

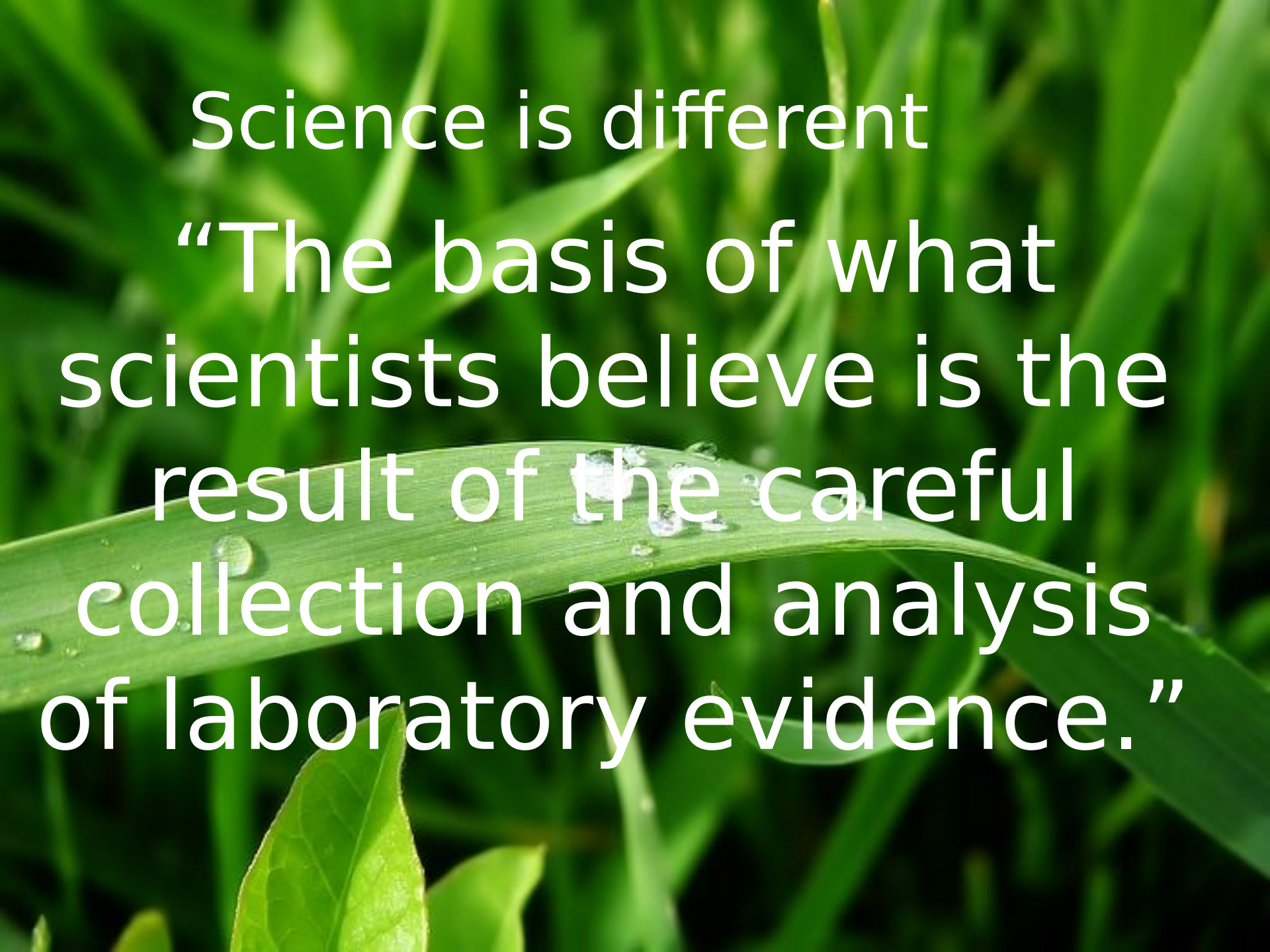
Mastering **Biology** Practicals

(Questions and Answers)



Cecilia Kiprop
Isaac Kinyanjui

New Examination format
with full colour photographs



Science is different
“The basis of what
scientists believe is the
result of the careful
collection and analysis
of laboratory evidence.”

Value of BIOLOGY PAPER 3

- EACH MARK is equivalent to 1% ,
- The Paper contributes to 40% of the exam grade,
- Plan to **score over 35 marks** out of the 40 marks possible,

Practical skills tested

- **Manipulative skills** tested in;
 - Handling of chemicals & apparatus, e.g. enzymes, osmosis using visking tubing,
 - Cutting & preparing of sections , e.g. leaf sections, stem sections, flower sections,
 - Use of a hand lens,
 - Use of a light microscope,

Continued

- **Following instructions**; in accordance with specified procedure. E.g. food tests, osmosis in plant tissue,
- **Observation, reading & interpretation**; involves recognize, identify & interpret specimen
e.g. identify a specimen and give reasons for the answer.

Continued

- **Presentation of results & calculations from data**; involves accurate and relevant conclusion.

E.g. change size & mass of plant tissue in varied solutions, Stomatal distribution

General experimental procedure

- Read through **ALL** the questions carefully (in the first 15 minutes) without writing anything;
- Determine the “**Aim of the experiment**”
- Start with the **question requiring to be left** for a duration;
- **Avoid writing** what is not required by the question;
- **Save time**; While waiting for reaction to occur use the time to write the procedure;
- **Accurately record all observations, measurements, timing**

**(Paper 3) is organised into
three questions**

Each PRACTICAL EXAM paper has
three questions,

- one taken from botany,
- the other from Zoology
- the third from physiology.

Physiology Questions are designed to test a candidates' ability to;

- Follow instructions,
- Handle apparatus safely;
- Make accurate measurements;
- Make accurate observations;
- Record observations,
- Evaluate & interpret observations using biological facts,
- Use the recorded data in calculations,
- evaluate experiments

Types of physiology questions

- Food tests;
- Enzymes investigation;
- Osmosis investigations;

Food test questions

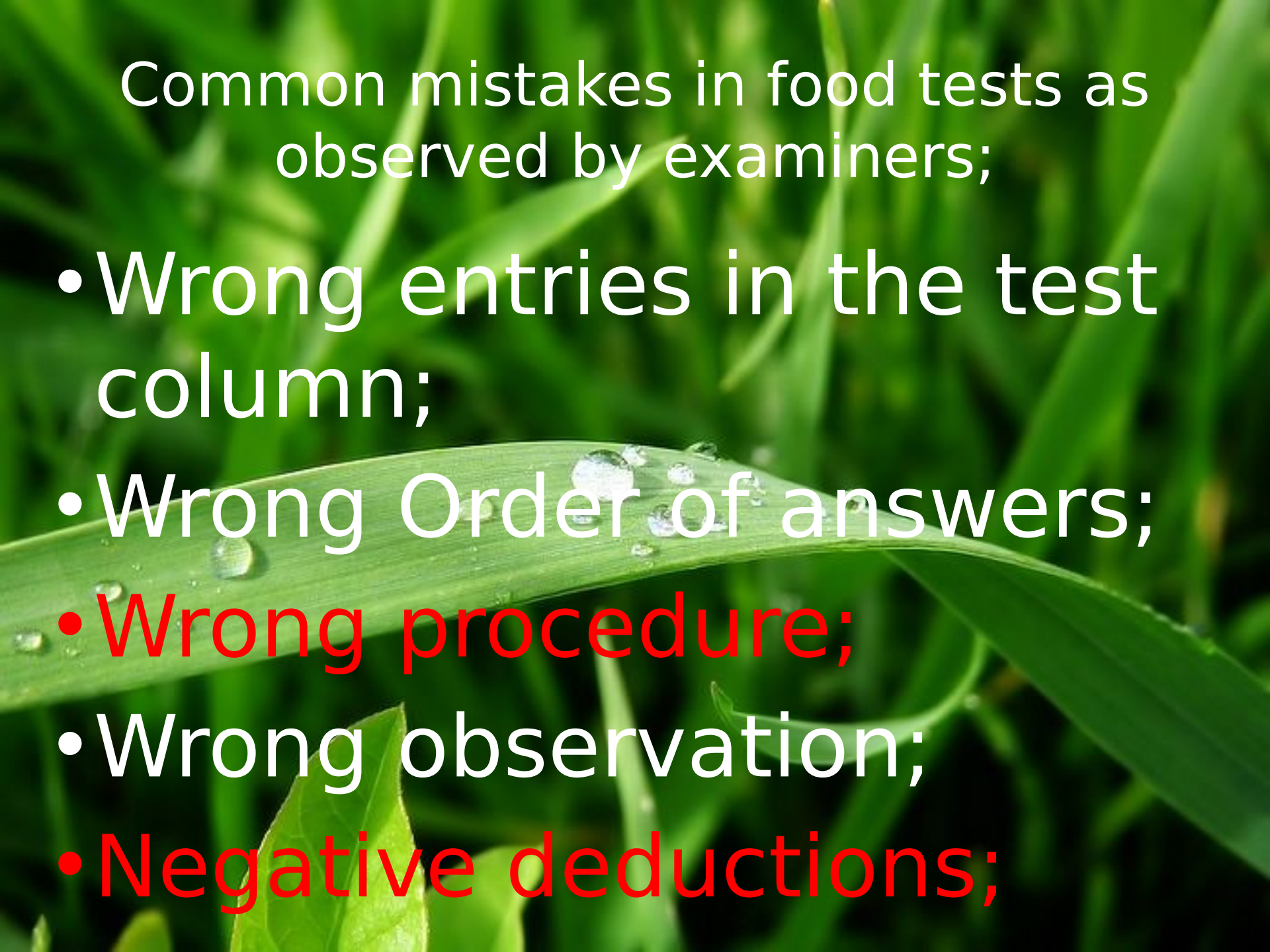
Start by seeking the identification of;

- Starch;
- Reducing sugar;
- Non-reducing sugars;
- Proteins;
- lipids;
- Vitamin C

Food tests

Food test are intended to identify the constituents of biological materials in;

- Seeds;
- Solutions;
- Powders;
- Fruits;
- Seedlings;



Common mistakes in food tests as
observed by examiners;

- Wrong entries in the test column;
- Wrong Order of answers;
- Wrong procedure;
- Wrong observation;
- Negative deductions;

Appropriate test titles

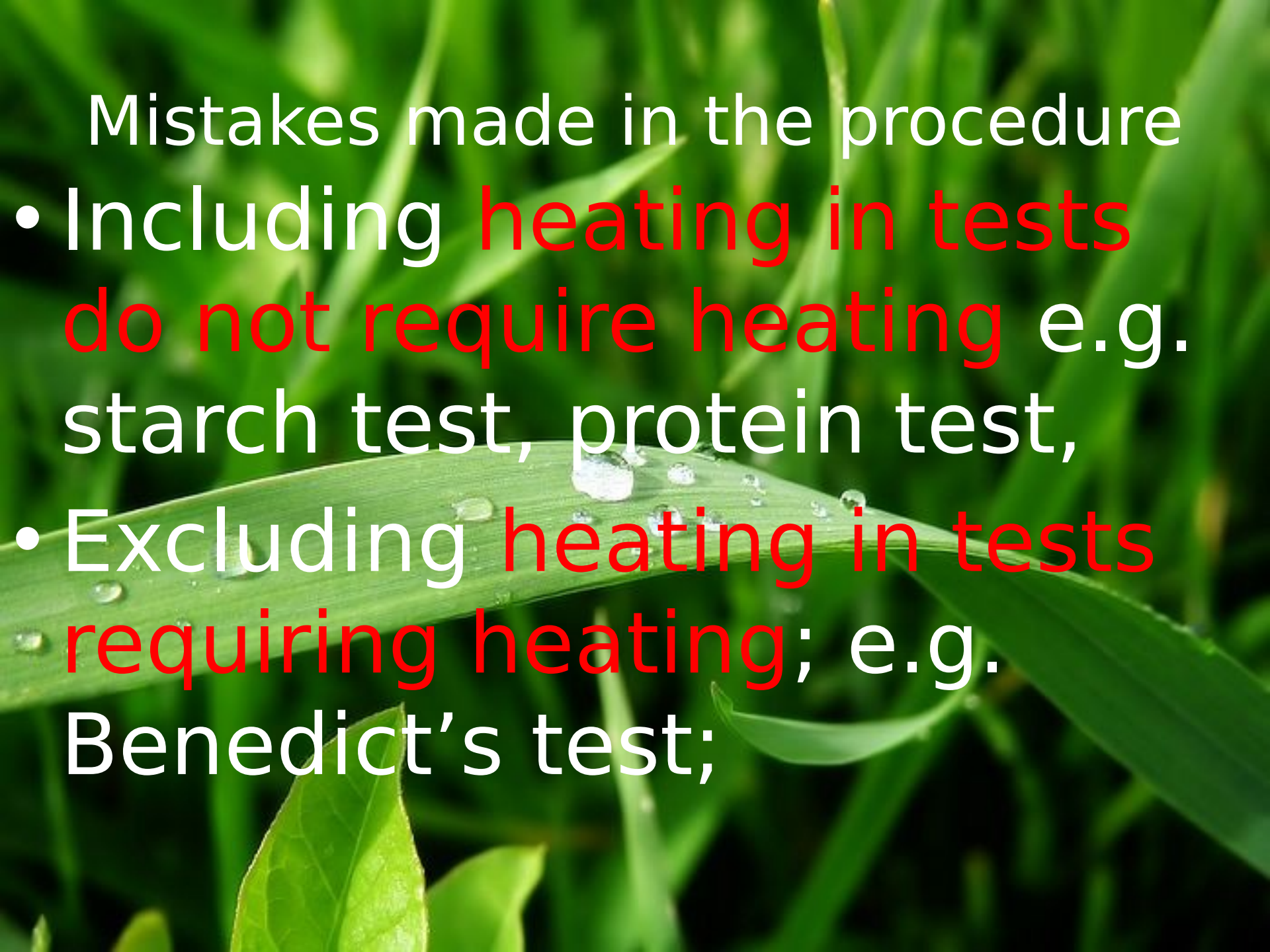
Food test	Chemical Test	Food substance
Starch test	Iodine test	Starch
Protein test	Buuret's test	Protein
Reducing sugar test	Benedict's test	Reducing sugar
Non-reducing sugar test	Benedict's test	Non-Reducing sugar
Vitamin C test	Dichlorophenolindophenol	Vitamin C
Lipid test	Ethanol test	Lipid

Explaining Wrong Order of answers

- Answers to section (a) should never be given in section (b) or vice versa;
- Answers written outside the spaces provided will not be marked;

Explaining wrong procedure

- No marks are awarded for observations and deductions if the procedure is wrong;



Mistakes made in the procedure

- Including heating in tests do not require heating e.g. starch test, protein test,
- Excluding heating in tests requiring heating; e.g. Benedict's test;

Continued

- Omission; e.g.

Failure to indicate **amount of heating**;
instead of "heating to boil"

- Failure to state the form of reagents used like referring to iodine alone instead of **iodine solution**;

- Failure to state the **quantity of the solution** used instead of *"added three drops of iodine solution"*

Continued

- **Wrong order of presentation;**

e.g. in protein test sodium hydroxide solution is added before the copper (II) sulphate solution;

In the test for vitamin C it is the solution of the food sample that is added to the reagent drop wise until no further change is observed. This is the only case where a food sample is added to the reagent.

Continued

- Failure to mention the substance involved in the test;
- Incorrect procedure; “*add two drops of iodine solution and observe*”
- Correct procedure; “*add two drops of iodine solution to substance M*”

Continued

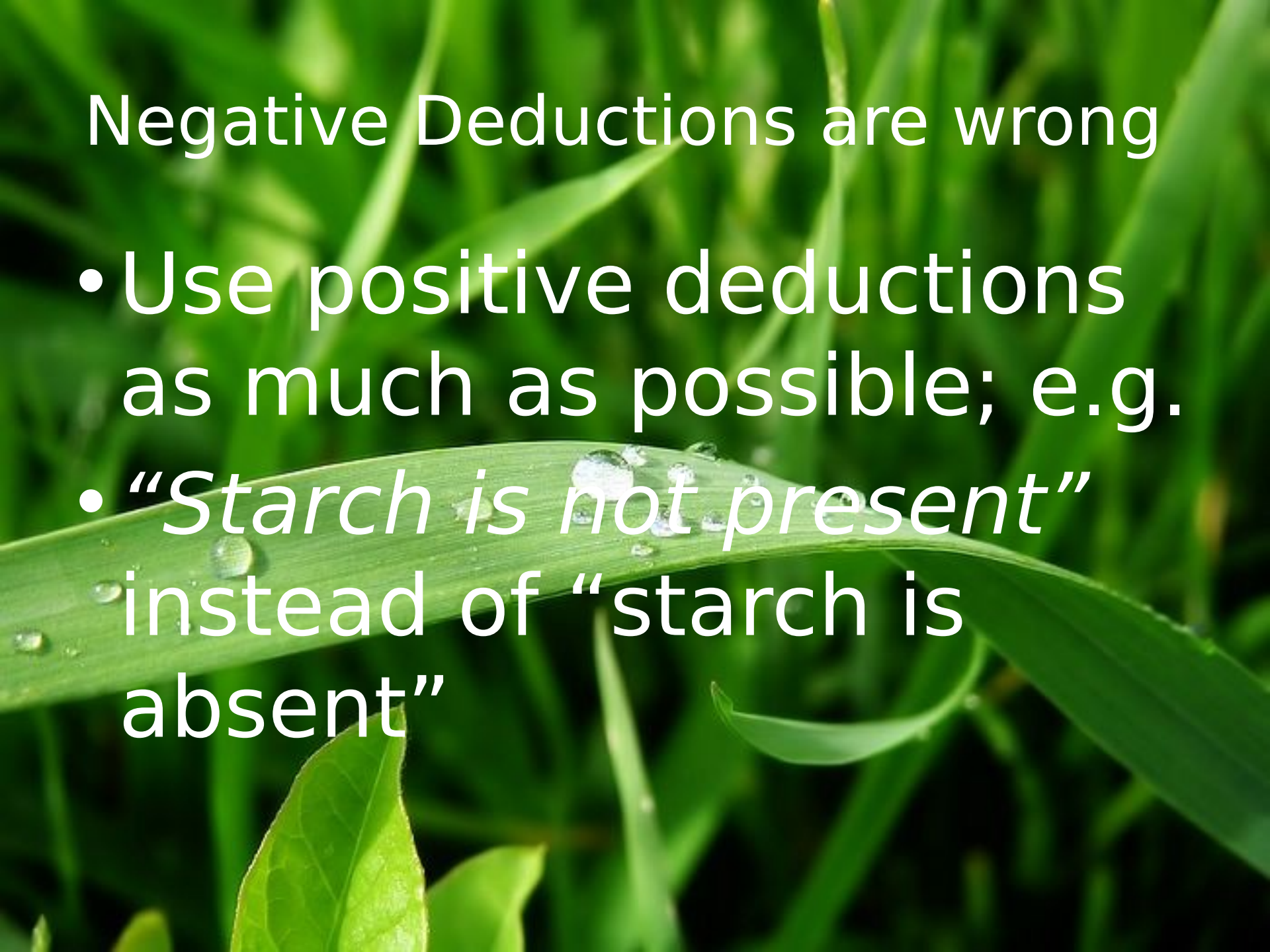
- Use of “materials” not provided by the examiner. E.g.
- If a powder is labeled “V” then it is wrong for a student to write; “to *starch powder* add two drops of iodine solution”
- Because that information is not provided in the question;
- Use of a white tile while none was provided in the starch test.

Wrong Observation

- Wrong observation will lead to wrong conclusion;

Examples of wrong observations;

- Greenish instead of light green,
- Yellowish instead of light yellow,
- Bluish instead of light blue,
- No change instead of colour X persisted;
- No reaction instead of colour X persisted;
- Black instead of blue-black;



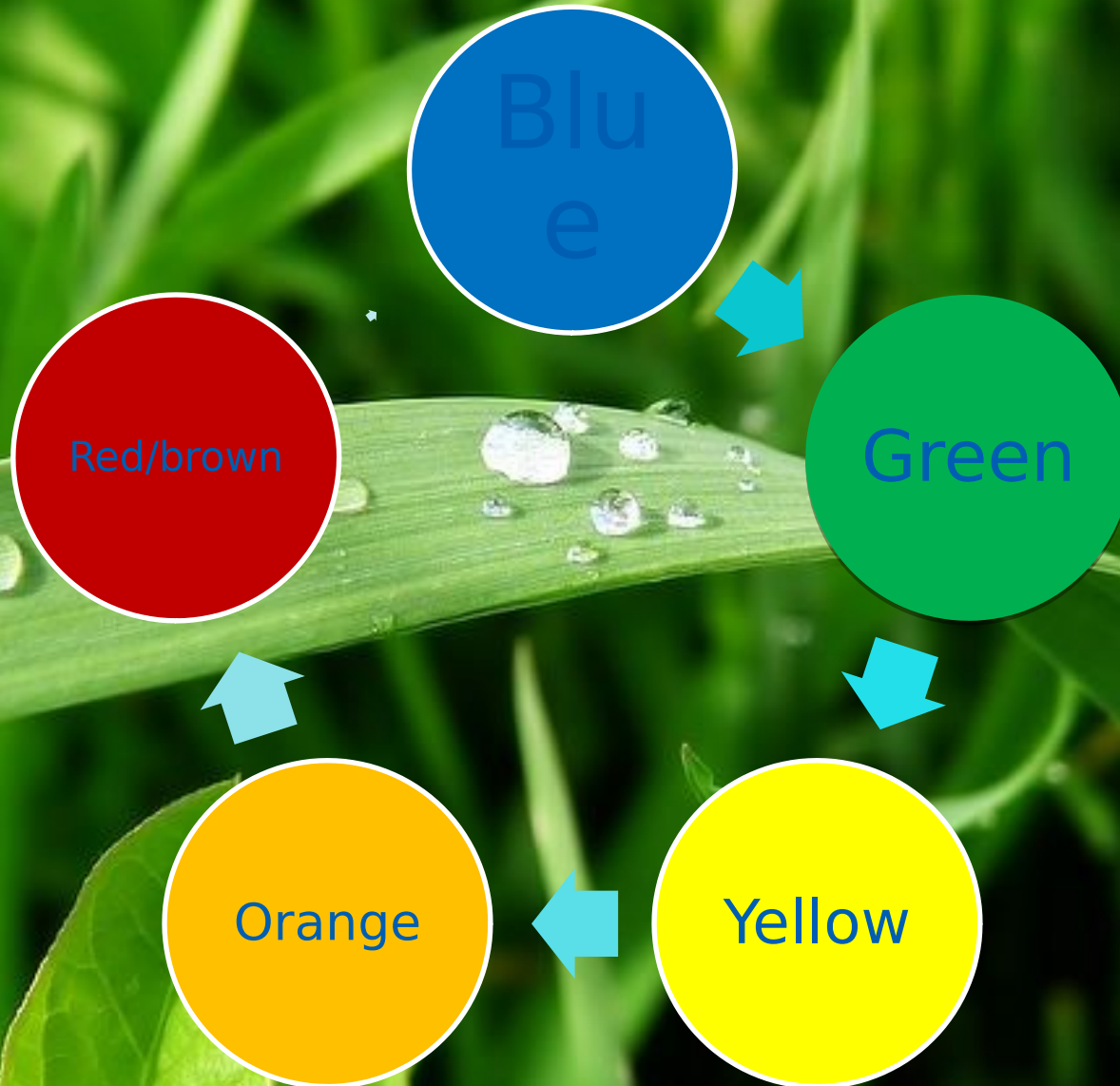
Negative Deductions are wrong

- Use positive deductions as much as possible; e.g.
- “*Starch is not present*” instead of “starch is absent”

REDUCING SUGARS TEST / BENEDICT'S TEST

- Place 2 cm³ of a solution of the food substance being tested in test tube
- Add equal amounts (2 cm³) of Benedict's solution.
- Heat to boil the resulting blue mixture
- The colour changes from *blue to green, then yellow, then orange, then red-brown precipitate.*

Colours of results



HOW DOES THE HUMAN BODY BENEFIT FROM THE FOOD SUBSTANCES?

- **Starch**
- **Benefits:** on oxidation release energy in the body
- **Explanation;** Starch is hydrolysed into glucose which in the cells is oxidized to release energy.

Continued

Reducing sugar

Benefit: on oxidation release energy to the body

Explanation; **Glucose** is oxidized in the cells to release energy

Non reducing sugars e.g. sucrose

Benefit: on oxidation release energy to the body

Explanation; **The** sugar is first hydrolysed into glucose /fructose which is then oxidized in the cells to release energy.

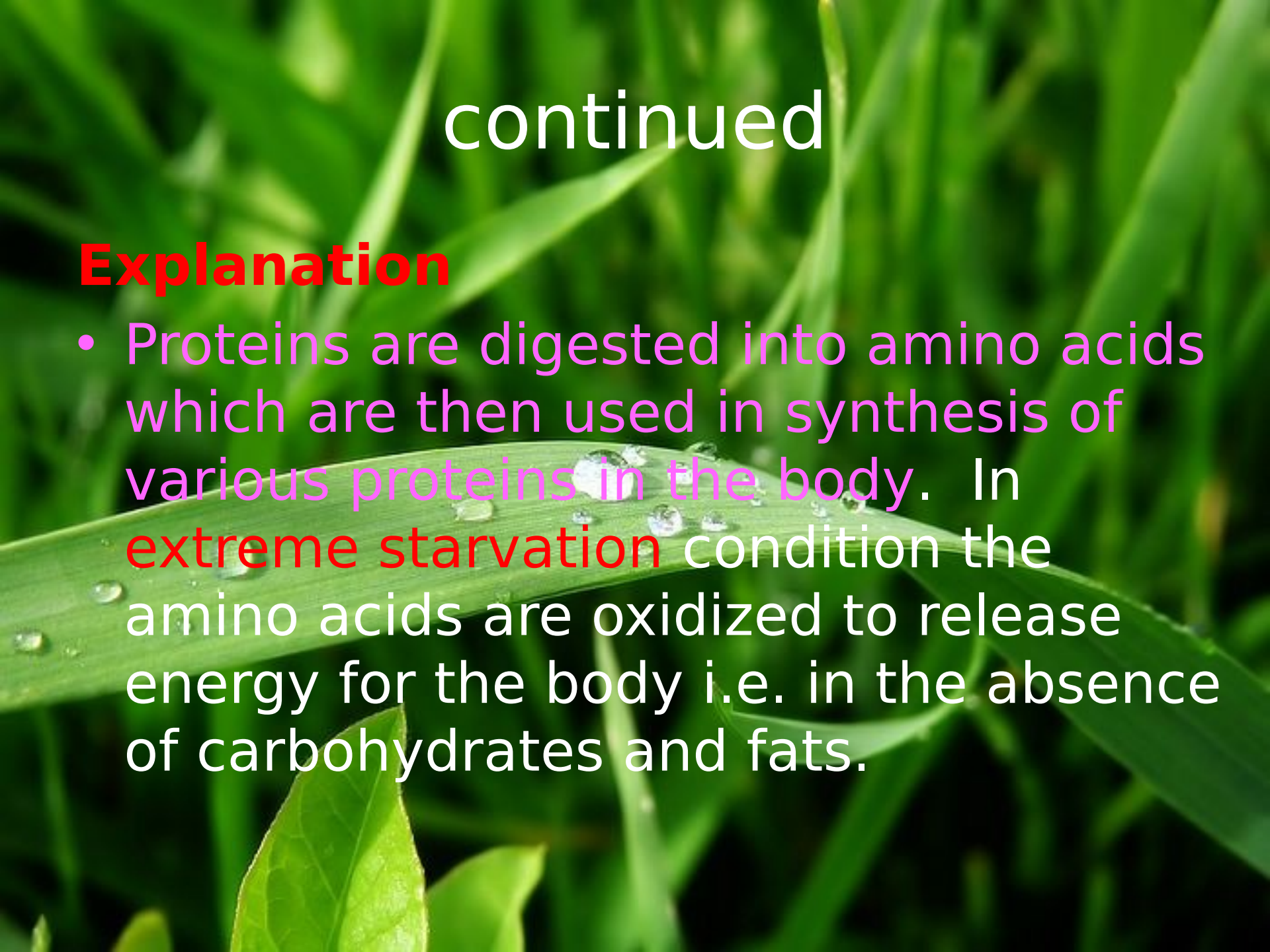


continued

Proteins

Benefit:

- ✓ Growth e.g. thyroxine hormone,
- ✓ Role in nutrition e.g. digestive enzymes,
- ✓ Respiration & transport, e.g. haemoglobin,
- ✓ Excretion e.g. urease in urea formation,
- ✓ Support & movement, e.g. collagen, actin/myosin,
- ✓ Sensitivity & coordination, e.g. rhodopsin,
- ✓ Reproduction e.g. prolactin,

The background of the slide is a close-up photograph of green grass. Several blades of grass are visible, some in sharp focus and others blurred. Small, clear dew drops are scattered across the surface of the grass blades, particularly on a prominent blade in the lower half of the image.

continued

Explanation

- Proteins are digested into amino acids which are then used in synthesis of various proteins in the body. In **extreme starvation** condition the amino acids are oxidized to release energy for the body i.e. in the absence of carbohydrates and fats.

continued

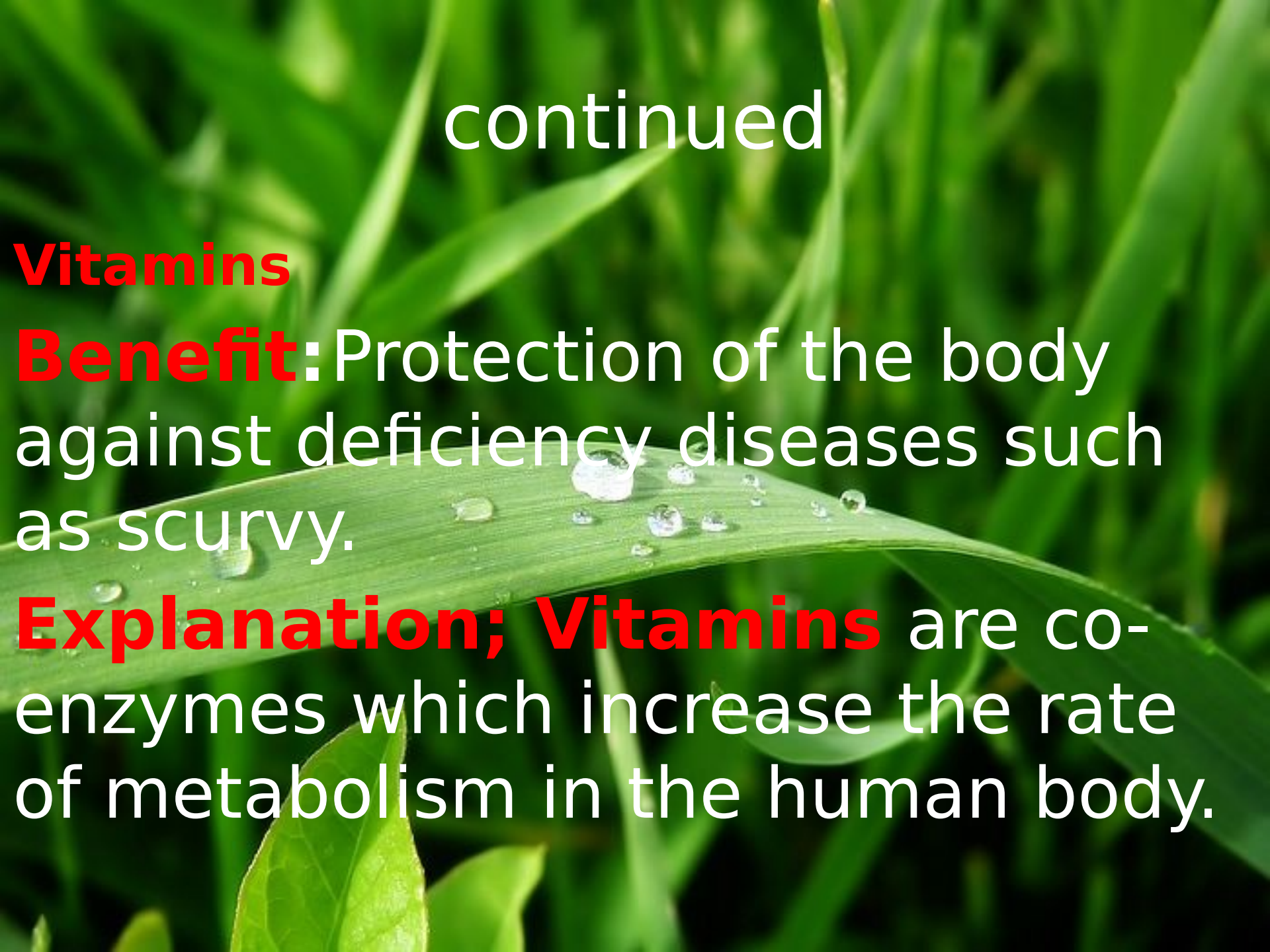
Lipids

Benefit:

- ✓ on oxidation provides energy to the body
- ✓ Insulation of the body from cold i.e. heat insulators

Explanation

- Fats are oxidized to release energy for the body (only in the absence of carbohydrates)
- Stored fats / adipose tissue provides insulation to the body.

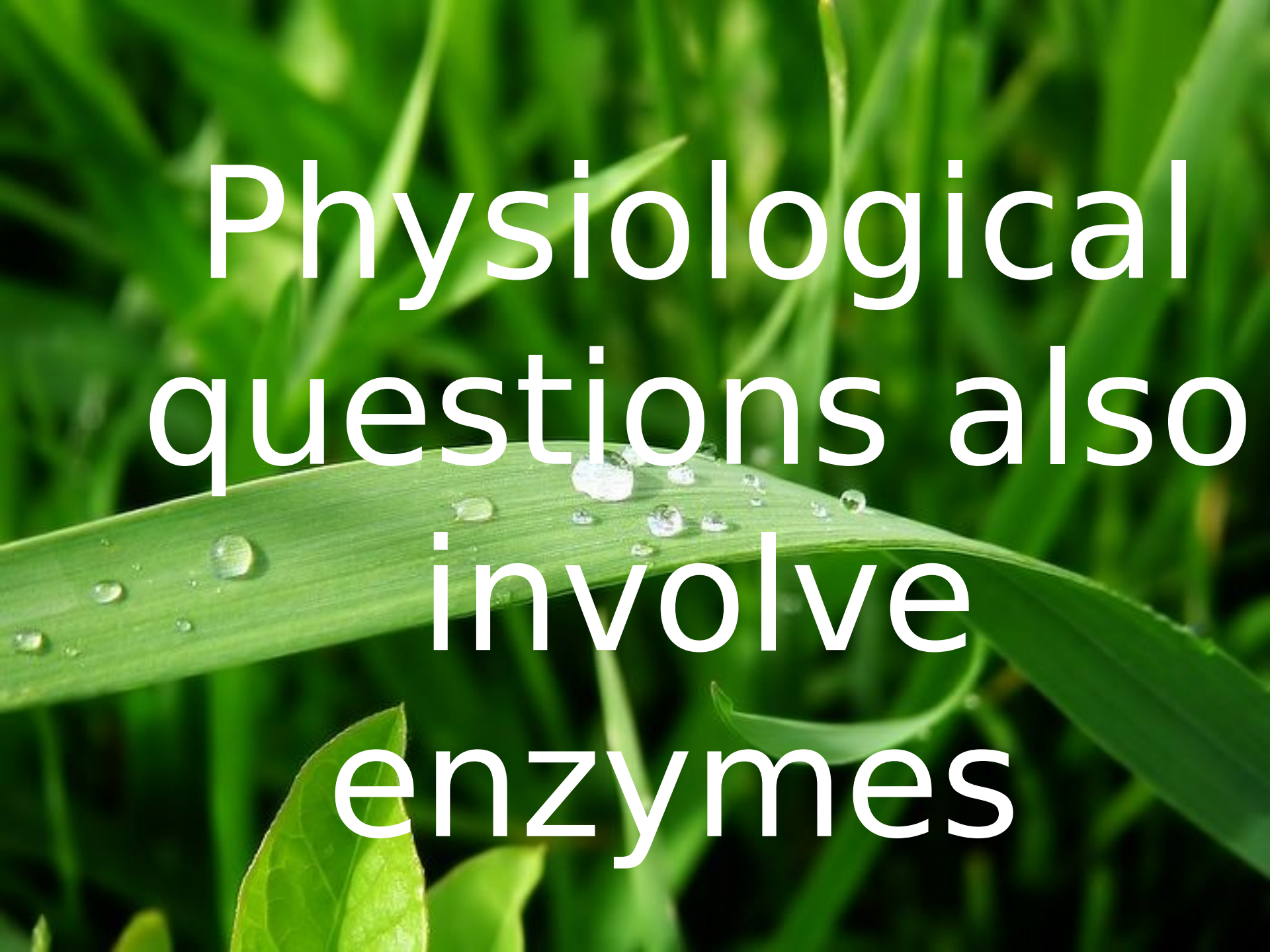


continued

Vitamins

Benefit: Protection of the body against deficiency diseases such as scurvy.

Explanation; Vitamins are co-enzymes which increase the rate of metabolism in the human body.



Physiological
questions also
involve
enzymes

Physiological questions involving enzymes

- Designed to test the student knowledge of enzymes,

Sources of enzymes may;

- **Biological tissues** like liver, germinating seeds, Irish potato tuber, intestinal content, onion bulbs, carrot tips, apple,
- **Bought industrially** made enzyme,

Enzyme based Questions involve;

- **Amylase** ; hydrolyze Starch (amylose) into maltose;
- **Sucrase (invertase)**; hydrolyze sucrose (cane sugar) into glucose & fructose;
- **Catalase**; converts hydrogen peroxide into water & oxygen;
- **Hydrogenase**; remove hydrogen to oxidize animal & plant tissue;

Areas tested in enzyme questions

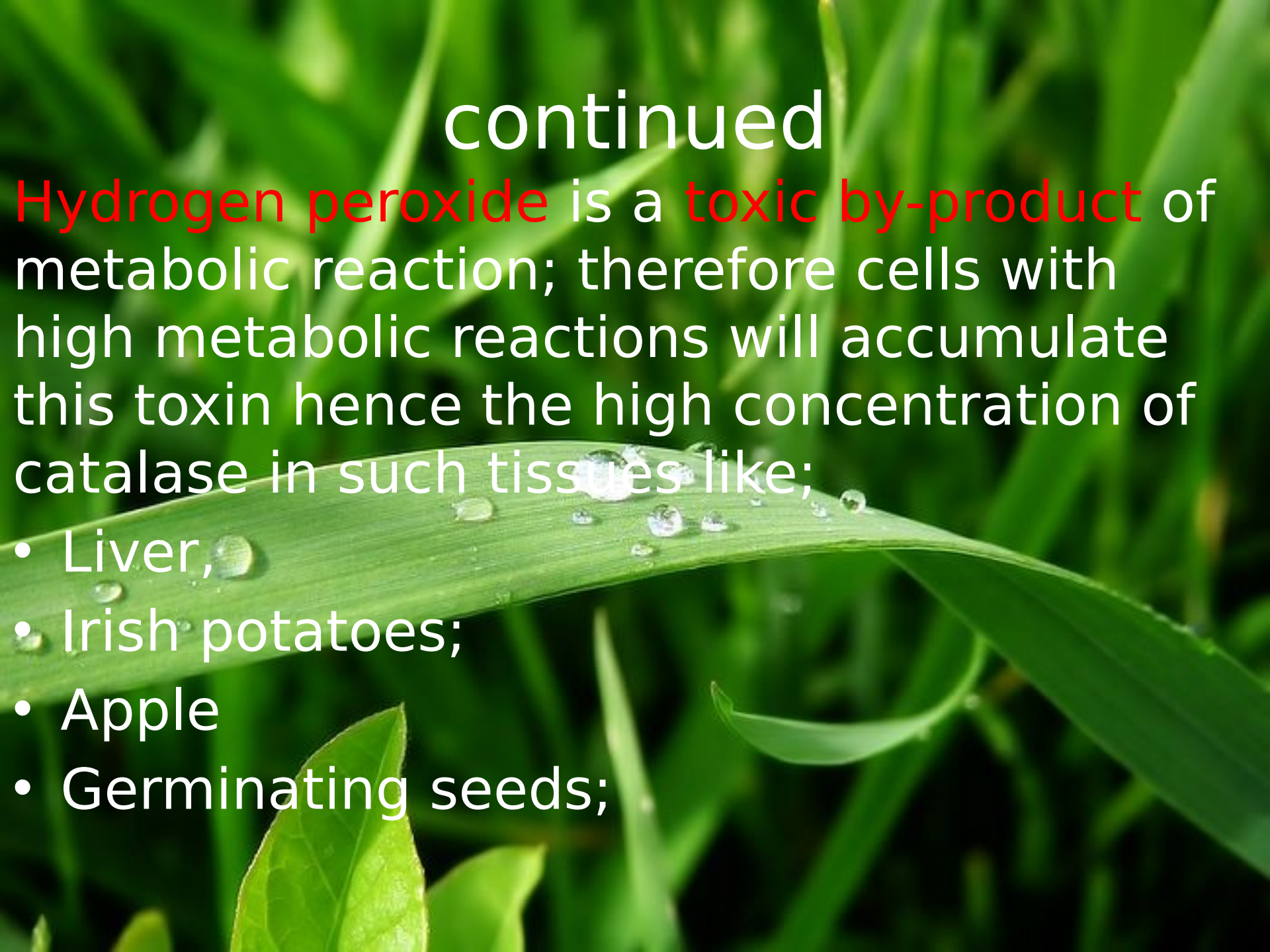
- Effect of **pH** on rate of reaction;
- Effect of **temperature** on rate of reaction;
- Effect of **enzyme concentration** on rate of reaction;
- Effect of **substrate concentration** on rate of reaction;
- Effect of **co-factors** on rate of reaction

Enzyme; Sucrase

- **Hydrolyzes** sucrose to fructose & glucose,
- Found in; insect guts; plant storage organs like sugar cane stem, carrot tap root,
- **Tested by testing** the production of reducing sugars using Benedict's reagent,

Enzyme; catalase

- **Hydrolyzes hydrogen peroxide** to water & oxygen;
- **Effervescences**; indicates oxygen production hence shows catalase activity;
- **Arise in temperature** also indicates catalase activity because the reaction is exothermic,

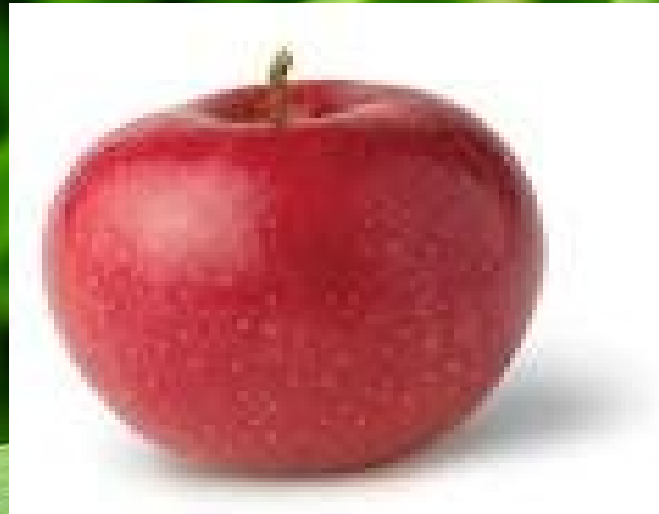


continued

Hydrogen peroxide is a toxic by-product of metabolic reaction; therefore cells with high metabolic reactions will accumulate this toxin hence the high concentration of catalase in such tissues like;

- Liver,
- Irish potatoes;
- Apple
- Germinating seeds;

Photos of the tissues



Enzyme; amylase

- Hydrolyzes starch to maltose;
- Disappearance of starch detected using iodine solution indicates amylase activity;
- Appearance of reducing sugar detected using Benedict's reagent indicates amylase activity too,

Effects of temperature on enzymes

- All enzymes have minimum, optimum & maximum temperature, depending on source;
- The effect of temperature to any enzyme controlled reaction is to double the rate of reaction for every 10°C increase, until optimum (most favourable).

Continued

- Temperature increase leads to high kinetic energy of enzymes & substrate,
- Above optimum temperature vibrations of the enzyme break hydrogen & disulphide bonds within leading to a change in the active site this is **denaturation**,
- Use a water bath to maintain a constant temperature,

Advantages of using a water bath in enzyme controlled reactions

- Easier control of temperature,
- Allow the candidate to pay attention parts of the question,
- Safer because test tube do not spurt out,
- Several solutions may be put in the same water bath,

Precautions in temperature effect on enzyme questions

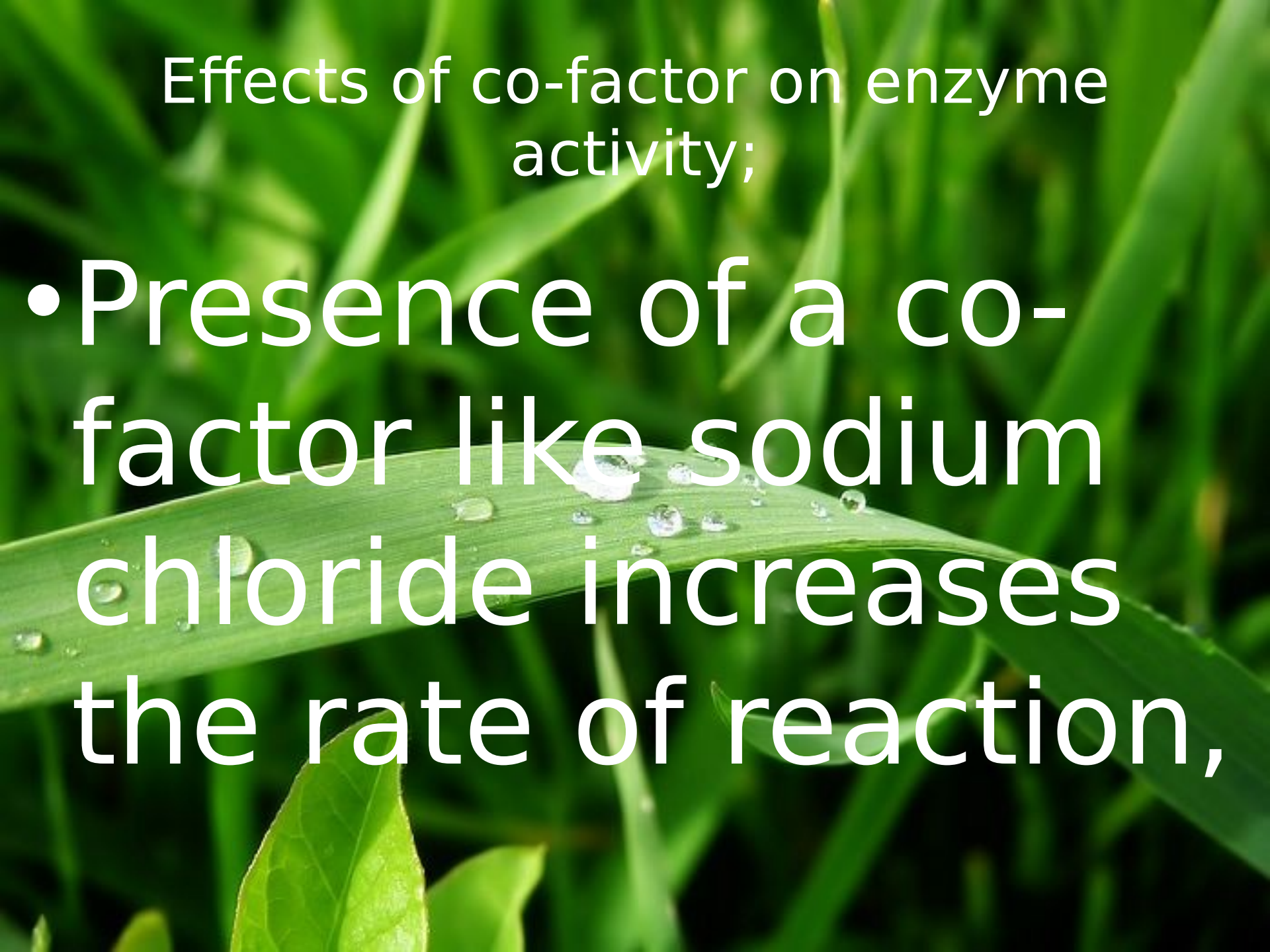
- Avoid heating hydrogen peroxide its unstable,
- Keep all other factors constant,
- Bring the enzyme & substrate solution to optimum before mixing,
- If the question does not specify the temperature to investigate then choose below optimum & above optimum,

Effect of pH on enzyme activity

- Every enzyme depending its source work at narrow optimum pH range,
- The enzyme activity reduces outside this optimum, because the enzyme gets denatured,

Common acid-base indicators

Indicator	Colour in acid medium	Colour in base medium
Litmus	Red	Blue
Phenolphthalein	Colourless	Pink
Methyl orange	Pink	Yellow
Bromothymol blue	Yellow	Blue

The background of the slide is a close-up photograph of green grass. Several blades of grass are visible, with numerous small, clear water droplets resting on their surfaces. The lighting is bright, creating highlights on the droplets and the grass blades.

Effects of co-factor on enzyme activity;

- Presence of a co-factor like sodium chloride increases the rate of reaction,

How to detect a practical question involving enzymes

- A practical question involving an enzyme has certain characteristics which should help one to discover even the type and name of the enzyme being used in the question.

suggested hints

Questions dealing with effect of temperature on enzymes;

- will involve **boiling** some of the materials **before** it is allowed to react
- **Boiling** is meant to **denature** the enzyme. This means that if the enzyme has been **denatured** it will not act on the substrate to **give** the products.

suggested hints

- the element of time in the experiment suggests enzyme reaction,
- The purpose of allowing the experiment to stay for 20 or 30 minutes is to give the enzyme time to work on the substrate.

suggested hints

- working with **two colourless** solutions in food tests, then likely one of them may be hydrolysing enzyme and the other the **substrate,**

suggested hints

- Mixing dilute HCL, or Na_2CO_3 with the a substance before allowing it to react with the second substance overtime,
- Suggests the testing of the effect of pH on an enzyme,

suggested hints

- the production of a gas during the experiment
- E.g. In the fermentation of glucose by Zymase enzymes, glucose is broken by the enzymes to form ethanol energy and carbon (IV) oxide gas which forms bubbles and when tested with calcium hydroxide solution it turns white ppt.
- Zymase enzymes are produced by yeast fungus.

suggested hints

- **the production of a gas during the experiment**

E.g. Decomposition of hydrogen peroxide by catalase enzyme

- If hydrogen peroxide is added to fresh animal or plant material, the catalase enzyme found in the tissue catalyses the breakdown of hydrogen peroxide forming water and oxygen gas which is given off as gas bubbles.

suggested hints

The catalase controlled reaction can be speeded up **by increasing the surface area of the plant or animal tissue** being used

e.g.

- By slicing the specimen into smaller pieces
- By crushing the specimen
- By powdering the specimen

Commercial applications of enzymes

- **Pharmaceutical industry;** catalase is used in wound dressings.

Catalase converts hydrogen peroxide in the dressing to oxygen and water. Oxygen speeds up healing and inhibits dangerous , anaerobic bacteria.

continued

- **Milk industry**; lactase hydrolyzes lactose in milk in the processing of milk free of lactose for lactose intolerant persons,
- **Textile industry**; leather for clothing is softened using a protease from bacteria
- Detergent industry ; stains are removed using lipase, amylase and protease



continued

- **Food processing;**
 - **protease** softens gluten, making the rolling of biscuits easier,
 - **Isomerase** converts glucose to fructose; this is sweeter so less needs to be used in slimmers' biscuits,
 - **Lipase** ;helps chocolate coverings to flow

**PHYSIOLOGIC
AL
QUESTIONS
INVOLVING
OSMOSIS**

Physiological questions involving osmosis include,

- Observe the texture of plant epidermal cells, in varying solutions,
- Measure length & mass of plant tissues,
- Observe a visking tubing texture,
- Use the data obtained to calculate % change in size & mass,

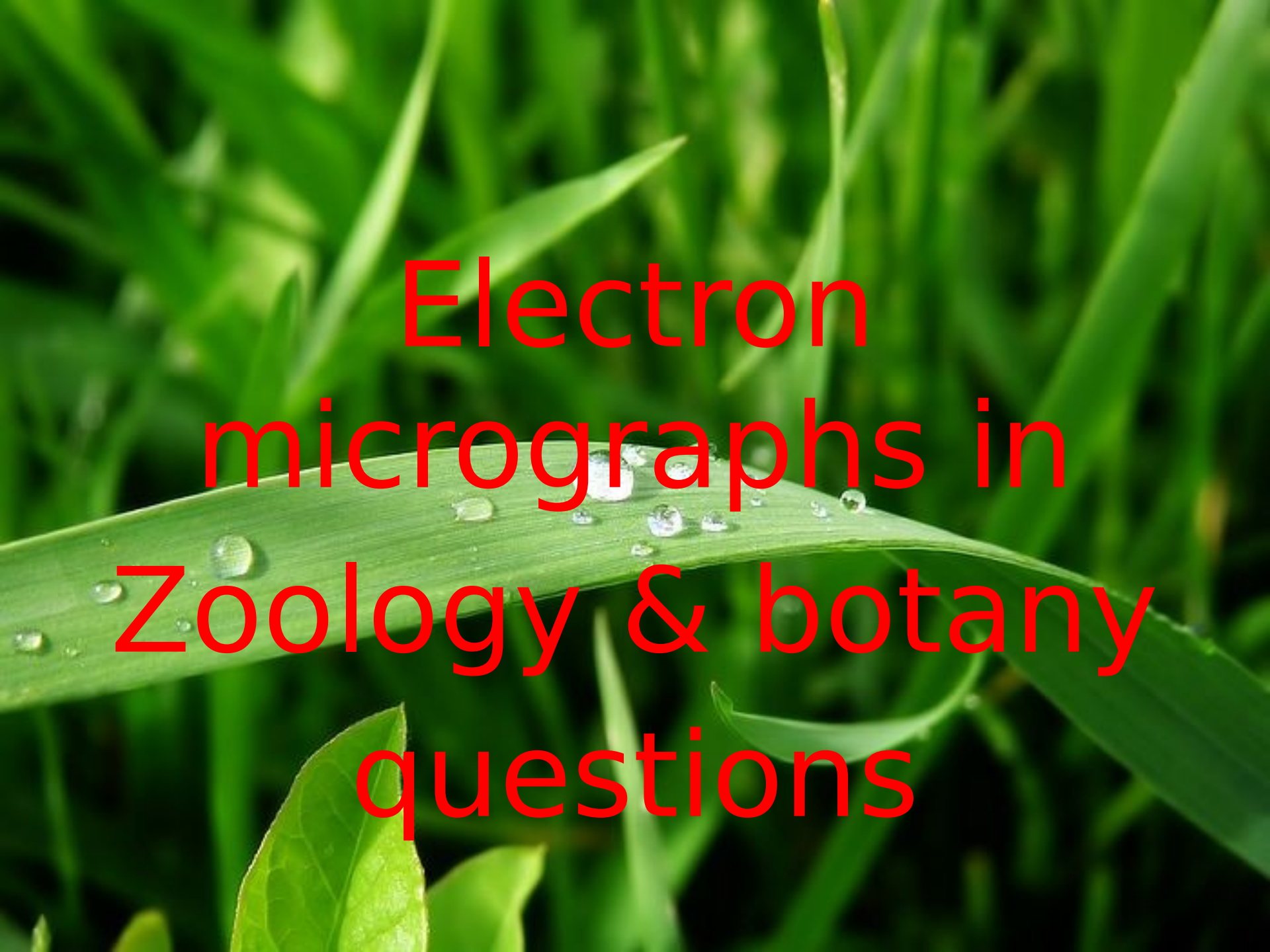
Osmosis questions

Designed to test;

- water relations of plant cells;
- Effects of hypotonic & hypertonic solutions on cells & tissue;

Plasmolysis of onion cells





Electron micrographs in Zoology & botany questions

Electron micrograph questions in botany or zoology

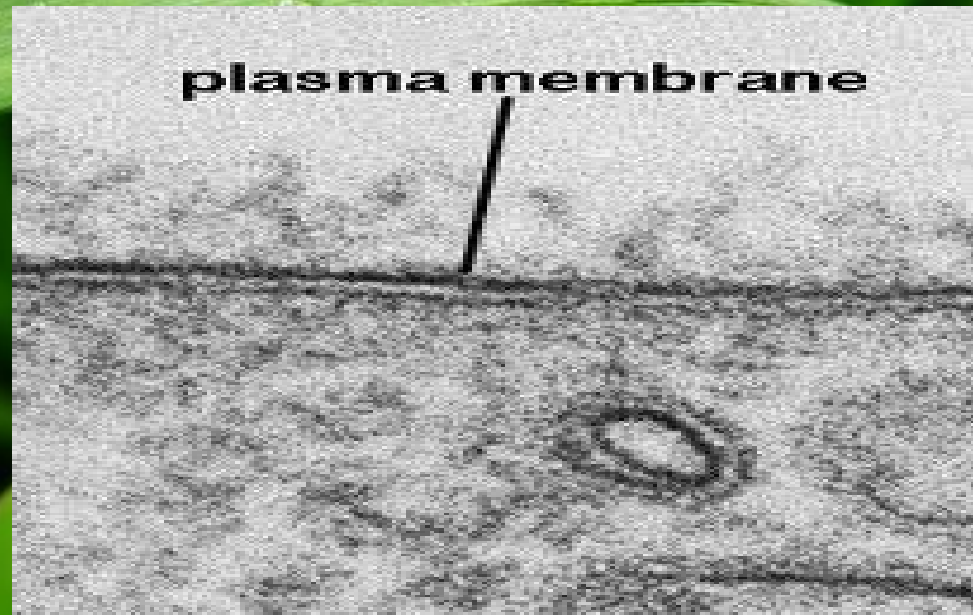
The evaluation will involve;

- Identification of organelles,
- State the functions of the organelles,
- Determine the size of organelles,
- Identify cell activity at the time of micrograph,

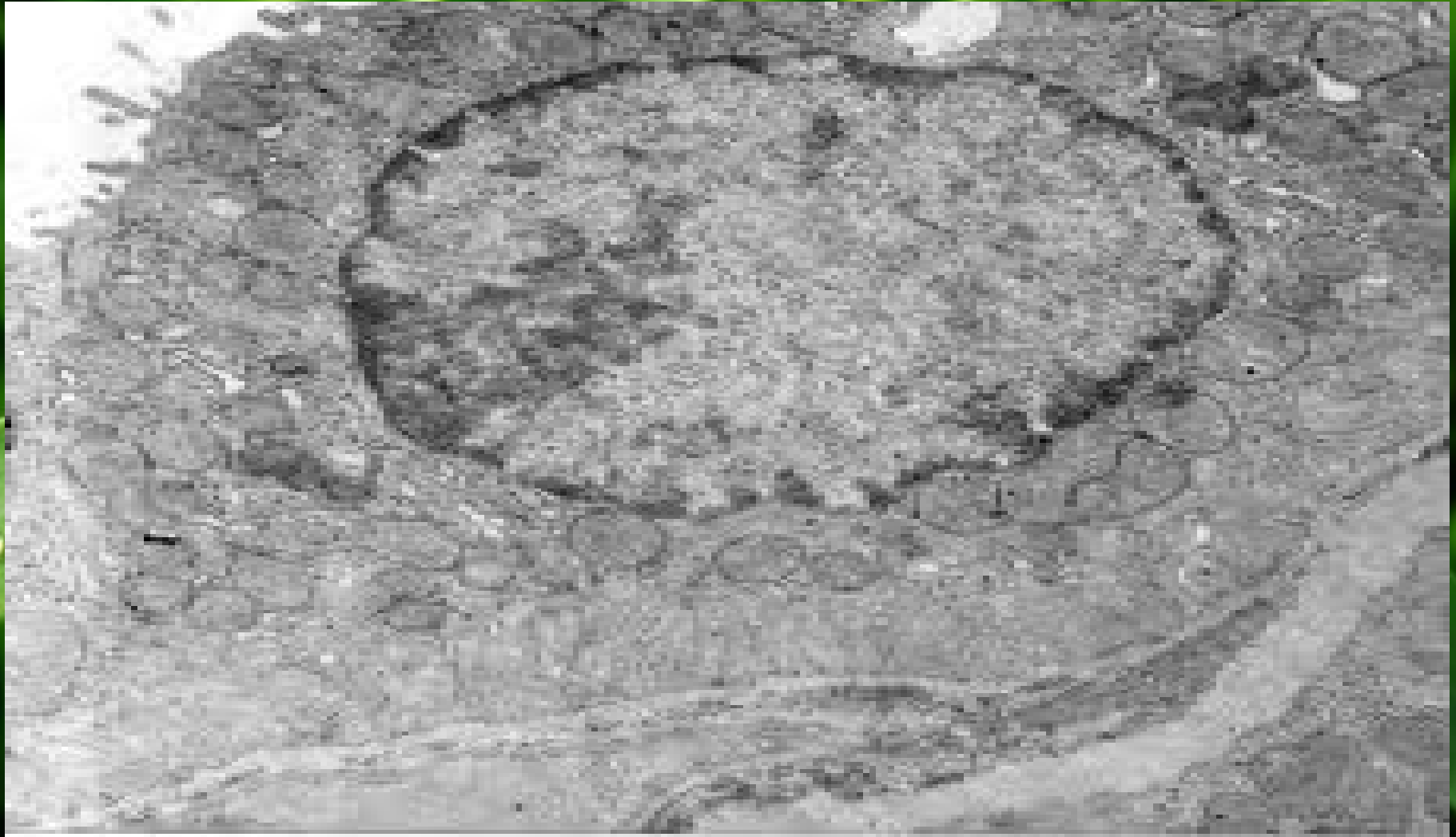
Hints on Identification of various structures in electron micrographs

Cell membrane will show as;

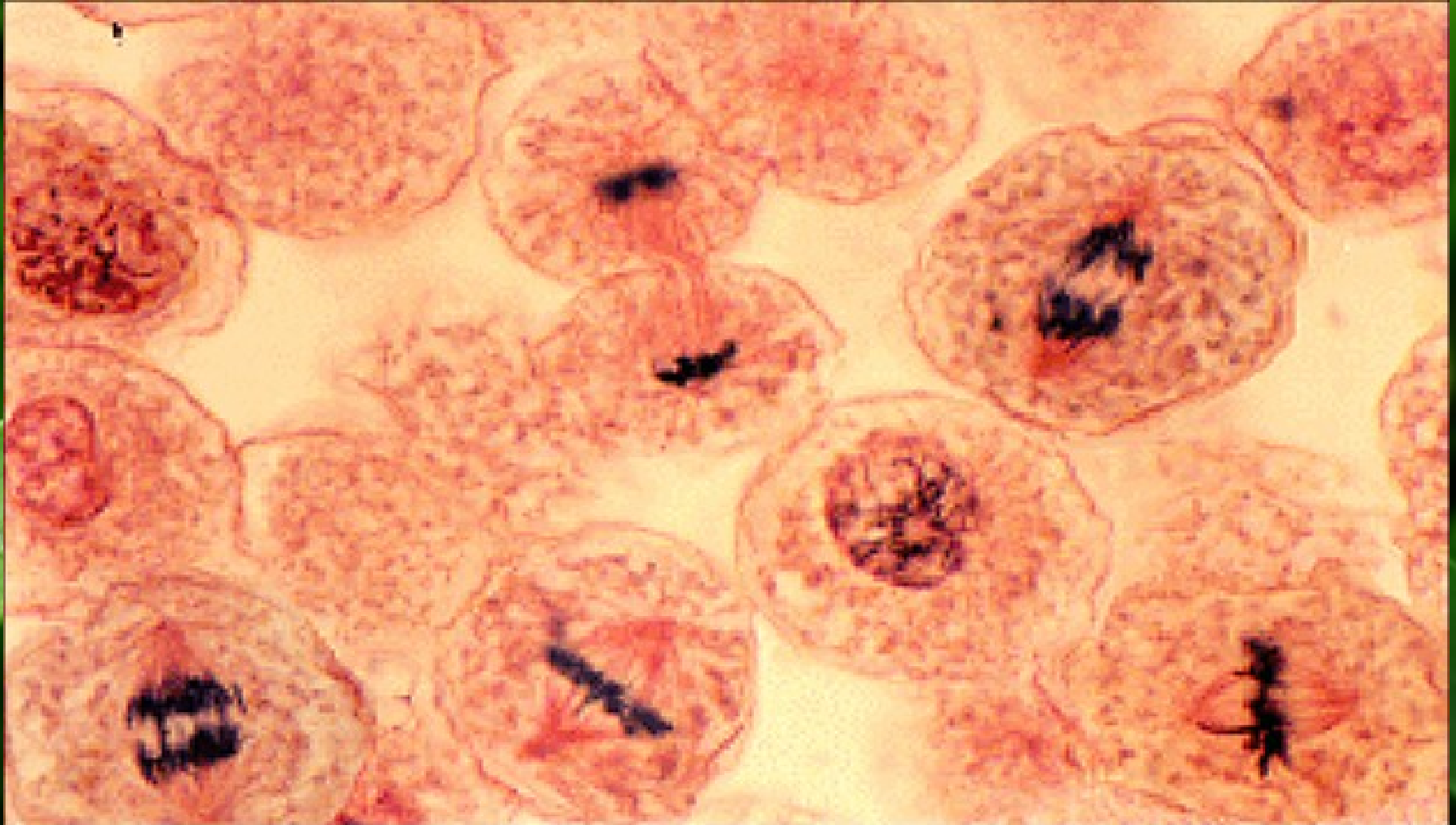
- two parallel dark lines (tramline appearance)
- Invaginations of phagocytosis & pinocytosis,



Identify the cell membrane



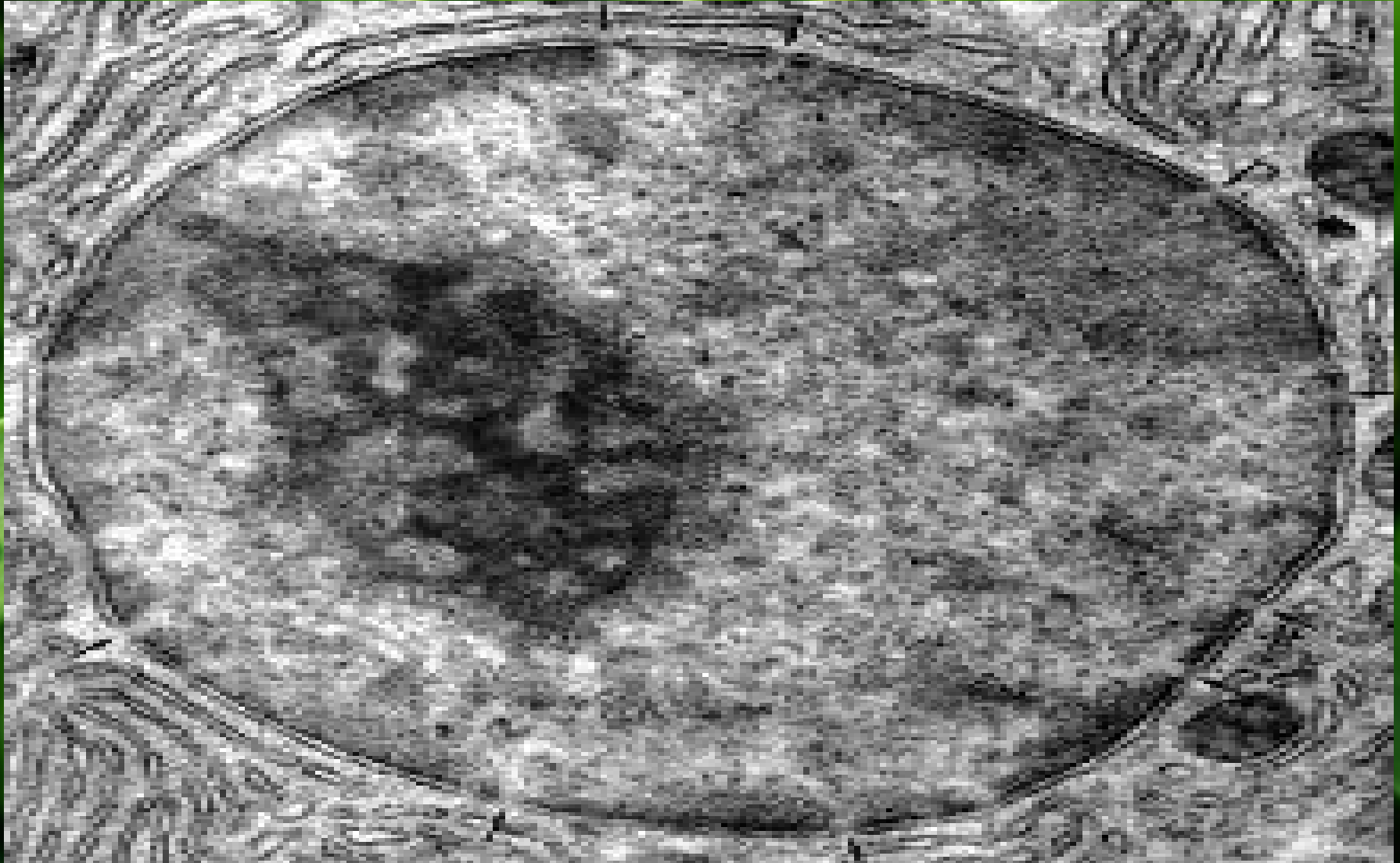
Identify the stages of cell division



Interpreting Nucleus micrograph

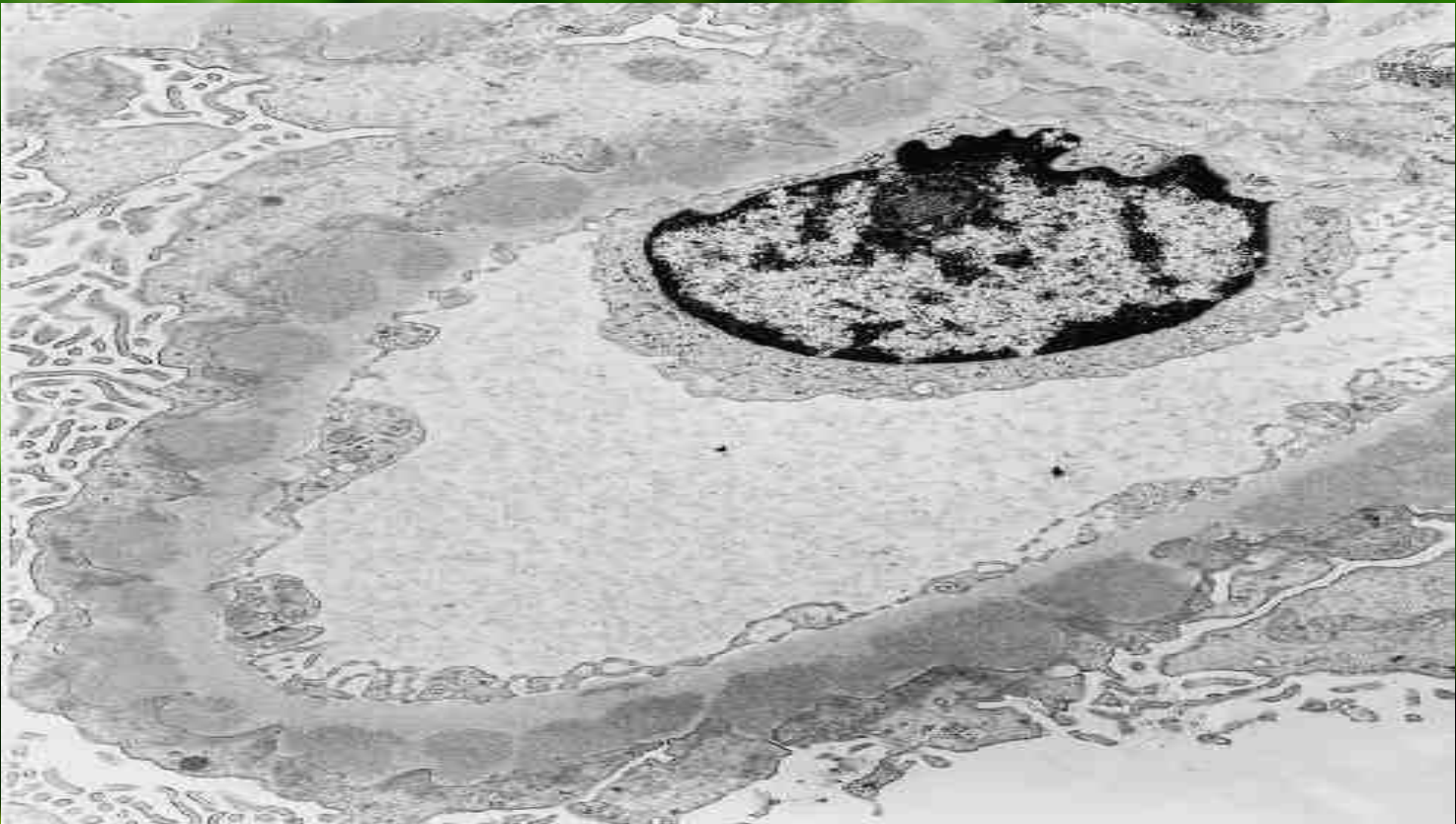
- **Nucleus** appears large & bounded by a double-layered membrane,
- **Nucleolus** appears circular part inside the non-dividing nucleus ,
- **Chromosomes or chromatids** appears dark,
- **Nucleoplasm** is lighter,

Identify the Nucleus parts



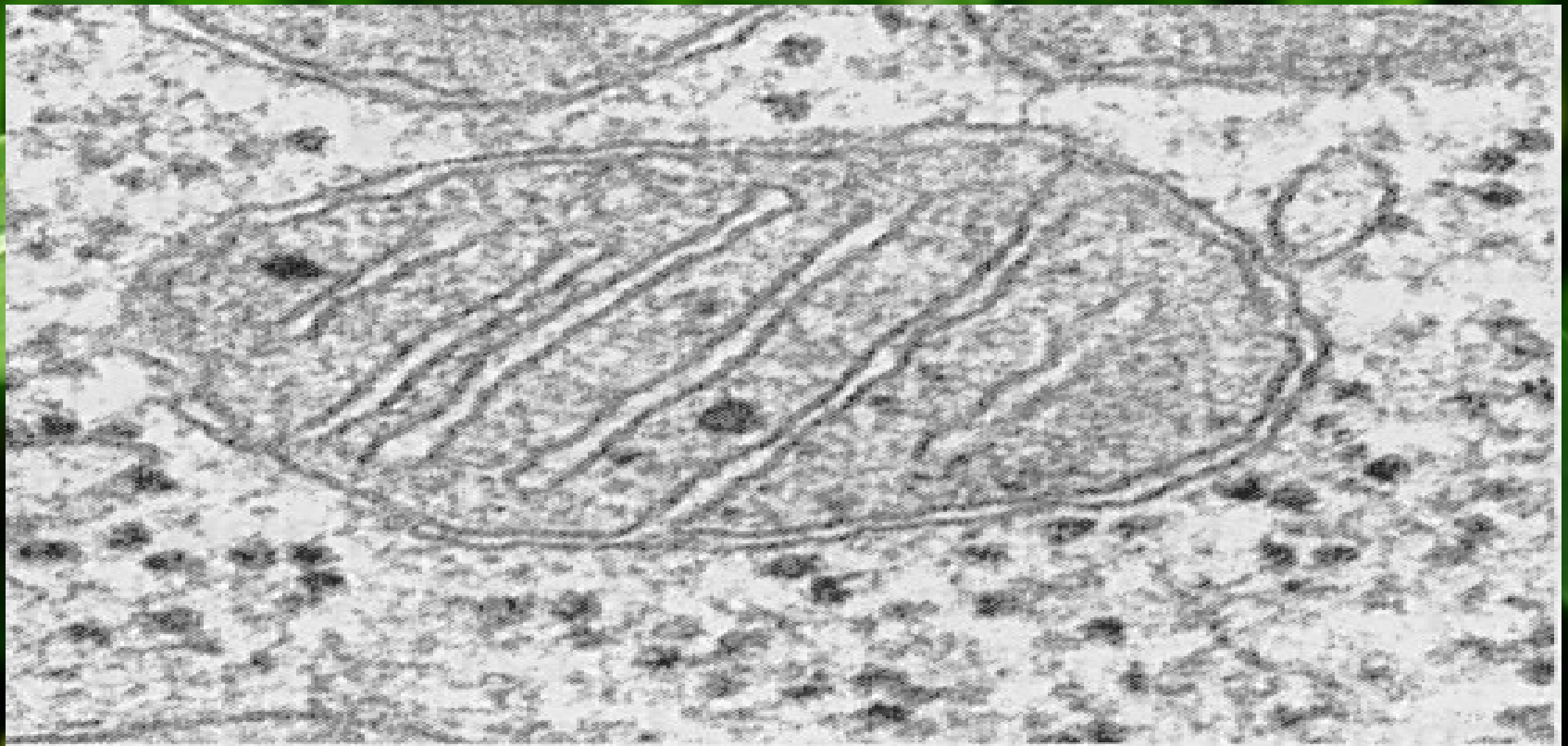
Interpreting cytoplasm micrograph

- Cytoplasm appears clear with dark spots scattered all over the cytosol.



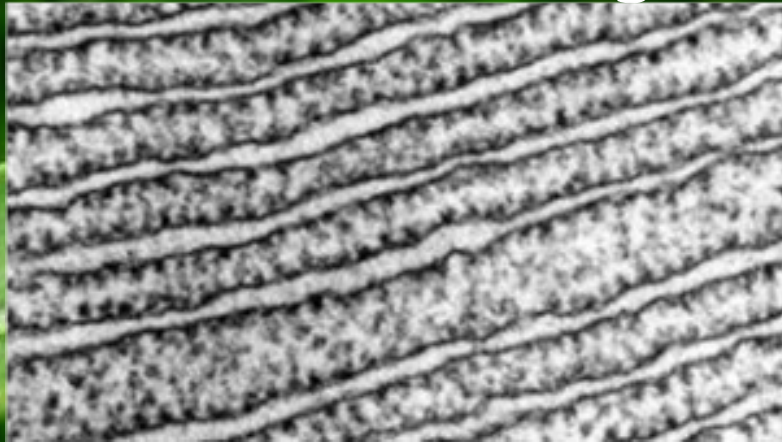
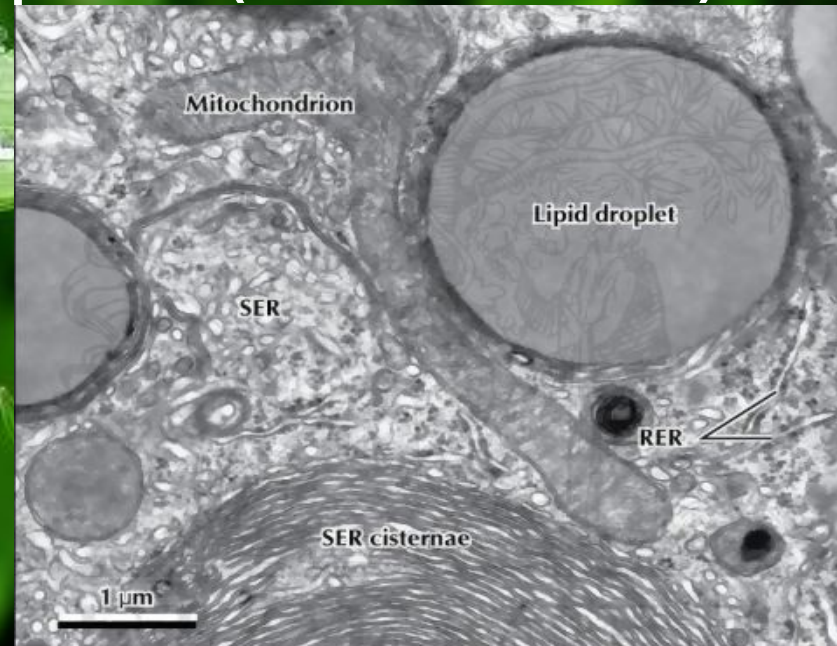
Interpreting mitochondrion micrograph

- Appear as dark shape with outer membrane surrounding an inner highly folded membrane.



Interpreting endoplasmic reticulum (ER) micrograph

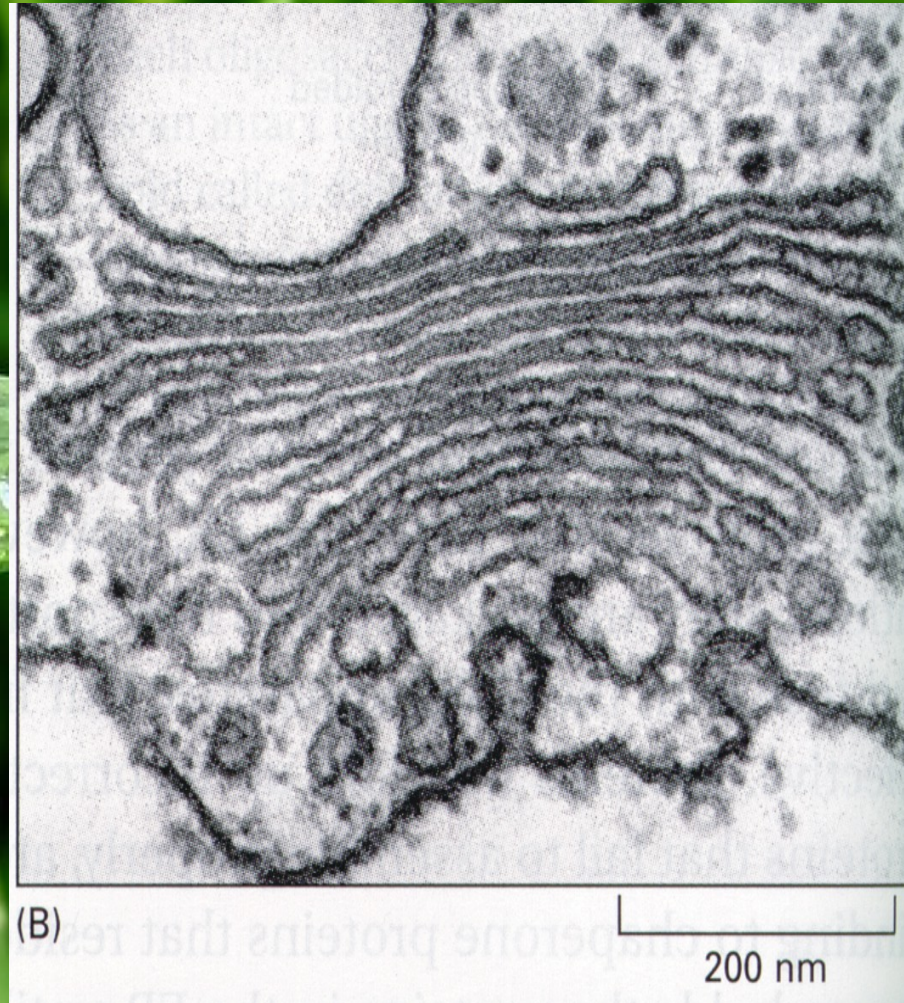
- Rough ER; Appear as double membrane extending from nucleus membrane marked with granular spots (ribosomes)



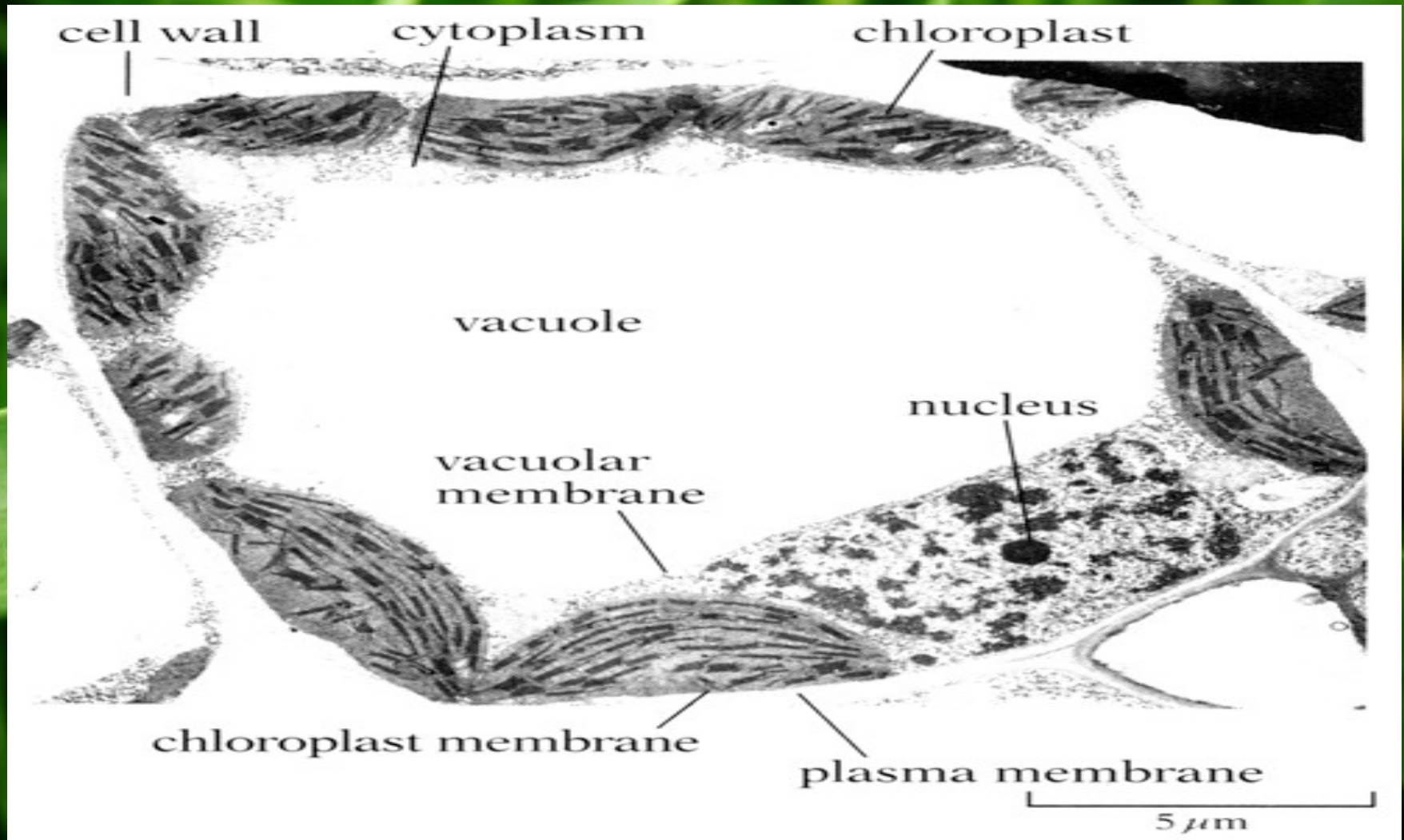
Smooth ER; appear as double membrane with a entire surface.

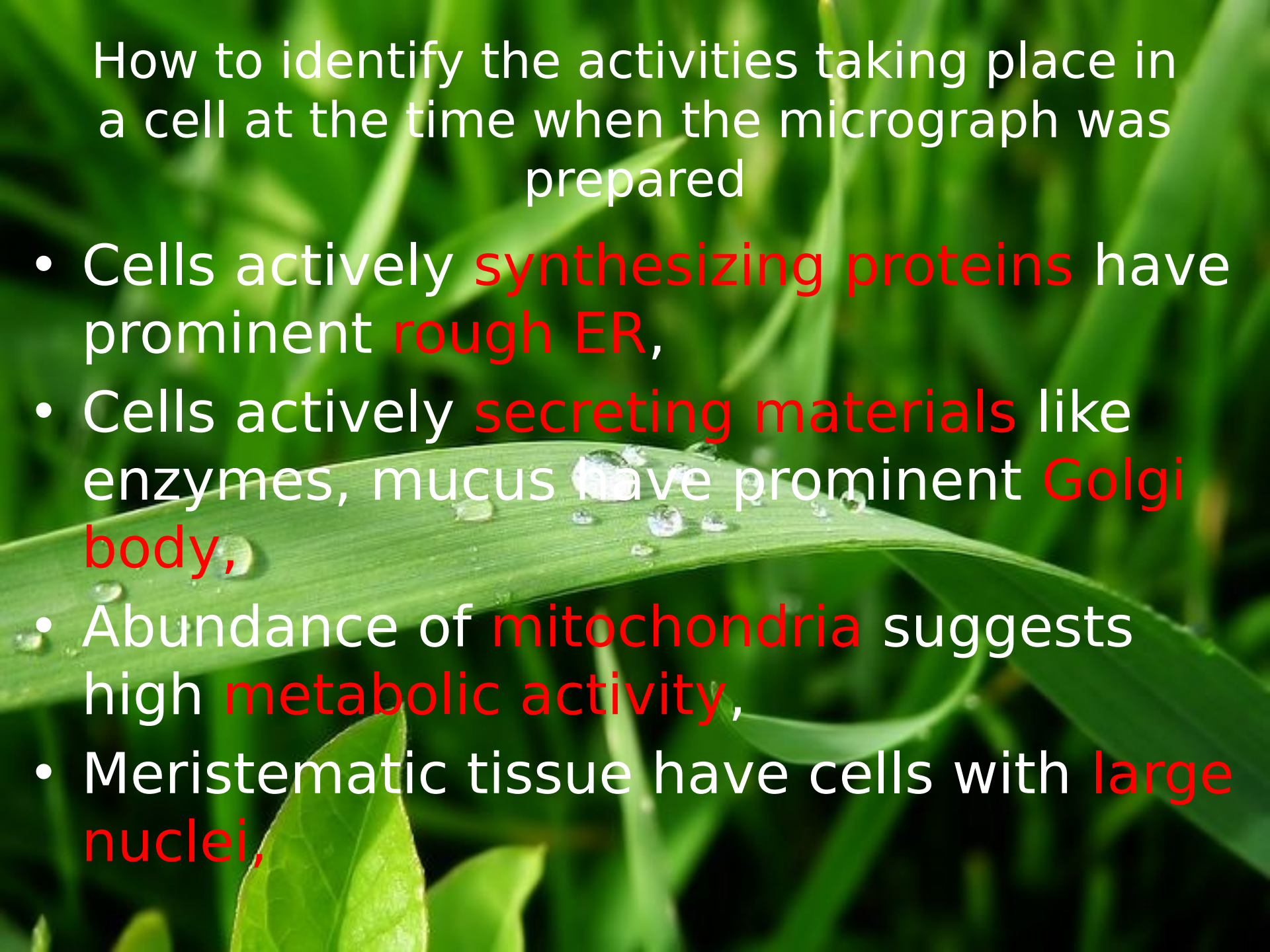
Interpreting Golgi apparatus micrograph

- Appear as flattened sacks packed together



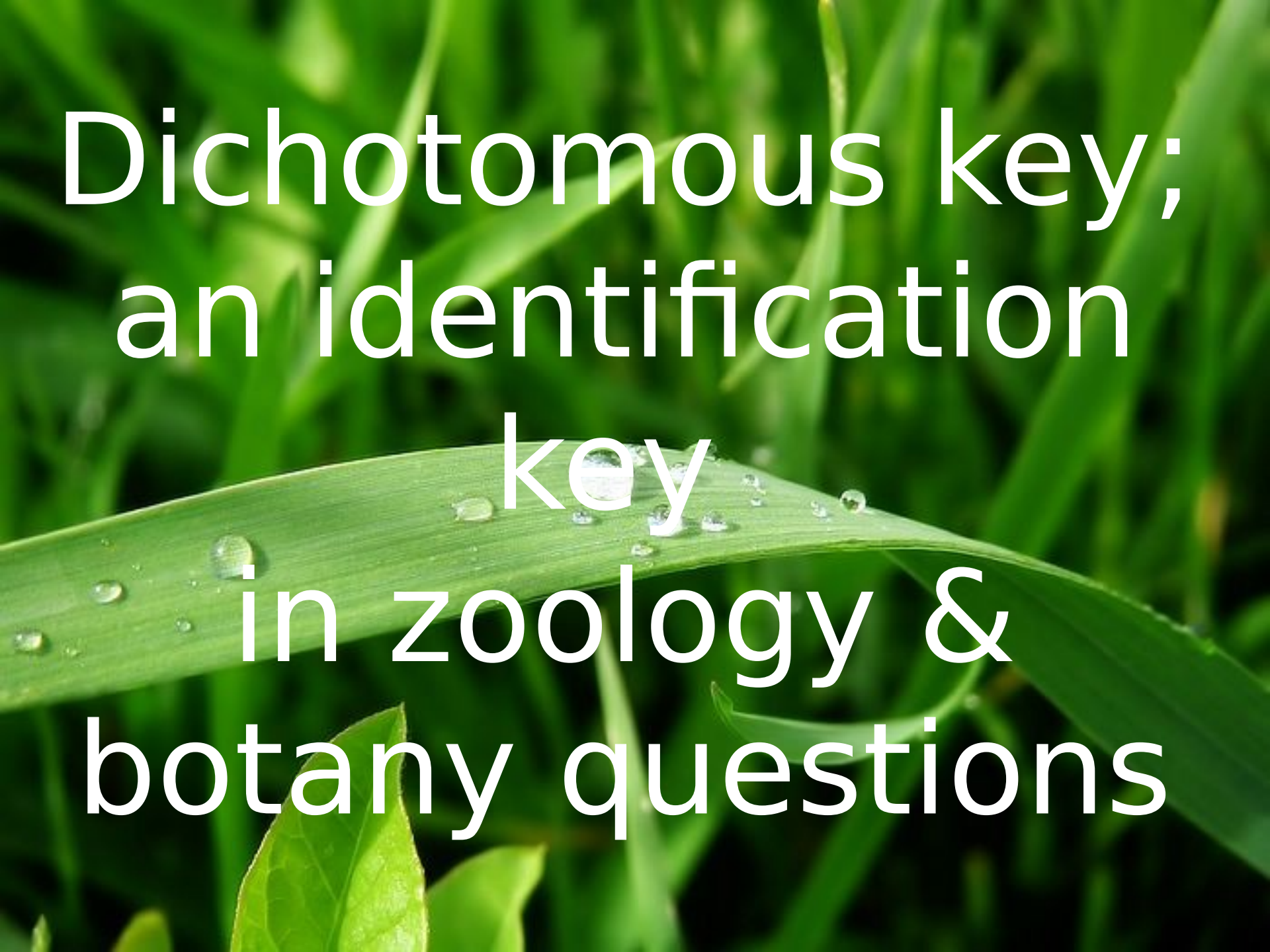
Interpreting cell vacuoles micrographs





How to identify the activities taking place in a cell at the time when the micrograph was prepared

- Cells actively **synthesizing proteins** have prominent **rough ER**,
- Cells actively **secreting materials** like enzymes, mucus have prominent **Golgi body**,
- Abundance of **mitochondria** suggests high **metabolic activity**,
- Meristematic tissue have cells with **large nuclei**,



Dichotomous key;
an identification
key
in zoology &
botany questions

Guidelines on how to use dichotomous keys

- Dichotomous keys consist of a series of **observable features** numbered and contrasting pairs called “leads”.
- To identify any organism read through the first pair statement and decide which fits the organism, if not follow the lead until you identify the organism.

Example



Use the photos with the dichotomous keys to identify the organisms

1. (a) head with antennae.....go to 2
 (b) head with no antennae....go to 3
2. (a) head with two pairs of antennae...go to 4
 (b) head with one pair of antennaego to 5
3. (a) body divided into a cephalothorax and abdomen with a definite waist at their junction.....spider
 (b) body divided into a cephalothorax and abdomen without a definite waist at their junction.....tick
4. (a) body covered by a hard chalky exoskeleton.....crayfish
 (b) Body covered by a delicate exoskeleton.....water flea
5. (a) has three pairs of walking legs.....grasshopper
 (b) Has many pairs of walking legs..... go to 6
6. (a) has one pair of legs in each segment.....centipede
 (b) Has two pairs of legs in each segment.....millipede

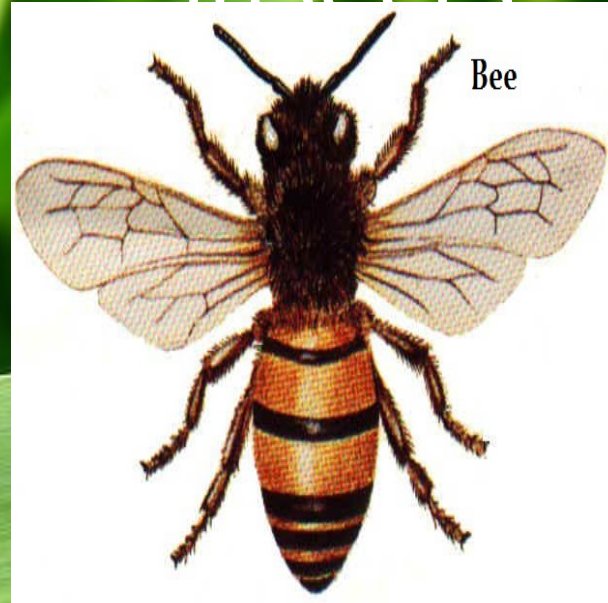
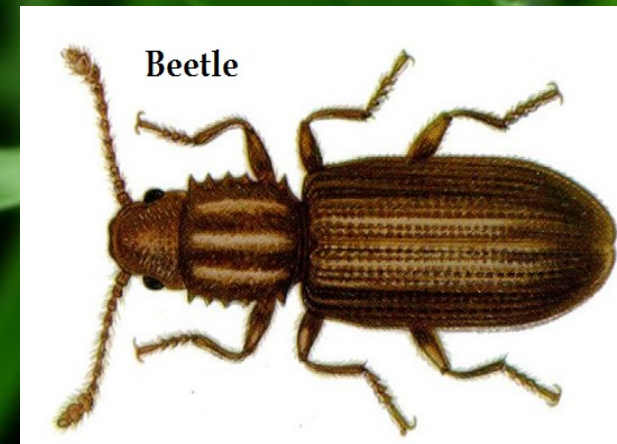
Complete this table

Specimen	Step followed	Identify
E	1a,2b,5a	grasshopper
F		
G		
H		
I		
J		
K		

Basic guidelines on construction of a dichotomous key

- Number of leads is equal to number of organisms minus one
- List the observable and taxonomic features of each specimen,
- The first feature used should divide the specimen into two proper taxonomic groups. E.g. venation type, cotyledon type, skeleton type,
- Use the other features to isolate the specimen from the rest of the group. E.g. leaf type, leaf margin type, number of legs,

Example; construct a dichotomous key to identify the following insects



Make a table of identifying features

features	butterfly	bee	Dragon fly	housefly	Louse
Wings	Present	Present	Present	Present	
Number of wings	Two pairs	Two pairs	Two pairs	One pair	
Nature of the wings	Scaly wings	All membranous	All membranous	Membranous	
Abdomen size	Medium size	Medium size	Long	Medium size	
Nature of the Body	Flattened body	Not flattened	Not flattened	Not flattened	

Constructed dichotomous key

1. (a) wings present.....go to 2
(b) Wings absent.....go to 7
2. (a) two pairs of wings.....go to 3
(b) One pair of wings.....house fly
3. (a) both pairs of wings membranousgo to 4
(b) Only the hind pair of wings membranous.....go to 6
4. (a) relatively long abdomen..... dragon fly
(b) Medium size abdomen.....go to 5
5. (a) both pairs of wings covered by coloured scales.....butterfly
(b) Wings not covered with scales.....bee
6.(a) front wings hard and shell-like.....beetle
(b) Front wings leathery.....grasshopper
7. (a) body dorsal ventrally flattened.....louse
(b) Body laterally flattened.....flea

Biology
illustrations
in
zoology & botany

Drawing vs diagram

- **Diagram** is a representation of an idea and not necessary an accurate record of reality.
- **Drawing** is an accurate record of a real

What examiners look for in a drawing

- Implements used; **use a pencil** only to draw and NOT ink.
- Best implements are;
 - » Sharp HB pencil
 - » soft eraser
 - » Ruler- to draw label lines
 - » New sharpener

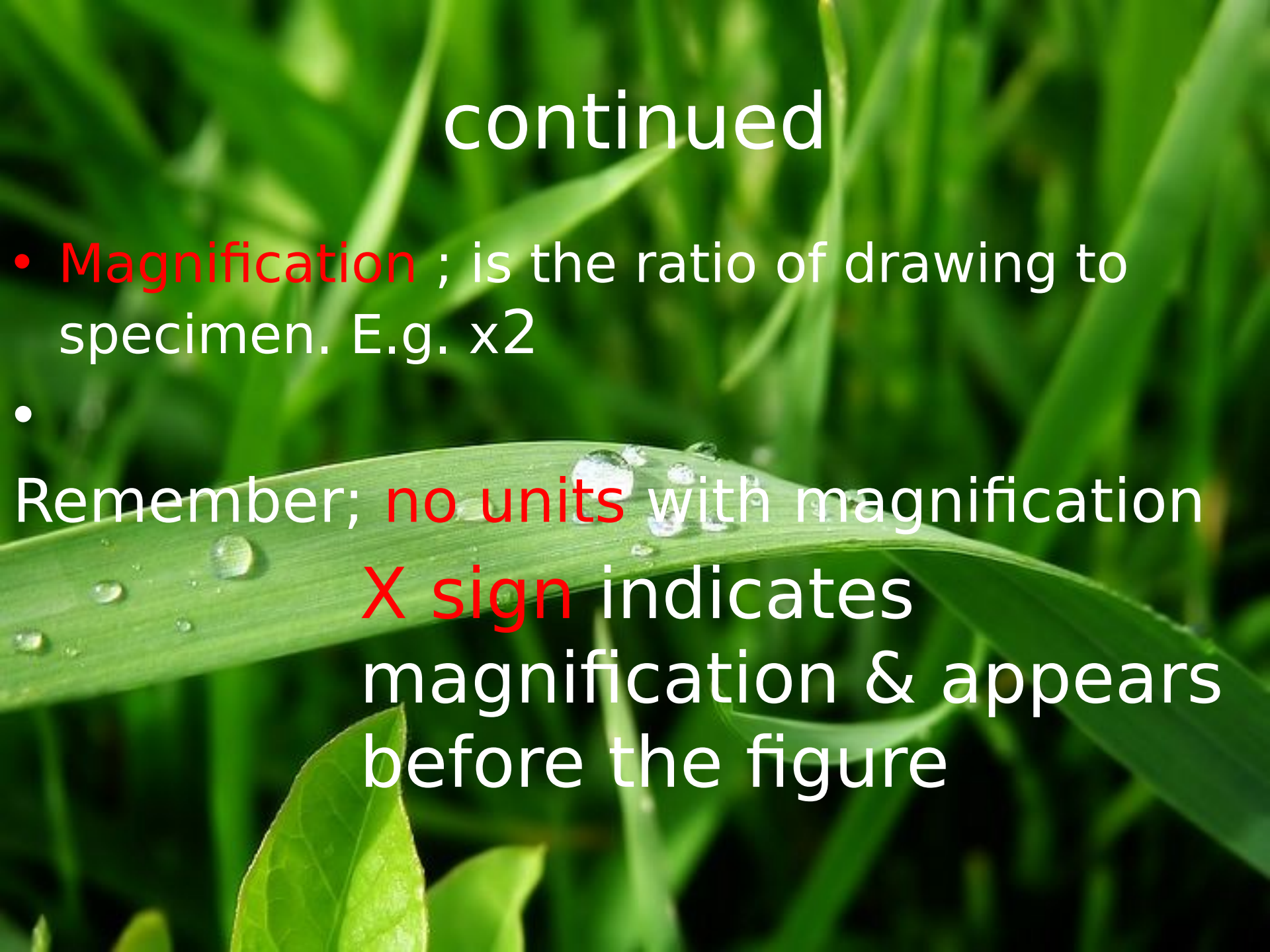
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- **Title or heading**; every drawing must have a title above or below the drawing.
E.g. parts of a leaf, cross-section of an orange fruit



continued

- **Size of drawing** ; correct size uses about 75% of space provided,
- *Smaller drawings suggest uncertainty, laziness and no need to be awarded marks*



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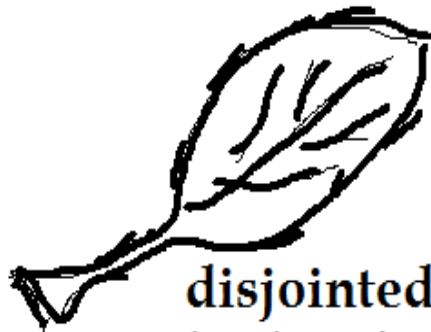
- **Magnification** ; is the ratio of drawing to specimen. E.g. x2

-

Remember; **no units** with magnification
X sign indicates
magnification & appears
before the figure

continued

- **Clarity of lines**; lines must be thin, continuous & freehand drawn.
- Avoid blurred lines, messy lines, line drawn over each other, and heavy lines.



disjointed, heavyline,
broken line, crossing over
each other

Clarity of lines continued

- The following should be drawn with double lines to show dimensions;
 - » Roots of plants
 - » Edges of longitudinally cut flowers
 - » Edges of cut fruits
 - » Filaments of stamens

Continued

- **Proportions;** reasonable representation of different lengths of the s



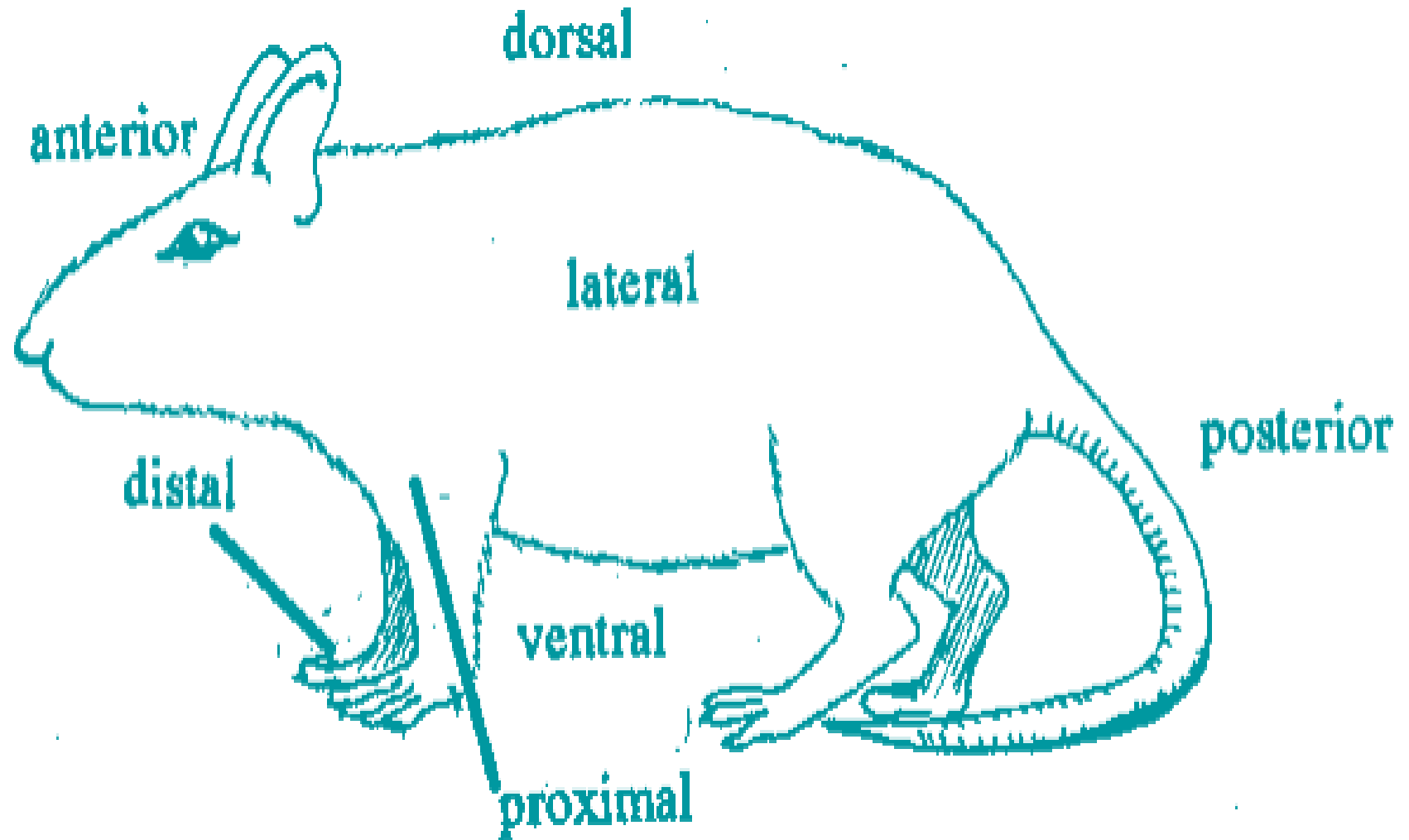
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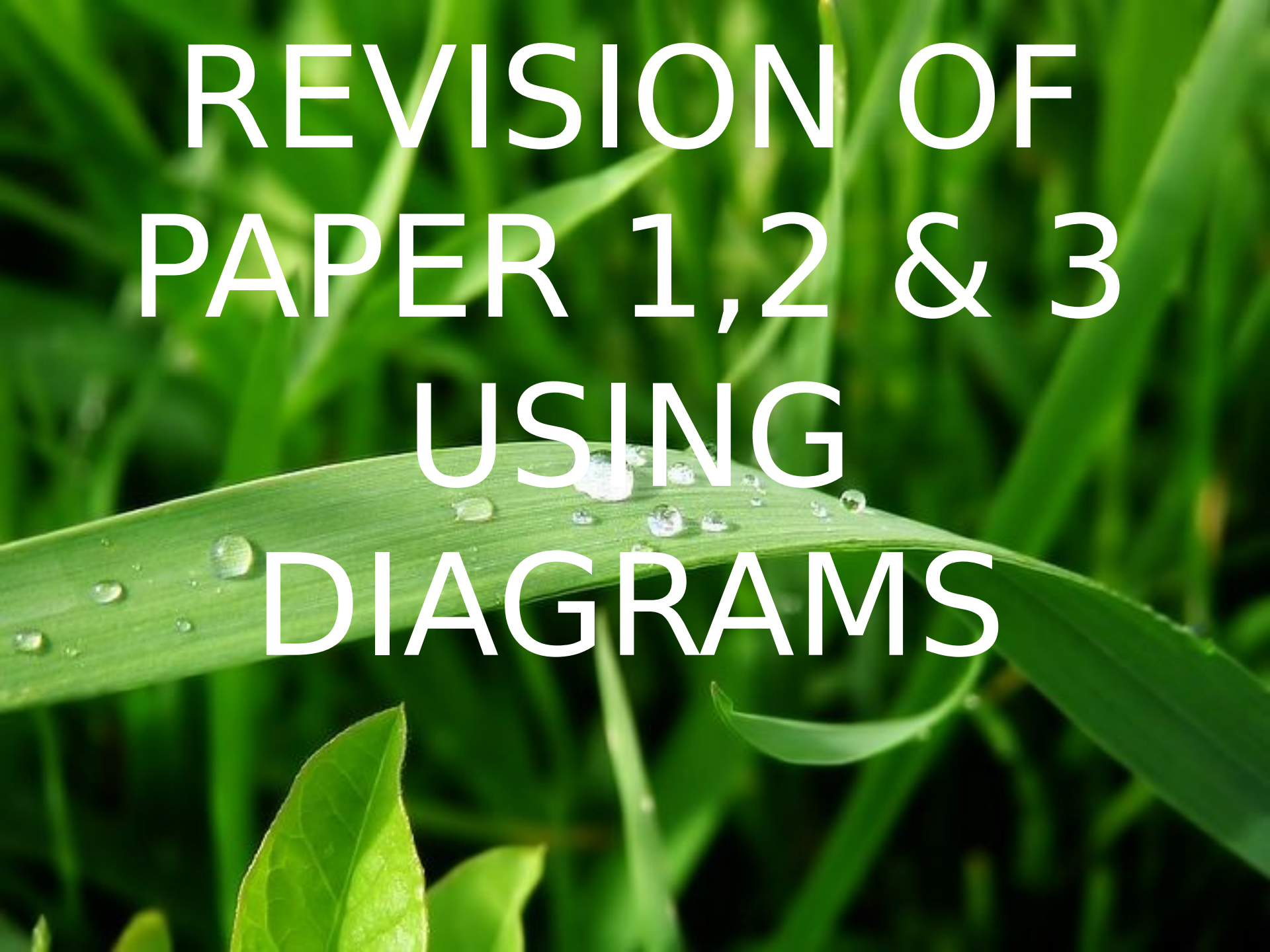
- **Neatness of labeling and labels;**
 - Draw all label lines with a ruler,
 - Label lines must never cross each other,
 - Label lines must be whole,
 - Label line must touch the part being labeled,
 - Label line are without arrow heads,
 - Fully label all parts of a drawing,
 - Use a pencil to draw label lines,
 - Use ink to write labels,

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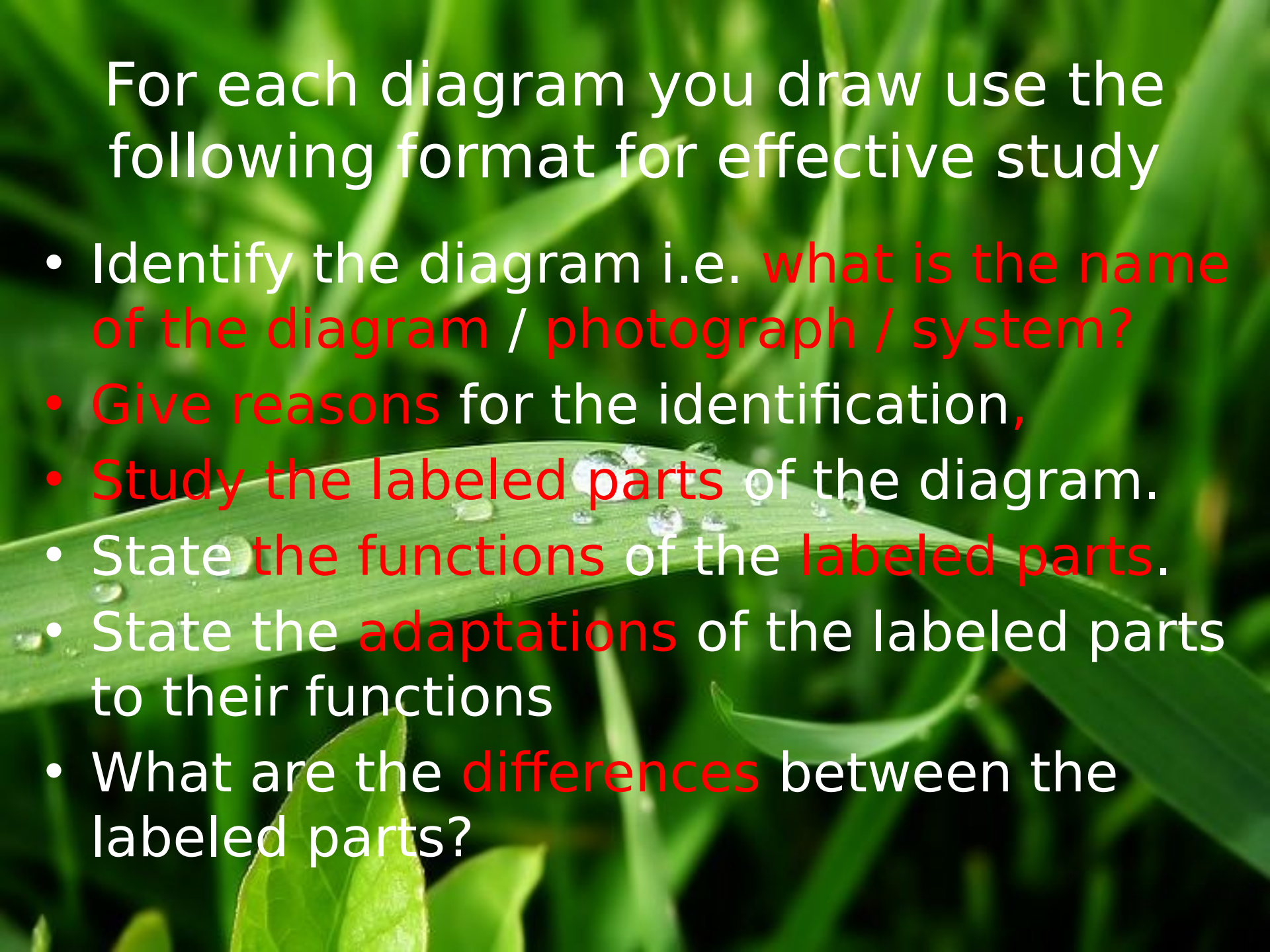
- **Accurate drawing**; drawing must show the true number of parts.
- Its wrong to draw twenty parts of a structure **while in reality they are ten.**
- Therefore;
 - Being keen to detail,
 - Draw what is seen,
 - Count up the structures,
 - Measure the parts and draw accurately

ANATOMICAL TERMINOLOGY





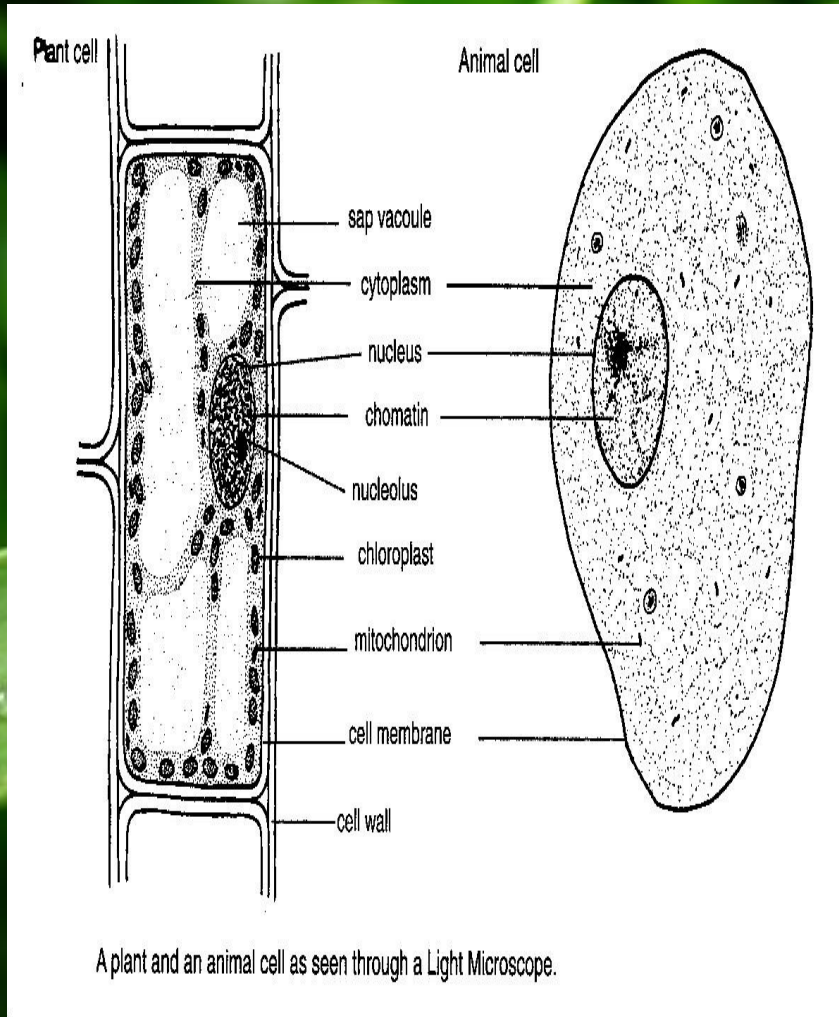
REVISION OF PAPER 1,2 & 3 USING DIAGRAMS



For each diagram you draw use the following format for effective study

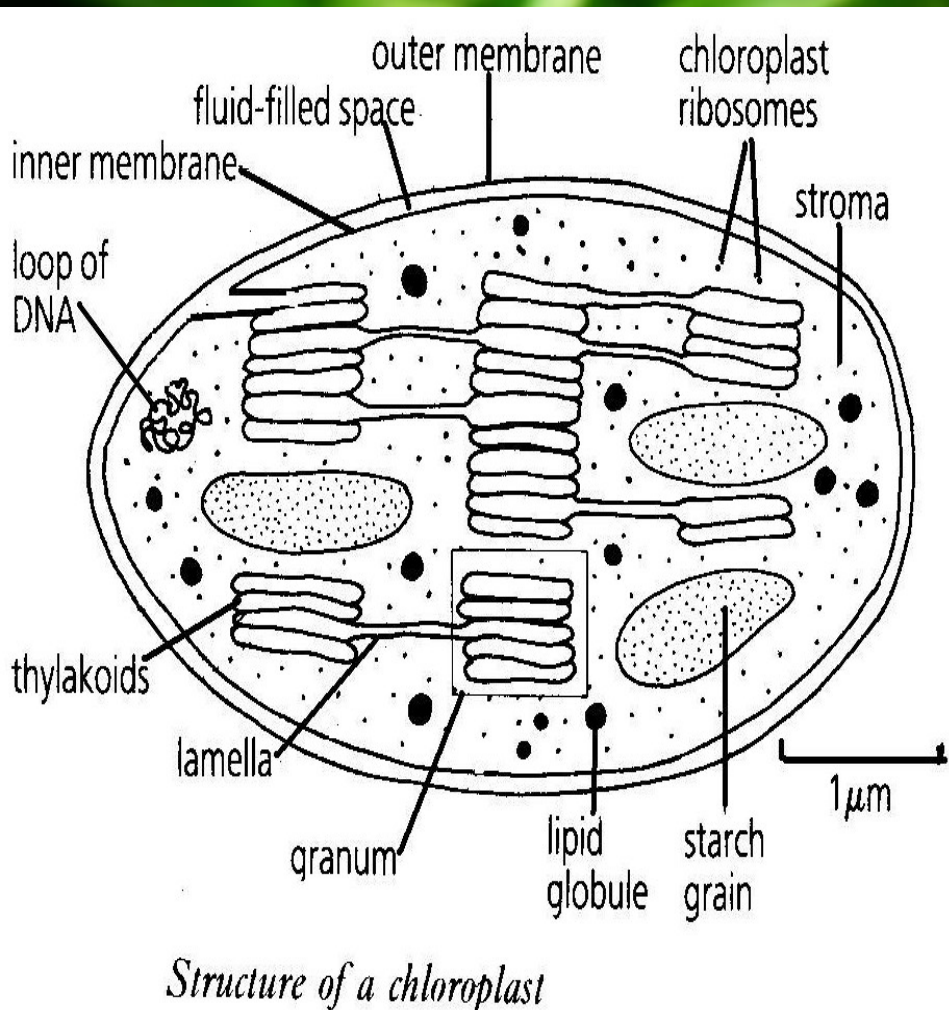
- Identify the diagram i.e. **what is the name of the diagram / photograph / system?**
- **Give reasons** for the identification,
- **Study the labeled parts** of the diagram.
- State **the functions** of the **labeled parts**.
- State the **adaptations** of the labeled parts to their functions
- What are the **differences** between the labeled parts?

EXAMPLE 1



- **Write the identification of the drawing or diagram (1 mark)**
- **Give the reason(s) for your answer in (a) above (3 marks)**
- **Label all the parts appropriately (4 marks)**
- **Give the function(s) of each part labelled in (c) above (4 marks)**
- **State the adaptation(s)/modification (s) of each of the structures labelled in (d) above (4 marks)**
- **State the distinguishing feature(s) of each structure labelled in (d) above (4 marks)**

EXAMPLE 2



- **Write the identification of the drawing or diagram (1 mark)**
- **Give the reason(s) for your answer in (a) above (3 marks)**
- **Label all the parts appropriately (4 marks)**
- **Give the function(s) of each part labelled in (c) above (4 marks)**
- **State the adaptation(s)/modification (s) of each of the structures labelled in (d) above (4 marks)**
- **State the distinguishing feature(s) of each structure labelled in (d) above (4 marks)**



THANK YOU
FOR
YOUR TIME