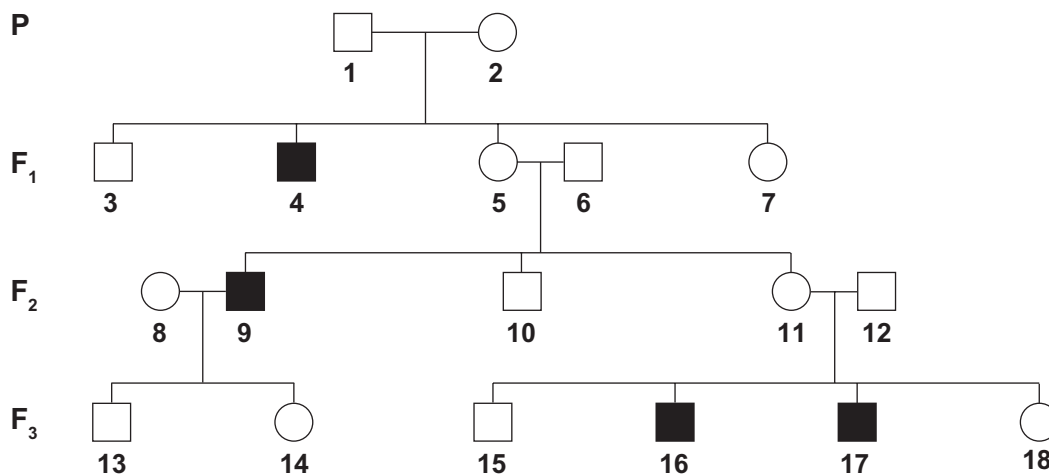
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- [2]

-
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16

- 6 Haemophiliacs possess a non-functional form of the gene responsible for the production of blood clotting factors.

The pedigree diagram below shows the incidence of haemophilia in an affected family.



Individuals within the pedigree are numbered. Males are represented by squares and females by circles. Those who have haemophilia are represented by solid symbols.

- (a) On the basis of the information provided, is the inheritance of haemophilia:

(i) autosomal or sex-linked? _____

Justify your answer _____

 _____ [1]

(ii) dominant or recessive? _____

Justify your answer _____

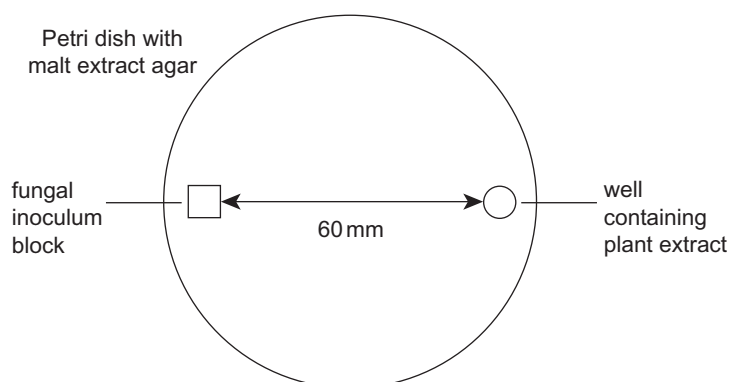
 _____ [1]

- (b) Using the symbols **h** to represent the allele for haemophilia and **H** for the normal allele, state the genotype of each of the following:

• individual 2 _____

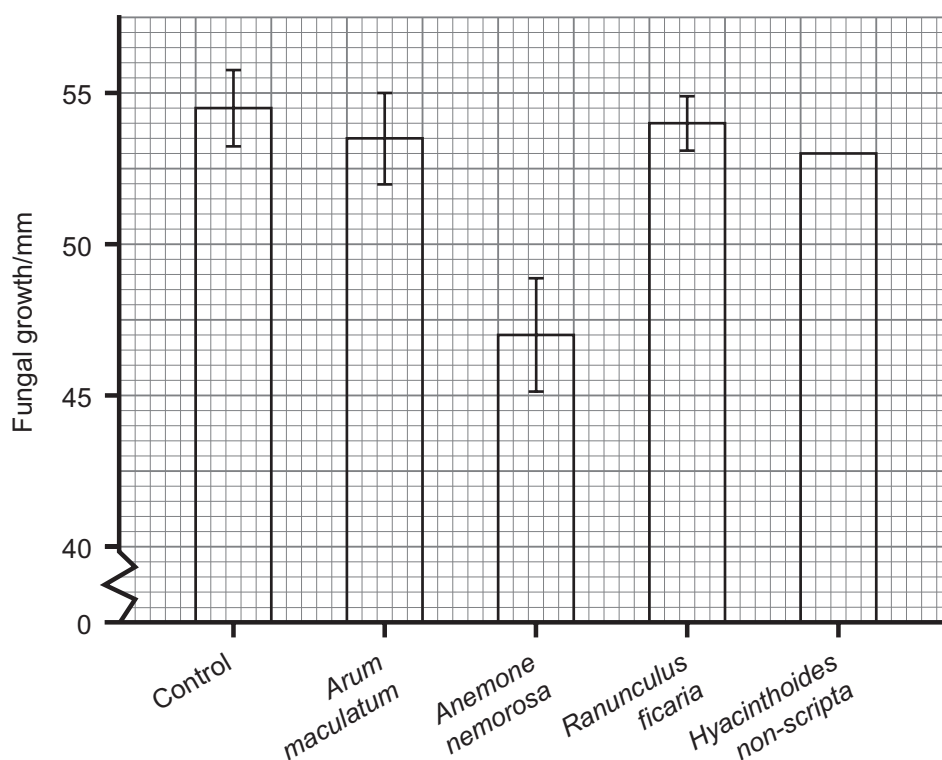
• individual 4 _____ [2]

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Marks	Remark



The plant extracts were prepared by grinding 5g of fresh plant tissue in 2 cm³ of cooled boiled water. Ten replica plates were produced for each plant species and the plates were incubated at 25 °C. Following inoculation of the test plates, fungal growth was measured and recorded every 24 hours. Fungal growth was taken as the distance from the edge of the inoculum block to the colony edge, measured as the extent of growth out from the inoculum block towards the plant extract well opposite.

The bar chart below shows the mean fungal growth after 4 days for extracts of plant species and also for a control. 95% confidence limits are also shown except for *H. non-scripta*.



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(b) The mean growth value for bluebell (*H. non-scripta*) after four days was 53mm and the standard deviation (error) of the mean was 0.442.

- (i) Using the information provided and your Statistics sheets, calculate the 95% confidence limits for *H. non-scripta*.

upper limit _____

lower limit _____ [3]

- (ii) Complete the graph provided by adding the 95% confidence limits for *H. non-scripta*. [1]

- (iii) The null hypothesis for this investigation stated that there was no significant difference between the effects of each of the plant extracts on the growth of the fungus. Based on the information provided, state your decision about the null hypothesis. Explain your answer.

[2]

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Marks	Remark

The plant species involved in this investigation are woodland species which grow and make use of the high light levels in spring before the tree canopy closes. During summer their leaves die and are decomposed, a process that enriches soil fertility. The anti-fungal effect of plant tissue is greatest in early spring as the delicate leaves emerge through the soil, but is significantly reduced by the summer following the closure of the tree canopy.

- (c) Explain the advantage to the plants of the pattern of anti-fungal activity described above.

[2]

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THIS IS THE END OF THE QUESTION PAPER

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Biology

Statistical Formulae and Tables

Statistics Sheets

Statistical Formulae and Tables

1 Definition of Symbols

n = sample size

$\bar{x}$ = sample mean

$\hat{\sigma}$ = estimate of the standard deviation

These parameters are obtained using a calculator with statistical functions, remembering to use the function for $\hat{\sigma}$ – which may be designated a different symbol on the calculator – with $(n - 1)$ denominator.

2 Practical Formulae

2.1 Estimation of the standard deviation (error) of the mean ($\hat{\sigma}_{\bar{x}}$)

$$\hat{\sigma}_{\bar{x}} = \sqrt{\frac{\hat{\sigma}^2}{n}}$$

2.2 Confidence limits for population mean

$$\bar{x} \pm t \sqrt{\frac{\hat{\sigma}^2}{n}}$$

which can be rewritten, in terms of $\hat{\sigma}_{\bar{x}}$, as

$$\bar{x} \pm t(\hat{\sigma}_{\bar{x}})$$

where t is taken from t tables for the appropriate probability and $n - 1$ degrees of freedom.

3 Tests of significance

3.1 Student's *t* test

Different samples are denoted by subscripts; thus, for example, $\bar{x}_1$ and $\bar{x}_2$ are the sample means of sample 1 and sample 2 respectively.

The following formula for t is that to be used:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2}}}$$

which can be rewritten, in terms of $\hat{\sigma}_{\bar{x}}$, as

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\hat{\sigma}_{\bar{x}_1}^2 + \hat{\sigma}_{\bar{x}_2}^2}}$$

with $n_1 + n_2 - 2$ degrees of freedom.

3.2 Chi squared test

Using the symbols O = observed frequency, E = expected frequency and Σ = the sum of

$$\chi^2 = \Sigma \frac{(O - E)^2}{E}$$

with $n - 1$ degrees of freedom (where n is the number of categories).

Table 1 Student's t values

d.f.	$p = 0.1$	0.05	0.02	0.01	0.002	0.001
1	6.314	12.706	31.821	63.657	318.31	636.62
2	2.920	4.303	6.965	9.925	22.327	31.598
3	2.353	3.182	4.541	5.841	10.214	12.924
4	2.132	2.776	3.747	4.604	7.173	8.610
5	2.015	2.571	3.365	4.032	5.893	6.869
6	1.943	2.447	3.143	3.707	5.208	5.959
7	1.895	2.365	2.998	3.499	4.785	5.408
8	1.860	2.306	2.896	3.355	4.501	5.041
9	1.833	2.262	2.821	3.250	4.297	4.781
10	1.812	2.228	2.764	3.169	4.144	4.587
11	1.796	2.201	2.718	3.106	4.025	4.437
12	1.782	2.179	2.681	3.055	3.930	4.318
13	1.771	2.160	2.650	3.012	3.852	4.221
14	1.761	2.145	2.624	2.977	3.787	4.140
15	1.753	2.131	2.602	2.947	3.733	4.073
16	1.746	2.120	2.583	2.921	3.686	4.015
17	1.740	2.110	2.567	2.898	3.646	3.965
18	1.734	2.101	2.552	2.878	3.610	3.922
19	1.729	2.093	2.539	2.861	3.579	3.883
20	1.725	2.086	2.528	2.845	3.552	3.850
21	1.721	2.080	2.518	2.831	3.527	3.819
22	1.717	2.074	2.508	2.819	3.505	3.792
23	1.714	2.069	2.500	2.807	3.485	3.767
24	1.711	2.064	2.492	2.797	3.467	3.745
25	1.708	2.060	2.485	2.787	3.450	3.725
26	1.706	2.056	2.479	2.779	3.435	3.707
27	1.703	2.052	2.473	2.771	3.421	3.690
28	1.701	2.048	2.467	2.763	3.408	3.674
29	1.699	2.045	2.462	2.756	3.396	3.659
30	1.697	2.042	2.457	2.750	3.385	3.646
40	1.684	2.021	2.423	2.704	3.307	3.551
60	1.671	2.000	2.390	2.660	3.232	3.460
120	1.658	1.980	2.358	2.617	3.160	3.373
∞	1.645	1.960	2.326	2.576	3.090	3.291

*Reproduced from R E Parker: "Introductory Statistics for Biology", Second Edition
Studies in Biology No 43, Edward Arnold (Publishers) Ltd*

Table 2 χ^2 values

d.f.	$p = 0.900$	0.500	0.100	0.050	0.010	0.001
1	0.016	0.455	2.71	3.84	6.63	10.83
2	0.211	1.39	4.61	5.99	9.21	13.82
3	0.584	2.37	6.25	7.81	11.34	16.27
4	1.06	3.36	7.78	9.49	13.28	18.47
5	1.61	4.35	9.24	11.07	15.09	20.52
6	2.20	5.35	10.64	12.59	16.81	22.46
7	2.83	6.35	12.02	14.07	18.48	24.32
8	3.49	7.34	13.36	15.51	20.09	26.13
9	4.17	8.34	14.68	16.92	21.67	27.88
10	4.87	9.34	15.99	18.31	23.21	29.59
11	5.58	10.34	17.28	19.68	24.73	31.26
12	6.30	11.34	18.55	21.03	26.22	32.91
13	7.04	12.34	19.81	22.36	27.69	34.53
14	7.79	13.34	21.06	23.68	29.14	36.12
15	8.55	14.34	22.31	25.00	30.58	37.70
16	9.31	15.34	23.54	26.30	32.00	39.25
17	10.09	16.34	24.77	27.59	33.41	40.79
18	10.86	17.34	25.99	28.87	34.81	42.31
19	11.65	18.34	27.20	30.14	36.19	43.82
20	12.44	19.34	28.41	31.41	37.57	45.32
21	13.24	20.34	29.62	32.67	38.93	46.80
22	14.04	21.34	30.81	33.92	40.29	48.27
23	14.85	22.34	32.01	35.17	41.64	49.73
24	15.66	23.34	33.20	36.42	42.98	51.18
25	16.47	24.34	34.38	37.65	44.31	52.62
26	17.29	25.34	35.56	38.89	45.64	54.05
27	18.11	26.34	36.74	40.11	46.96	55.48
28	18.94	27.34	37.92	41.34	48.28	56.89
29	19.77	28.34	39.09	42.56	49.59	58.30
30	20.60	29.34	40.26	43.77	50.89	59.70
40	29.05	39.34	51.81	55.76	63.69	73.40
50	37.69	49.33	63.17	67.50	76.15	86.66
60	46.46	59.33	74.40	79.08	88.38	99.61
70	55.33	69.33	85.53	90.53	100.43	112.32
80	64.28	79.33	96.58	101.88	112.33	124.84
90	73.29	89.33	107.57	113.15	124.12	137.21
100	82.36	99.33	118.50	123.34	135.81	149.45

*Reproduced from R E Parker: "Introductory Statistics for Biology", Second Edition
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