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# 25th INTERNATIONAL BIOLOGY OLYMPIAD 

$$
5 \text { - } 13 \text { July, } 2014
$$

INDONESIA


## $25^{\text {th }}$

International
Biology
Olympiad
Bali, Indonesia 2014

## PRACTICAL TEST 1 <br> CELL \& MOLECULAR BIOLOGY <br> ANSWER KEY

Total points: 64.5
Duration: 90 minutes

| COUNTRY: | .......................................... |
| :---: | :---: |
| STUDENT ID: | .......................................... |

## Task (64.5 points)

## Plasmid Identification and Telomere Analysis

Part A. Confirmation of plasmid sample $X, Y$, and $Z$ by restriction analysis and DNA electrophoresis. (40 points)

## Q 1.1. 8 points

For row 4 \& 5-6 points; 1 series with two enzyme and 1 series EcoRI
For row 2-1 point if students fill 1 ( $\mu \mathrm{l}$ ) for every cell
For row 1-1 point for correct volume of water to add up to final volume of $10 \mu \mathrm{l}$

Table I. Design of Experiment for Plasmid Identification

| No. | Reagents | Series 1 (Volume in $\mu \mathrm{L}$ ) |  |  | Series 2 (Volume in $\mu \mathrm{L}$ ) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\begin{gathered} \hline \text { Plasmid } \\ 1 \end{gathered}$ | $\begin{gathered} \text { Plasmid } \\ 2 \\ \hline \end{gathered}$ | $\begin{gathered} \hline \text { Plasmid } \\ 3 \\ \hline \end{gathered}$ | $\begin{gathered} \text { Plasmid } \\ \hline 1 \end{gathered}$ | $\begin{gathered} \text { Plasmid } \\ 2 \\ \hline \end{gathered}$ | $\begin{gathered} \hline \text { Plasmid } \\ 3 \\ \hline \end{gathered}$ |
|  |  | S1 | S2 | S3 | S4 | S5 | S6 |
| 1 | Sterile water | 7 | 7 | 7 | 6 | 6 | 6 |
| 2 | 10 X Restriction buffer solution | 1 | 1 | 1 | 1 | 1 | 1 |
| 3 | DNA Plasmid | 1 | 1 | 1 | 1 | 1 | 1 |
| 4 | EcoRI* | 1 | 1 | 1 | 1 | 1 | 1 |
| 5 | HindIII* | 0 | 0 | 0 | 1 | 1 | 1 |
|  | Volume total | 10 | 10 | 10 | 10 | 10 | 10 |

* If the enzyme is used in the reaction, add $1 \mu \mathrm{~L}$ enzyme

Or

| No. | Reagents | Series 1 (Volume in $\mu \mathrm{L}$ ) |  |  | Series 2 (Volume in $\mu \mathrm{L}$ ) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\begin{gathered} \text { Plasmid } \\ 1 \end{gathered}$ | $\begin{aligned} & \text { Plasmid } \\ & 2 \end{aligned}$ | $\begin{gathered} \text { Plasmid } \\ 3 \end{gathered}$ | $\begin{gathered} \hline \text { Plasmid } \\ 1 \\ \hline \end{gathered}$ | $\begin{gathered} \hline \text { Plasmid } \\ 2 \end{gathered}$ | $\begin{gathered} \text { Plasmid } \\ 3 \end{gathered}$ |
|  |  | S1 | S2 | S3 | S4 | S5 | S6 |
| 1 | Sterile water | 6 | 6 | 6 | 7 | 7 | 7 |
| 2 | 10 X Restriction buffer solution | 1 | 1 | 1 | 1 | 1 | 1 |
| 3 | DNA Plasmid | 1 | 1 | 1 | 1 | 1 | 1 |


| 4 | EcoRI* $^{*}$ | 1 | 1 | 1 | 1 | 1 | 1 |
| :--- | :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| 5 | HindIII* $^{*}$ | 1 | 1 | 1 | 0 | 0 | 0 |
|  | Volume total | 10 | 10 | 10 | 10 | 10 | 10 |

## Q1.2 Answers . (6 points - 1 points each lane)

| enzymes | Series 1 | Series 2 |
| :---: | :---: | :---: |
| HindIII A |  | $\vee$ |
| EcoR1 | $\vee$ | $\vee$ |

Series 1


## Q 1.3 DNA Electrophoresis Result of Plasmid Restriction Experiment (26 points):

1 point for each ladder (1x2)
4 points for each lane (4x 6) :

- 1 point for the presence of DNA and
- 3 points for correct sized band


1 point for each lane of ladder

3 points for each correct lane (or none)- partial digest, if the correct bands are thicker than the uncorrect one. Points are given based on the filled table 1 (error carried forward where applicable)

| Code in problem sheet | Plasmid 1 | Plasmid 2 | Plasmid 3 |
| :--- | :--- | :--- | :--- |
| Real size | 3750 | 3786 | 3600 |
| EcoRI restriction | $3000+750$ | 3786 (linearized) | 3600 (linearized) |
| HindIII restriction | 3750 | 3786 (linearized) | uncut |
| EcoRI + HindIII restriction | $3000+750$ | $2686+1100$ | $2862+738$ |

Part B. Cell reproduction and telomere analysis of Paramaecium ( 24.5 points)
Q 2.1. (1 points $\times 2=2$ points)

| Culture | Binary Fission | Conjugation |
| :---: | :---: | :---: |
| A | $\downarrow$ | - |
| $B$ | $\vee$ | $\downarrow$ |

Q 2.2. (2.5 points)

| Day | Cell Concentration (Cell/mL) |  |  | Average cell <br> concentration <br> (cells/mL) <br> N (Q2.2) | Log of <br> Averag <br> e cell <br> concen <br> tration |
| :---: | ---: | ---: | :---: | ---: | ---: |
|  | A | B | C | 1 | 0.00 |
| 0 | 1 | 1 | 1 | 11 | 1.05 |
| 1 | 8 | 10 | 16 | 109 | 2.04 |
| 2 | 80 | 120 | 128 | 875 | 2.94 |
| 3 | 640 | 960 | 1024 | 7893 | 3.90 |
| 4 | 5760 | 7680 | 10240 |  |  |

$$
\begin{gathered}
N=N_{0} 2^{n} \\
\log N=\log N_{o}+n \log 2 \\
\log N-\log N_{0}=n \log 2 \\
n=\left(\log N-\log N_{0}\right) / \log 2 \\
n=\text { fission rate (per day) } \\
x=\text { day } ;
\end{gathered}
$$

$N=$ average cell number

## G= 1 day/fission rate $\rightarrow$

## Graph 8 points:

- Axis $X$ and $Y: 2$ points (1 point for each axis)
- 5 points : 1 point for each value of $\log \mathbf{N}$
- 1 point for drawing the line



Q 2.3 (12 points)

| No. | True | False |
| :---: | :---: | :---: |
| a | $\vee$ |  |
| $b$ |  | $\checkmark$ |
| c |  | $\checkmark$ |
| d | $\checkmark$ |  |
| $e$ |  | $\checkmark$ |
| $f$ | $V$ |  |

# 25th INTERNATIONAL BIOLOGY OLYMPIAD 

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\begin{gathered}
5-13 \text { July, } 2014 \\
\text { INDONESIA }
\end{gathered}
$$


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Bali, Indonesia 2014

# PRACTICAL TEST 2 <br> PLANT ANATOMY AND PHYSIOLOGY ANSWER KEY 

Total points: 96
Duration: 90 minutes

| COUNTRY: | ............................................ |
| :---: | :---: |
| STUDENT: | ............ |

The answers have to be given either with a tick $(\sqrt{ })$ or with Arabic numbers. The numbers "1" and " 7 " can look very similar in handwriting. To make sure that those two numbers can be well distinguished by the IBO staff, please write them as you normally would into the following box.


## Task 1: Determination of plant pigment (36 points)

TLC plate photograph (4 points).

|  | 4 | 3 | 2 | 1 |
| :---: | :---: | :---: | :---: | :---: |
| - Did the experiment (1 point) and TLCed both samples (1 point) <br> - Properly marked the scale on the TLC plate <br> - Solvent reached the top end of the plate <br> - 4 pigment spots appear on the plate | all parameters are correct | Three parameters are correct | Two parameters are correct | Only one parameter is correct |

## Q 1.1 (12 points)

\(\left.$$
\begin{array}{|c|c|c|}\hline \text { Spot } & \begin{array}{c}\text { Rf values of four major pigments } \\
\text { (precision: two places after the } \\
\text { decimal point) } \\
\text { (@ 2 point) }\end{array} & \begin{array}{c}\text { Pigment number from Table 1 } \\
\text { (@ 1 point) }\end{array} \\
\hline 1 & \begin{array}{c}0.73-0.89(0.81) \rightarrow 2 \\
0.66(0.73-0.89) 0.98 \rightarrow 1\end{array}
$$ \& \beta -carotene <br>
\hline 2 \& 0.15-0.17(0.16) \rightarrow 2 <br>

0.14(0.15-0.17) 0.19 \rightarrow 1\end{array}\right]\)\begin{tabular}{c}
Xanthophyll <br>
\hline 3

 

$0.12-0.14(0.13) \rightarrow 2$ <br>
$0.11(0.12-0.14) 0.15 \rightarrow 1$ <br>
\hline 4
\end{tabular}

## Q. 1.2 (4 points)

| True | False |
| :---: | :---: |
|  | $\checkmark$ |
| $\vee$ |  |
| $\vee$ |  |
|  | $\checkmark$ |

Q 1.3 (10 points)

## Group 1

| Extract | A |  | Total Chlorophyll <br> $(\mathrm{mg} / \mathrm{L})$ | Chlorophyll a <br> $(\mathrm{mg} / \mathrm{L})$ | Chlorophyll b <br> $(\mathrm{mg} / \mathrm{L})$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $649(\mathrm{~nm})$ | $665(\mathrm{~nm})$ |  |  |  |
| C | $0.038-$ <br> 0.041 | $0.083-$ <br> 0.090 | $1.2663-1.369$ | $0.91822-0.99684$ | $0.3413-0.3648$ |
| D | $0.111-$ <br> 0.117 | $0.273-$ <br> 0.281 | $3.8853-4.0541$ | $3.10074-3.17578$ | $0.7617-0.8549$ |

## Group 2

| Extract | A |  | Total Chlorophyll <br> $(\mathrm{mg} / \mathrm{L})$ | Chlorophyll a <br> $(\mathrm{mg} / \mathrm{L})$ | Chlorophyll b <br> $(\mathrm{mg} / \mathrm{L})$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $649(\mathrm{~nm})$ | $665(\mathrm{~nm})$ |  |  |  |
| C | $0.043-$ <br> 0.050 | $0.088-$ <br> 0.105 | $1.3968-1.6405$ | $0.9579-1.1505$ | $0.4318-0.4815$ |
| D | $0.100-$ <br> 0.111 | $0.245-$ <br> 0.263 | $2.6771-6.5043$ | $2.7805-2.9637$ | $0.6935-0.8387$ |

## Group 3

| Extract | A |  | Total Chlorophyll <br> $(\mathrm{mg} / \mathrm{L})$ | Chlorophyll a <br> $(\mathrm{mg} / \mathrm{L})$ | Chlorophyll b <br> $(\mathrm{mg} / \mathrm{L})$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $649(\mathrm{~nm})$ | $665(\mathrm{~nm})$ |  |  |  |
| C | $0.033-$ <br> 0.052 | $0.073-$ <br> 0.096 | $1.1053-1.6256$ | $0.81002-1.01568$ | $0.2893-0.6024$ |


| D | $0.111-$ <br> 0.127 | $0.264-$ <br> 0.282 | $3.8304-4.2602$ | $2.97744-3.13188$ | $0.831-1.1052$ |
| :--- | :---: | :---: | :---: | :---: | :---: |

## Group 4

| Extract | A |  | Total Chlorophyll <br> $(\mathrm{mg} / \mathrm{L})$ | Chlorophyll a <br> $(\mathrm{mg} / \mathrm{L})$ | Chlorophyll b <br> $(\mathrm{mg} / \mathrm{L})$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $649(\mathrm{~nm})$ | $665(\mathrm{~nm})$ |  |  |  |
| C | $0.029-$ <br> 0.043 | $0.068-$ <br> 0.082 | $0.9948-1.3602$ | $0.76456-0.87572$ | $0.2246-0.478$ |
| D | $0.123-$ <br> 0.131 | $0.291-$ <br> 0.296 | $4.2351-4.4256$ | $3.27822-3.30064$ | $0.9327-1.1006$ |

## Q 1.4 (2 points)

## Group 1

| Extract | Ratio of chlorophyll |
| :---: | :---: |
| C | $\mathbf{2 . 2 1 8 4 - 2 . 3 8 9 4}$ |
| D | $\mathbf{3 . 5 3 3 7}-\mathbf{4 . 0 0 9 4}$ |

## Group 2

| Extract | Ratio of chlorophyll |
| :---: | :---: |
| C | $2.6904-2.7326$ |
| D | $3.7148-4.0708$ |

## Group 3

| Extract | Ratio of chlorophyll |
| :---: | :---: |
| C | $1.6860-2.7999$ |
| D | $2.8338-3.5830$ |

## Group 4

| Extract | Ratio of chlorophyll |
| :---: | :---: |
| C | $1.8321-3.4041$ |
| D | $2.9989-3.5148$ |

Q 1.5 (4 points)

| True | False |
| :---: | :---: |
| $\checkmark$ |  |
|  | $\checkmark$ |
| $\checkmark$ |  |
| $\checkmark$ |  |

Task 2: Determination of starch content in root extract (21 points)
Q 2.1 (1 point)

| Starch <br> $[p p m]$ | 100 |
| :--- | :---: |
| Starch <br> solution <br> $(\mu \mathrm{L})$ | 400 |
| $\mathrm{H} 2 \mathrm{O}(\mu \mathrm{L})$ | 600 |

Q 2.2 (8 points)
Group 1

| Sample | Absorbance (580 nm) |
| :---: | :---: |
| Starch 250 ppm (C4) | $1.198-1.208 \rightarrow 2$ |
|  | $1.078(1.198-1.208) 1.329 \rightarrow 1$ |
| Starch 100 ppm (C6) | $0.484-0.486 \rightarrow 2$ |
|  | $0.436(0.484-0.486) 0.535 \rightarrow 1$ |


| Sample C7 | $0.375-0.401 \rightarrow 2$ |
| :---: | :---: |
|  | $0.338(0.375-0.401) 0.441 \rightarrow 1$ |
| Sample C8 | $0.825-0.839 \rightarrow 2$ |
|  | $0.743(0.825-0.839) 0.923 \rightarrow 2$ |

## Group 2

| Sample | Absorbance (580 nm) |
| :---: | :---: |
| Starch 250 ppm (C4) | $1.204-1.235 \rightarrow 2$ |
|  | $1.084(1.204-1.235) 1.358 \rightarrow 1$ |
| Starch 100 ppm (C6) | $0.485-0.494 \rightarrow 2$ |
|  | $0.437(0.485-0.494) 0.543 \rightarrow 1$ |
| Sample C7 | $0.406-0.428 \rightarrow 2$ |
|  | $0.365(0.406-0.428) 0.471 \rightarrow 1$ |
| Sample C8 | $0.843-0.863 \rightarrow 2$ |
|  | $0.759(0.843-0.863) 0.949 \rightarrow 1$ |

## Group 3

| Sample | Absorbance (580 nm) |
| :---: | :---: |
| Starch 250 ppm (C4) | $1.136-1.154 \rightarrow 2$ |
|  | $1.022(1.136-1.154) 1.269 \rightarrow 1$ |
| Starch 100 ppm (C6) | $0.445-0.459 \rightarrow 2$ |
|  | $0.401(0.445-0.459) 0.505 \rightarrow 1$ |
| Sample C7 | $0.362-0.377 \rightarrow 2$ |
|  | $0.326(0.362-0.377) 0.415 \rightarrow 1$ |
| Sample C8 | $0.778-0.805 \rightarrow 2$ |
|  | $0.700(0.778-0.805) 0.886 \rightarrow 1$ |

## Group 4

| Sample | Absorbance (580 nm) |
| :---: | :---: |
| Starch 250 ppm <br> $(C 4)$ | $1.158-1.163 \rightarrow 2$ |


| Starch 100 ppm <br> (C6) | $0.457-0.466 \rightarrow 2$ |
| :---: | :---: |
| Sample C7 | $0.411(0.457-0.466) 0.513 \rightarrow 1$ |
| Sample C8 | $0.344(0.382-0.396 \rightarrow 2$ |
|  | $0.795-0.812 \rightarrow 2) 0.436 \rightarrow 1$ |
|  | $0.716(0.795-0.812) 0.893 \rightarrow 1$ |

Q 2.3 (4 points)
Q 2.3 (4 points)
a: $4.45 \times 10^{-3}-0.01$

Q 2.4 (4 points)
Group 1 (02):
C7: 78-83;
C8: 171 - 174

Group 2 (01):
C7: 84-87 ;
C8: 174-175

Group 3 (03):
C7: 79-82;
C8: 171-175

Group 4 (04):
C7: 82-85;
C8: 171-175

## Q 2.5 (4 points)

| True | False |
| :---: | :---: |
| $\checkmark$ |  |
|  | $\checkmark$ |
| $\checkmark$ |  |
| $\checkmark$ |  |

Task 3. Observation of structural adaptation in plants (39 Points)
Q 3.1 ( 6 points @ 0.5 point)

| Tissue type | Presence |  |  |
| :--- | :---: | :---: | :---: |
| Specimen | X | Y | Z |
| Cortex |  |  |  |
| a. sclerenchyma | + | + | - |
| Endodermis | + | + | + |
| Xylem |  |  |  |
| a. primary xylem | + | + | + |
| b. secondary xylem | - | - | - |

Q. 3.2 (9 points)

| Specimen | Diagram (number) |
| :---: | :---: |
| X | 4 |
| Y | 2 |
| Z | 6 |

Q 3.3 (9 points)

| Specimen | No aerenchyma | Lysigenous* $^{*}$ | Schizogenous** |
| :---: | :---: | :---: | :---: |
| X | $\sqrt{ }$ |  |  |
| Y |  | $\sqrt{ }$ |  |
| Z |  |  | $\sqrt{ }$ |

* This type of intercellular space arises through dissolution of entire cells.
** This type of intercellular space arises through separation of cell walls from each other along more or less extended areas of their contact.


## Q 3.4 (9 points)

| Organ | Monocotyledonous |  |  | Dicotyledonous |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Root | Stem | Leaf | Root | Stem | Leaf |
| X | $\checkmark$ |  |  |  |  |  |
| Y | $\checkmark$ |  |  |  |  |  |
| Z |  |  |  | $\checkmark$ |  |  |

## Q 3.5 (6 points)

| Specimen | Control | Flooding |
| :---: | :---: | :---: |
| $X$ | $\checkmark$ |  |
| $Y$ |  | $\checkmark$ |
| $Z$ |  | $\checkmark$ |

## End of the Practical Exam

# 25th INTERNATIONAL BIOLOGY OLYMPIAD 

$5^{\text {th }}-13^{\text {th }}$ July, 2014<br>INDONESIA



## $25^{\text {th }}$

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Bali, Indonesia 2014

## PRACTICAL TEST 3

## ANIMAL ANATOMY, PHYSIOLOGY AND SYSTEMATICS ANSWER SHEET

Total points: 93.5
Duration: 90 minutes

| COUNTRY: | ............................................ |
| :---: | :---: |
| STUDENT: | ............................................ |

## Task (93.5 points)

## Acute Response of Fish Larvae to Rapid Changes in Salinity to Salt

Concentration, Calculation of $\mathrm{LC}_{50}$, and Classification of Prawns

## Part A. Acute Response of Fish Larvae to Rapid Changes in Salinity (12 points)

Q 1.1 and Q.1.2 (6 + 2 points)


Q 1.3. (2 points)
Mark the appropriate answer with a tick " $\checkmark$ "

| A | B | C | D |
| :--- | :--- | :--- | :--- |
|  |  |  | $\checkmark$ |

Q 1.4. (2 points)
Mark the appropriate answer with a tick " $\checkmark$ "


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## PRACTICAL TEST 4 <br> ECOLOGY AND ETHOLOGY ANSWER KEY (Rev. 09-07-14)

Total points: 100
Duration: 90 minutes


The answers have to be given either with a tick $(\sqrt{ })$ or with Arabic numbers. The numbers "1" and "7" can look very similar in handwriting. To make sure that those two numbers can be well distinguished by the IBO staff, please write them as you normally would into the following box.


## Biogeography and Biodiversity

## TASK 1. ISLAND BIOGEOGRAPHY

Question 1.1 ( 5 points: $5 \times 1$ ) (straightforward - no partial points) values slightly outside the range were still accepted.

| No. | Island | Distance from mainland $(\mathrm{km})$ <br> (accepted range in parentheses) |
| :---: | :--- | :---: |
| 1. | Ternate | $12.8(12.4-13.2)$ |
| 2. | Tidore | $9.7(9.3-10.1)$ |
| 3. | Mare | $13.0(12.6-13.4)$ |
| 4. | Moti | $14.1(13.7-14.5)$ |
| 5. | Makian | $17.8(17.4-18.2)$ |

## Grading Rule:

- Measurements within range are accepted for 1 point each, no partial points.
- *Range determined as mean of 20 measurements that have been made during our simulation, $+/$ - standard deviation which reached 0.35 . Therefore, the accepted range was determined as mean $+/-0.40$.

Question 1.2 (10 points: $10 \times 1$ ) (straightforward)


## Number of Species in Equilibrium

Question 1.3 (2 points: $2 \times 1$ ) (straightforward)
Place a tick $(\sqrt{ })$ mark in the box of your selected correct answer.

| A | B | C | D | E |
| :---: | :---: | :---: | :---: | :---: |
| $\vee$ | $\vee$ |  |  |  |

TASK 2. PRIMARY SUCCESSION AFTER VOLCANIC ERUPTION
Part A : Succession and Plant Community Structure

Question 2.1 (3 points) (straightforward-no partial points)
Place a tick ( $\sqrt{ }$ ) mark in the box of your selected correct answer

| A | B | C | D | E |
| :--- | :--- | :--- | :--- | :--- |
|  |  |  | $\vee$ |  |

Question 2.2 (5 points; $10 \times 0.5$ ) (straightforward-no partial points)
Fill in your calculated similarity indices in the boxes provided.

| Year | 1934 | 1949 | 1963 | 1979 | 1991 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1949 | 0.60 |  |  |  |  |
| 1963 | 0.52 | 0.32 |  |  |  |
| 1979 | 0.48 | 0.29 | 0.94 |  |  |
| 1991 | 0.52 | 0.26 | 0.89 | 0.95 |  |

Question 2.3 (2 points) (straightforward-no partial points)
Place a tick $(\sqrt{ })$ mark in the box of your selected correct answer.

| A | B | C | D | E |
| :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | $\sqrt{ }$ |

## Question 2.4 (4 points: $4 \times 1$ )

Place a tick $(\sqrt{ })$ mark in the box of your selected correct answer. (straightforward-no partial points)

| Statement | True | False |
| :---: | :---: | :---: |
| A |  | $\checkmark$ |
| B |  | $\checkmark$ |
| C | $\sqrt{ }$ |  |
| D |  | $\checkmark$ |

## Question 2.5 (6 points)



## Grading Rule

- Correct format of graph using correct data from table (two separate graphs for coastal and inland plants will also be accepted) ( 5 points)
- correct axes and labels (1 point)

Question 2.6 (2 points: $2 \times 1$ ) (straightforward-no partial points)
Place a tick $(\sqrt{ })$ mark in the box of your selected correct answer.

| Statement | True | False |
| :---: | :---: | :---: |
| A |  | $\sqrt{ }$ |
| B | $\sqrt{ }$ |  |

## Part B : Dispersal Biology of Ficus

Question 2.7. (15 points) Answer data may vary slightly among participants)

| Fruit Serial Number | Fruit Diameter (mm) |  |  |
| :---: | :---: | :---: | :---: |
|  | Ficus hispida | Ficus septica | Ficus variegata |
| 1 | 32.12 |  |  |
| 2 |  |  | 22.54 |
| 3 |  | 21.22 |  |
| 4 |  |  | 20.42 |
| 5 |  | 20.56 |  |
| 6 |  | 18.74 |  |
| 7 |  |  | 21.45 |
| 8 |  | 19.63 |  |
| 9 | 28.34 |  |  |
| 10 |  |  | 24.21 |
| 11 |  | 23.22 |  |
| 12 | 30.46 |  |  |
| 13 |  | 21.43 |  |
| 14 |  |  | 21.55 |
| 15 | 29.12 |  |  |
| 16 |  | 24.24 |  |
| 17 | 27.50 |  |  |
| 18 |  | 20.45 |  |
| 19 |  |  | 24.54 |
| 20 |  |  | 22.11 |
| 21 |  | 18.12 |  |
| 22 |  |  |  |
| 23 | 25.12 |  |  |
| 24 |  |  | 23.50 |
| 25 | 26.42 |  |  |
| 26 |  |  | 20.22 |
| 27 |  | 22.86 |  |
| 28 | 31.22 |  |  |
| 29 |  |  | 23.42 |
| 30 |  | 17.15 |  |
| Mean | 28.79 | 21.05 | 22.28 |
| Std. Dev. | 2.42 | 2.21 | 1.51 |

*Measurements should be with two decimal places.

## Grading Rule

- Each measurement $=0.25$ point (total 7.5 points).

Note: Standard deviation (square root of variance) using either formula (divided by " n " as in the variance formula given, or divided by " $n-1$ ") were accepted.

- Mean and standard deviation $=2.5$ points for each species.
- Measurements will be compared to our own record of measurements.


## Question 2.8. (8 points) (Example)



## Grading Rule:

- Correct format of bar graph (4 points)
- Graph based on correct values from Question 2.7 (2 points)
- Standard deviation given correctly (1 point)
- Vertical axis given correct label and units (1 point)


## Question 2.9 (4 points: $4 \times 1$ )

Place a tick $(\sqrt{ })$ mark in the box of your selected correct answer: (straightforward - no partial points)

| Statement | True | False |
| :---: | :---: | :---: |
| A | $\vee$ |  |
| B | $\vee$ |  |
| C | $\vee$ |  |
| D |  | $\checkmark$ |

## Question 2.10 (3 points: $3 \times 1$ ) (straightforward - no partial points)

Place a tick $(\sqrt{ })$ mark in the box of your selected correct answer:

| Statement | True | False |
| :---: | :---: | :---: |
| A | $\checkmark$ |  |
| B |  | $\checkmark$ |
| C | $\vee$ |  |

## TASK 3. SPECIATION IN SONGBIRDS

Question 3.1 (1 point: $2 \times 0.5$ ) (straightforward - no partial points)
Place a tick $(\sqrt{ })$ mark in the box of your selected correct answer.

Note: Students were given full points if they tick the two correct anwers, and were not penalized if they additionally ticked one other answer which is incorrect.

| A | B | C | D | E |
| :--- | :--- | :--- | :--- | :--- |
|  |  | $\vee$ |  | $\checkmark$ |

Question 3.2 (18 points: $9 \times 2$ ) (straightforward-no partial points)

| Songbird <br> Number | Syllable Repertoire | Acceptable Range for <br> Answers |
| :---: | :---: | :---: |
| 1 | 11 | $9-13$ |
| 2 | 19 | $17-21$ |
| 3 | 30 | $28-32$ |
| 4 | 20 | $18-22$ |
| 5 | 29 | $27-31$ |
| 6 | 11 | $9-13$ |
| 7 | 32 | $30-34$ |
| 8 | 12 | $10-14$ |
| 9 | 24 | $22-26$ |

## Question 3.3 (3 points: $3 \times 1$ )

| Group | Songbird Number |
| :---: | :---: |
| $\ldots$ | $1,6,8$ |
| $\ldots$ | $2,4,9$ |
| $\ldots$ | $3,5,7$ |

## Grading Rule:

- Grading within a group will only be based on the first three numbers (in the case where students enter more than three songbird numbers in a group).
- Full point (1) given if all three numbers are correct.
- Partial point ( 0.5 ) given if two numbers are correct.
- No points ( 0 ) given if only one number or none is correct.


## Question 3.4 ( 8 points: $2 \times 4$ )

Note: statistical calculations were graded very leniently. Two formulas for variance (divided by " n " as in the formula given, or divided by " $\mathrm{n}-1$ ") were accepted.

Since it was not specified in the question, both onetailed and two-tailed tests were accepted as correct.
t-values may vary according to the acceptable range for answers (number of different syllables).

| Group .... | Group .... |
| :---: | :---: |
| 11 | 30 |
| 11 | 29 |
| 12 | 32 |
| 11.33 | 30.33 |
| 110.22 |  |


| Calculated t-value | 20.152 |
| :--- | :---: |
| Table t-value | 2.132 (one-tailed) or <br> 2.776 (for two-tailed <br> test) |

## Grading Rule:

- 1 point each for mean and variance for two groups.
- 2 points each for calculated $t$-value and table $t$-value.


## Question 3.5 (1 point) (straightforward - no partial points)

Place a tick $(\sqrt{ })$ mark in the box of your selected correct answer.

| $A$ | $B$ |
| :--- | :--- |
|  | $\checkmark$ |

$\qquad$
$\qquad$

