IB Biology Investigations

Volume 1 (Standard Level)

COPY MASTERS

(For use with the IB Diploma programme)

(Fourth edition)

Author: Paul Billiet

Series editor: David Greig

Table of Contents

Syllabus reference: Sub-Topic 3.5 Skill

Many species of flowering plants can easily regenerate their tissues if they are damaged. Gardeners take advantage of this to clone plants by taking cuttings. Stimulating plants to grow from cuttings can be carried out in liquid media or solid media.

Materials

- cutting tool
- alcohol
- cuttings from a plant e.g. *Tradescantia, Impatiens*, geranium, bamboo, African violet, begonia

General Method

1. Make sure that the plant to be cloned is well watered; it should not be wilting. Cuttings taken early in the day will be more successful as the plant will be fully turgid.
2. Clean the knife with alcohol and select healthy tissue from the plant to be cloned.

Warning: Sharp instruments, handle with care

3. Take the cuttings from the upper parts of the plant showing recent growth and remove any flower heads or flower buds. Lateral branches are better than the terminal branch.
4. Keep the cuttings cool and moist before they are used. Store the cuttings in damp paper in a fridge if they are not to be used immediately.
5. Remove the leaves from the lower third of the cuttings.

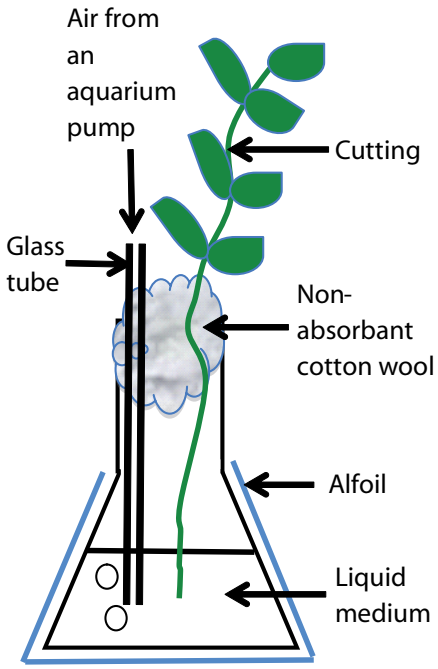
Method A: Using a liquid medium

Materials

- wide-necked conical flasks 50cm^3
- glass tubing 20cm
- plastic tubing
- aquarium pump
- non-absorbant cotton wool
- liquid media
- distilled water
- aluminium foil

Method

1. Place the cutting in the flask so that the cut end is immersed in the culture medium.
2. Insert the glass tube in to the medium and hold the cutting and tube with non-absorbent cotton wool.
3. Attach the glass tube to an aquarium pump using glass tubing. Adjust the height of tube in the flask, it should be under the surface of the liquid but not touching the bottom. Adjust the aquarium pump so there is a steady flow of air to aerate the liquid.
4. Cover the flask in aluminium foil. This stops light entering the flask so algae will not grow in it.
5. Leave the plants in a cool, humid environment out of direct sunlight.



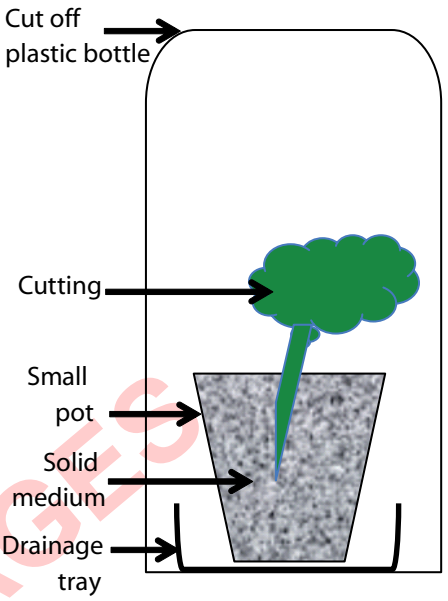
Method B: Using a solid medium

Materials

small pots
cut off plastic bottle
medium: 40% medium grade vermiculite & 60% perlite or 50% vermiculite & 50% sand
tray

Method

1. Make a hole in the cutting medium big enough to put the stem of the cutting in. Gently push the cutting into the hole and firm the medium around it so it is supported.
2. Water the pot until the liquid starts to flow out into the draining tray. The medium is then at field capacity.
3. Place the plastic bottle over the pot and the cutting. Leave the plant in a cool place out of direct sunlight.



To investigate further

- Does a particular species of plant root better in solid or liquid media?
- Hormone rooting powder or gel can be bought in garden centres these contain synthetic hormones such as indole acetic acid (IAA) or 1-naphthylactetic acid (NAA). Do they have the same effect on different species of plants? The cutting will need to be treated before they are planted.

Warning: The rooting powders or gels are biologically active compounds. Use gloves. Do not agitate the powder form. Use in a well ventilated area.

- Honey is said to stimulate rooting in plants. How could you test this?
- Do certain mineral nutrients affect rooting and root growth?

  Standard plant mineral nutrient solutions can be prepared (e.g. Sachs solution or Knop's solution) and equivalent solutions lacking one of the minerals can also be prepared.

- Mycorrhizal fungi are said to improve the rooting of their host species. Soil supplements containing mycorrhizal fungi can be obtained from organic garden suppliers.

Warning: The mycorrhiza may cause allergies. Use gloves. Do not agitate the powder form. Use in a well ventilated area.

I B Biology Investigations

Volume 1 (Standard Level)

TEACHING NOTES

(For use with the IB Diploma programme)

(Fourth edition)

Author: Paul Billiet

Series editor: David Greig

Syllabus Correlation Table (Core)

Core Topic	Practical Number	Sub topic	Syllabus reference	Title
1	1A	1.1	**Skill:** Use of a light microscope to investigate the structure of cells and tissues, with drawing of cells. Calculation of the magnification of drawings and the actual size of structures and ultrastructures shown in drawings or micrographs. (Practical 1)	CELLS
	1B	1.4	**Skill:** Estimation of osmolarity in tissues by bathing samples in hypotonic and hypertonic solutions. (Practical 2)	ESTIMATING THE WATER POTENTIAL OF PLANT TISSUES
	1C		**Aim**: Dialysis tubing experiments can act as a model of membrane action. Experiments with potato, beetroot or single-celled algae can be used to investigate real membranes.	MEMBRANE INTEGRITY IN CABBAGE LEAF CELLS
	1D	1.6	**Skill:** Identification of phases of mitosis in cells viewed with a microscope or in a micrograph.	THE CELL CYCLE IN PLANT TISSUES
			Skill: Determination of a mitotic index from a micrograph.	
2	2A	2.1	**Skill:** Identification of biochemicals such as sugars, lipids or amino acids from molecular diagrams.	DIALYSIS: SEPARATING MOLECULES BY SIZE
	2B	2.2	**Application:** Use of water as a coolant in sweat.	WATER AS A COOLANT
	2C	2.3	**Skill:** Use of molecular visualization software to compare cellulose, starch and glycogen.	POLYSACCHARIDE MOLECULES
	2D	2.5	**Skill:** Experimental investigation of a factor affecting enzyme activity. (Practical 3)	MEASURING THE RATE OF REACTION OF AN ENZYME CONTROLLED REACTION
	2E	2.5 & 2.8	**Application:** Use of anaerobic cell respiration in yeasts to produce ethanol and carbon dioxide in baking.	IMMOBILISING YEAST ENZYMES
	2F	2.8	**Skill:** Analysis of results from experiments involving measurement of respiration rates in germinating seeds or invertebrates using a respirometer	RESPIRATION RATES OF AN INVERTEBRATE
	2G	2.9	**Skill:** Separation of photosynthetic pigments by chromatograph. (Practical 4)	LEAF PIGMENTS, THEIR EXTRACTION AND SEPARATION
	2H		**Skill:** Drawing an absorption spectrum for chlorophyll and an action spectrum for photosynthesis	USING SPECTROSCOPY TO STUDY LEAF PIGMENTS
	2I		**Skill:** Design of experiments to investigate the effect of limiting factors on photosynthesis.	METHODS TO MEASURE THE RATE OF PHOTOSYNTHESIS
3	3A	3.1	**Skill:** Use of a database to determine differences in the base sequence of a gene in two species.	USING A PROTEIN DATABASE
	3B	3.5	**Skill:** Design of an experiment to assess one factor affecting the rooting of stem-cuttings.	FACTORS AFFECTING ROOTING IN PLANTS
4	4A	4.1	**Skill:** Setting up sealed mesocosms to try to establish sustainability. (Practical 5)	ECOLOGICAL SUCCESSION IN A MICROBIAL ECOSYSTEM
	4B		**Skill:** Testing for association between two species using the chi-squared test with data obtained by quadrat sampling	PLANT ASSOCIATION TEST
5	5A	5.3	**Application:** Recognition features of bryophyta, filicinophyta, coniferophyta and angiospermophyta	DICHOTOMOUS KEY FOR PLANT PHYLA
			Skill: Construction of dichotomous keys for use in identifying specimens	
6	6A	6.1	**Application:** Use of dialysis tubing to model absorption of digested food in the intestine.	DIALYSING TUBING GUT
	6B	6.2	**Skill:** Recognition of the chambers and valves of the heart and the blood vessels connected to it in dissected hearts or in diagrams of heart structure.	THE ANATOMY OF THE HEART
	6C	6.4	**Skill:** Monitoring of ventilation in humans at rest and after mild and vigorous exercise. (Practical 6)	VENTILATION AND EXERCISE

Syllabus Correlation Table (Options)

Option Topic	Practical Number	Sub topic	Syllabus reference	Title
A	12A	A.2	**Application:** Use of the pupil reflex to evaluate brain damage.	THE PUPIL REFLEX
	12B	A.3	**Application:** Red-green colour-blindness as a variant of normal trichromatic vision.	THE RETINA AND COLOUR VISION
B	13A	B.1	**Skill:** Experiments showing zone of inhibition of bacterial growth by bactericides in sterile bacterial cultures	DO DISINFECTANTS KILL BACTERIA?
	13B		**Skill:** Gram staining of Gram-positive and Gram-negative bacteria	THE GRAM STAIN FOR BACTERIA
C	14A	C.1	**Skill:** Use of a transect to correlate the distribution of plant or animal species with an abiotic variable	STUDYING CHANGES IN A PLANT COMMUNITY USING A BELT TRANSECT
	14B			USING INVERTEBRATE PITFALL TRAPS ON A LINE TRANSECT
	14C	C.2 &4	**Skill:** Investigation into the effect of an environmental disturbance on an ecosystem Skill: Analysis of the biodiversity of two local communities using Simpson's reciprocal index of diversity	MEASUREMENT OF A DIVERSITY INDEX AND A BIOTIC INDEX
D	15A	D.1	**Skill:** Determination of the energy content of food by combustion	ENERGY FROM FOOD
	15B	D.4	**Skill:** Measurement and interpretation of the heart rate under different conditions	HEART RATE AND BLOOD PRESSURE
			Skill: Interpretation of systolic and diastolic blood pressure measurements	
	15C		**Skill:** Mapping of the cardiac cycle to a normal electrocardiogram (ECG) trace	TAKING AND READING AN ELECTROCARDIOGRAM
APPENDICES	1	6, 11 and D	The IB animal experimentation policy and the biology course safety guidelines.	INFORMED CONSENT FORM
	2	4.1	**Guidance:** Sampling should be based on random numbers. In each quadrat the presence or absence of the chosen species should be recorded.	TABLE OF RANDOM NUMBERS
	3			USING A TI CALCULATOR TO GENERATE RANDOM NUMBERS

3B FACTORS AFFECTING ROOTING IN PLANTS

Time: 1 hour to set up and 3 weeks to run

Syllabus reference: Topic 3.5

Skill: Design of an experiment to assess one factor affecting the rooting of stem-cuttings.

Liquid media

Although covering the flask with aluminium foil will prevent growth of algae, it will not prevent other microbes from growing. These may infect the medium. To reduce this risk it is best to make up the media with sterile water.

Investigating the effect of mineral deficiency on rooting using Sachs Solution

Showing the composition of the complete medium and the media deficient in one of the elements. In some cases the compound used in the complete medium (in blue) needs to be replaced by another compound (in red).

	The amount of mineral / g dm^{-3}						
Mineral content	**Complete**	**Minus Ca**	**Minus Fe**	**Minus N**	**Minus P**	**Minus S**	**Minus K**
KNO_3	0.70	0.70	0.70	KCl 0.52	0.70	0.70	$NaNO_3$ 0.59
$Ca_3H_4(PO_4)_2$	0.25	$NaH_2PO_4.2H_2O$ 0.71	0.25	0.25	$CaNO_3.4H_2O$ 0.16	0.25	0.25
$MgSO_4.7H_2O$	0.25	0.25	0.25	0.25	0.25	$MgCl_2.6H_2O$ 0.17	0.25
$CaSO_4$	0.25	K_2SO_4 0.2	0.25	0.25	0.25	$CaCl_2$ 0.16	0.25
NaCl	0.08	0.08	0.08	0.08	0.08	0.08	0.08
$FeCl_3\ 6H_20$	0.005	0.005	0	0.005	0.005	0.005	0.005

Safety

- Potassium nitrate (V): an oxidising agent and dangerous with some metals and flammable substances
- Iron (III) chloride-6-water: harmful as a solid
- Calcium nitrate (V)-4-water: an oxidising agent and an irritant
- Calcium chloride: irritant as a solid
- Sodium nitrate (V): an oxidising agent and harmful as solid. Dangerous with some metals and flammable materials.

These are **Sample Pages** only from the fourth edition of one of the IBID Science Volumes. This Volume is part of a series of full-colour **Copy Masters** as follows:

SUBJECT	VOLUME
BIOLOGY	Standard Level Investigations with Teaching Notes
	Higher Level Investigations with Teaching Notes
	Internal Assessment Handbook
CHEMISTRY	Standard Level Investigations with Teaching Notes
	Higher Level Investigations with Teaching Notes
	Internal Assessment Handbook
PHYSICS	Standard Level Investigations with Teaching Notes
	Higher Level Investigations with Teaching Notes
	Internal Assessment Handbook

These Volumes have been prepared and published specifically to support the teaching of the **IB Diploma Sciences**. They are for sale as either as paper copies or secure pdf files and may only be used by the purchasing school under the conditions of sale.

More information may be obtained from our website
<*www.ibid.com.au*>