Biology – Paper 3
(Practical)

Subject content:

Practical Assessment (Paper 3) [1h 50 mins, 40 marks]
Skill areas:

- Planning (P)
- Manipulation, measurement and observation (MMO)
- Presentation of data and observations (PDO)
- Analysis, conclusions and evaluation (ACE)

The assessment of Planning (P) will have a weighting of 15%.
The assessment of skill areas MMO, PDO and ACE will have a weighting of 85%.
2 – 3 compulsory practical questions

Popular concepts:

- movement of substance
- enzymes
- reproduction in plants
- nutrition in plants
- transport in plants
- heredity, molecular genetics (most likely for theory part)

Planning (P)

- identify key variables for a given question/problem
- outline an experimental procedure to investigate the question/problem
- describe how the data should be used to reach a conclusion
- identify the risks of the experiment and state precautions that should be taken to keep risks to a minimum

1. Independent + dependent + constant (at least 2) **variables**
   - If values for independent variable are not stated in qn, state five values to be used – within appropriate range + equal intervals
2. **Data recording**
3. **Data collection**
4. **Data presentation + interpretation** (what do you do with data?) (both sides)

1) Plot graph + show trend	• investigate effect of independent variable
2) Describe results + draw conclusions	• investigate presence or absence of certain substance • compare relative amounts of substances in two samples

5. **Increase reliability**
   - use a wide range of independent variables
   - repeat experiment + calculate average/mean

Answering format:

Outline a method that you could use to find the effect of temperature on rate of pepsin activity.

1. Add fixed volume of pepsin solution + fixed volume of protein mixture e.g. albumin mixture to test tube placed in water bath at 10°C
2. Data collection: measure time taken for cloudy protein mixture to become clear using stopwatch + record data in a table
3. Repeat steps 1 – 3 to diff test tubes placed in water bath at 20°C, 30°C, 40°C, 50°C
4. Data presentation: plot graph of time taken for protein mixture to become clear against temperature of water bath
5. Data interpretation:
   - If time taken decreases as temperature of water bath increases, then rate of pepsin activity increases with increasing temperature
   - If time taken increases as temperature of water bath increases, then rate of pepsin activity decreases with increasing temperature + lowest point of graph is optimum temperature of pepsin which gives highest rate of reaction
6. Increase reliability: repeat experiment at each temperature of water bath + calculate mean time taken for protein mixture to become clear

Plan an investigation to show how you could determine the concentration of cell sap of cells in potato strips.

1. Place potato strip of 6 cm in length into each of the salt solutions with concentrations 2%, 4%, 6%, 8%, 10% for 20 minutes
2. Data collection: measure final length of each strip using ruler + record measurement in table
3. Data presentation: plot graph of mean change in length against concentration of salt solution
4. Data interpretation:
   - concentration of salt solution at which there is no change in length is concentration of cell sap of potato strip
5. Increase reliability: repeat experiment at each concentration of salt solution concentration + calculate mean change in length of potato strip

Outline how you would investigate the effect of varying temperature on the digestion of sucrose by sucrase.

1. Incubate test tubes separately containing 2 cm^3 sucrose + 2 cm^3 sucrase solution in water bath at 10°C for 10 mins
2. Add sucrose to sucrase solution + leave for 20 mins
3. Data collection: carry out Benedict's test on mixture (Note: elaboration on procedure for Benedict's test is not required) + record colour changes observed in table
4. Data presentation: compare concentration of reducing sugar in each mixture by observing colour of mixture at the end of experiment
5. Data interpretation:
   - The closer the intensity of final colour of mixture to brick red, the faster the hydrolysis of sucrose by sucrase at that temperature.
   - A blue mixture for Benedict's test shows that sucrase is not active at that temperature and hence no hydrolysis of sucrose by sucrase into reducing sugars occurred
6. Increase reliability: repeat experiment for test tubes placed in water baths at 20°C, 30°C, 40°C and 50°C controlled by thermostat + ensure that volume of Benedict's solution added to each test tube + duration at which test tube is placed in boiling water bath is same

The activity of most enzymes, including catalase, is influenced by the changes in pH. Catalase is present in many plant and animal tissues. It chemically breaks down toxic hydrogen peroxide into water and oxygen.

You are given a cylinder of potato tissue, from which you are to cut 12 discs, each measuring 1 mm in thickness. When each disc is placed in hydrogen peroxide solution, it will rise due to the accumulation of oxygen bubbles formed around it.

Outline an investigation to determine the effect of pH on the activity of catalase and to determine the optimum pH of catalase.

1. Add 5 cm^3 of 6% hydrogen peroxide solution to test tube (constant variable) using syringe
2. Adjust pH of solution to pH 2 by adding dilute hydrochloric acid and sodium hydroxide
3. Repeat steps 1 – 2 to prepare four other test tubes of hydrogen peroxide solution of pH 4, 6, 8, 10
4. Add two pieces of potato discs of same diameter of 1 cm to each test tube

Height at fixed time

5. Data collection: record height of froth formed at the end of 2 mins using ruler + record results in table
6. Data presentation: plot graph of height of froth formed against pH of mixture
7. Data interpretation:
   - pH that gives greatest height of froth is optimum pH
   - pH changes beyond optimum pH will cause decrease in height of froth formed, indicating decrease in catalase activity
8. Increase reliability: repeat experiment at each pH + calculate mean height of froth

OR

Time at fixed height

5. Data collection: Measure time taken for potato disc to rise to surface using stopwatch + record time in table
6. Data presentation: plot graph of mean time taken for potato disc to rise to surface against pH of mixture
7. Data interpretation:
   - pH of mixture with shortest time taken for potato disc to rise is optimum pH
   - pH changes beyond optimum pH will cause increase in time taken for potato disc to rise, indicating decrease in catalase activity
8. Increase reliability: repeat experiment at each pH + calculate mean time taken for potato disc to rise to the surface

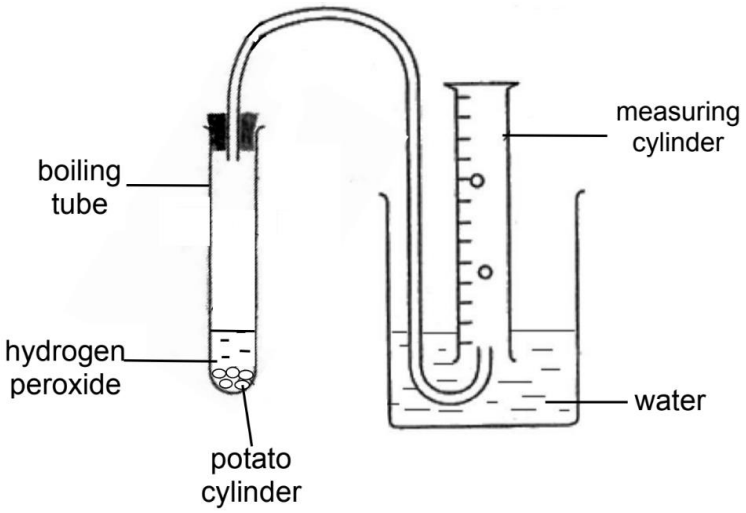
A student is provided with two unlabelled food samples. One of which is dried egg white and the other is maltose. Plan an experiment to identify each powder.

1. Place 1 g of each sample into a test-tube
2. Add 5 cm^3 water to each test tube + shake mixture
3. Data collection: perform Biuret test on each solution + record colour change observed
4. Data interpretation:
    - The mixture that turns from blue to violet is egg white
    - The solution that remains blue is maltose
5. Data collection: perform Benedict's test on each solution + record colour change observed
    - The mixture that shows green / brown / orange / brick-red precipitate is maltose
    - The solution that remains blue is egg white
6. Increase reliability: repeat experiment + record colour change

Dichlorophenolindophenol (DCPIP) is a chemical substance that can be used to test for the presence of ascorbic acid. When DCPIP reacts with ascorbic acid, the colour of the solution changes from dark blue to colourless. Ascorbic acid can be destroyed by heating it at high temperatures or by heating it for a long time. Fruit juices are often heat treated to kill bacteria which allows the juice to be kept for a long time without being refrigerated.
Outline a method using DCPIP to investigate the effect of heating on the ascorbic acid content in fruit juice.

1. Prepare 10 test tubes containing 2 cm^3 of ascorbic acid / fruit juice (constant variable)
2. Place two test tubes into water baths of 20°C, 40°C, 60°C, 80°C and 100°C respectively (changing variable)
3. Data collection: add 2 cm^3 of DCPIP into each of test tubes (constant variable)
4. Data collection: measure time taken for DCPIP to decolourise
5. Data interpretation:
    - If time taken for DCPIP to decolourise is long when test tube is subjected to heating, then ascorbic acid is broken down by heating / affected by heating
    - If time taken for DCPIP to decolourise is short when test tube is subjected to heating, then ascorbic acid is not broken down by heating / not affected by heating
6. Increase reliability: repeat experiment at every temperature + calculate average time taken for DCPIP to decolourise

Enzymes are often found in living tissues such as potatoes. The enzyme, catalase, found in a potato speeds up the rate of decomposition of hydrogen peroxide to produce oxygen and water. A student set up the apparatus shown below to investigate the effect of temperature on the rate of decomposition of hydrogen peroxide by catalase.



Plan an investigation based on the apparatus in the figure above to determine the effect of temperature on the rate of decomposition of hydrogen peroxide by catalase.

1. Constant variables:
   - length / width / thickness of potato / number of potato cylinders (exposed surface area matters, reject: mass / volume of potato)
   - concentration / volume of hydrogen peroxide solution
   - pH of hydrogen peroxide
   - volume of water in beaker
   - time taken for reaction

2. Independent variable: temperature of water bath that boiling tube is placed in (rej direct heating)
   - at least five temperatures covering good range + uniform intervals
   - controlled by thermostat

3. Data collection: measure volume of gas collected in measuring cylinder in 5 mins
4. Data presentation: plot graph of volume of gas collected against temperature of water bath
5. Data interpretation:
   - If volume of gas collected increases with increasing temperature (of water bath), it shows that rate of decomposition of H_2O_2 increases with increasing temperature
     Temperature that gives greatest volume of gas is highest rate of decomposition
   - If volume of gas collected decreases with increasing temperature (of water bath), it shows that the rate of decomposition of H_2O_2 decreases with increasing temperature

6. Increase reliability: repeat experiment at each temperature + calculate mean volume of gas
7. Increase accuracy: replace measuring cylinder with burette (more accurate measuring instrument with smaller measuring interval)

Light intensity is one factor that affects the rate of photosynthesis.
Outline how you would investigate the effect of light intensity on the rate of photosynthesis of a chloroplast suspension.

Independent variable: distance b/w tube containing chloroplast suspension & light source
Dependent variable: time taken for indicator solution to decolourise

1. Mix 60 cm^3 sucrose and chloroplast suspension mixture in a beaker, ensuring that percentage of chloroplast suspension in the mixture is 30% + add 6 cm^3 indicator solution and 6 cm^3 sulfuric acid and stir well. Place mixture in a black box to avoid photosynthesis from occurring.
2. Add 12 cm^3 mixture into specimen tube + place light source 5 cm away

3. Data collection: measure time taken for mixture to decolourise
4. Data presentation: convert time taken to rate + plot graph of rate against increasing distance

5. Increase reliability: repeat steps 2 – 3 for another 5 tubes, increasing distance by 5cm each time (i.e. light source placed at 10 cm, 15 cm, 20 cm, 25 cm, 30 cm)
6. Increase reliability: repeat experiment 3 times + calculate mean time taken for each distance

Specimen paper

A student stated that:

'Catalase activity is the same in all species of plants.'

Plan an investigation to test this statement. [6]

independent variable
at least two different species of plant ;

constant variables (max. two from:) ;;
same, size / mass, plant
same volume of hydrogen peroxide solution
same concentration of hydrogen peroxide solution
same temperature
same pH
same time
tissue from the same part of the plant, e.g. roots or leaves
same size / diameter of test tube

dependent variable
measure height of foam / measure volume of oxygen produced / count bubbles ;

detail of given method
adding hydrogen peroxide solution to plant tissue ;
preparation of plant material / method used to achieve the same surface area ;

novel method
collecting volume of gas with, gas syringe / upturned measuring cylinder ;

control
test hydrogen peroxide solution with, no plants / boiled plants ;

two or more replicates ;
relevant safety precaution ;

A student stated that:

‘Different types of plant tissue will lose different amounts of water by osmosis when immersed in a salt solution.’

Plan an investigation to find out if the student was correct.

independent variable:
1 use at least two different plant tissues ;

dependent variable:
2 calculate difference in mass / volume / length / density ;

method:
3 (soak / immerse) for a set time ;
4 method of measuring ;
5 blot the plant tissue dry / AW ;

6&7 constant variables max two from: ;;
• initial tissue size / shape / surface area
• salt solution concentration
• salt solution volume
• temperature (of solution)
• AVP e.g. different tissues from same plant

8 repeat the whole investigation at least two times (three trials) ;

Manipulation, measurement and observation (MMO)

- set up apparatus correctly by following written instructions or diagrams
- use common laboratory apparatus and techniques to collect data and make observations
- describe and explain how apparatus and techniques are used correctly
- make and record accurate observations with good details and measurements to appropriate degree of precision
- make appropriate decisions about measurements or observations

Presentation of data and observations (PDO)

- present all information in an appropriate form
- present all quantitative data to appropriate number of d.p./s.f.
- manipulate measurements effectively for analysis - plot graph

Data recording:

- Table format
  - vertical columns
  - heading: solidus notation (quantity + unit)
  - d.p. or s.f. constant throughout column
- Precision of measuring instruments:

Burette	**Pipette**	**Measuring cylinder**
2 d.p. ± 0.05 cm^3	1 d.p. exact	1 d.p. ± 0.5 cm^3
Thermometer	**Stopwatch**	**Calculated answers**
1 d.p. ± 0.5°C	nearest 1 s	depends on lower d.p. or s.f. of variable

Graph drawing:
[refer to notes]

Analysis, conclusions and evaluation (ACE)

- analyse and interpret data or observations appropriately in relation to the task
- draw conclusion(s) from interpretation of experimental data or observations and underlying principles
- make predictions based on their data and conclusions
- identify significant sources of errors and explain how they affect the results
- state and explain how to overcome or reduce significant errors, including how experimental procedures may be improved

Sources of error (SOE)

1. Instrumental error: inaccurate measuring instruments
2. Environmental error: external environmental factors that interfere with results
3. Human error: limitations of human ability

Error	Improvement
Colour change: Difficult to determine colour change - subjective	Use colorimeter / colour standard
Other factors: (depends on topic) ● temperature of surrounding / solution ● light intensity → ambient light changes in intensity as sunlight shines at certain times of the day ● relative humidity ● concentration of solution	Use thermostat to control temp of water bath (e.g. for enzymes, rate of reaction) Use blackout curtains over windows → constant ambient light
Foam height: uneven surface of foam / foam is unstable	Collect volume of gas produced
Counting bubbles: size of bubbles vary, volume of gas produced not proportional to number of gas bubbles observed	Collect volume of gas produced
Use drops of reagent: volume of each drop is inconsistent	Use burette to accurately add reagent
Observe many set-ups at the same time: may miss exact time when change occurred	Conduct experiment separately / repeat to obtain average
Timing after reaction / experiment start: Mixing reagents before start timing	
Remove air bubbles: volume of solution drawn reduced by presence of air bubbles	Tap on syringe to remove air bubbles
Precision of apparatus: smaller volumes not measured accurately	Use apparatus (e.g. syringe) with appropriate / higher precision

Experimental techniques

1. simple physiological experiments, involving tests for food substances, enzyme reactions, hydrogencarbonate indicator solution, cobalt(II) chloride paper etc.
2. simple physiological experiments, involving use of sharp instruments on plant or animal materials (accurate observations of specimens need hand lens of not less than ×6 magnification)
3. manipulative skills in assembling apparatus, in using chemical reagents and in using instruments as mounted needles, scalpels and razor blades, forceps and scissors
4. measurements using appropriate instruments (e.g. thermometer, syringe, measuring cylinder, ruler etc.) and simple arithmetical calculations
5. familiar and unfamiliar techniques to record observations + make deductions
6. recognise + observe features of familiar and unfamiliar biological specimens + record observations + make deductions about functions of specimens
7. produce clear line drawings of specimens + label + calculate magnification

- Be aware of how to cut specimen: longitudinal / transverse / cross-section
- Label length from point A to B on drawn diagram
- Magnification = x $\frac{drawing\ (cm)}{actual\ (cm)}$ (1 d.p.)