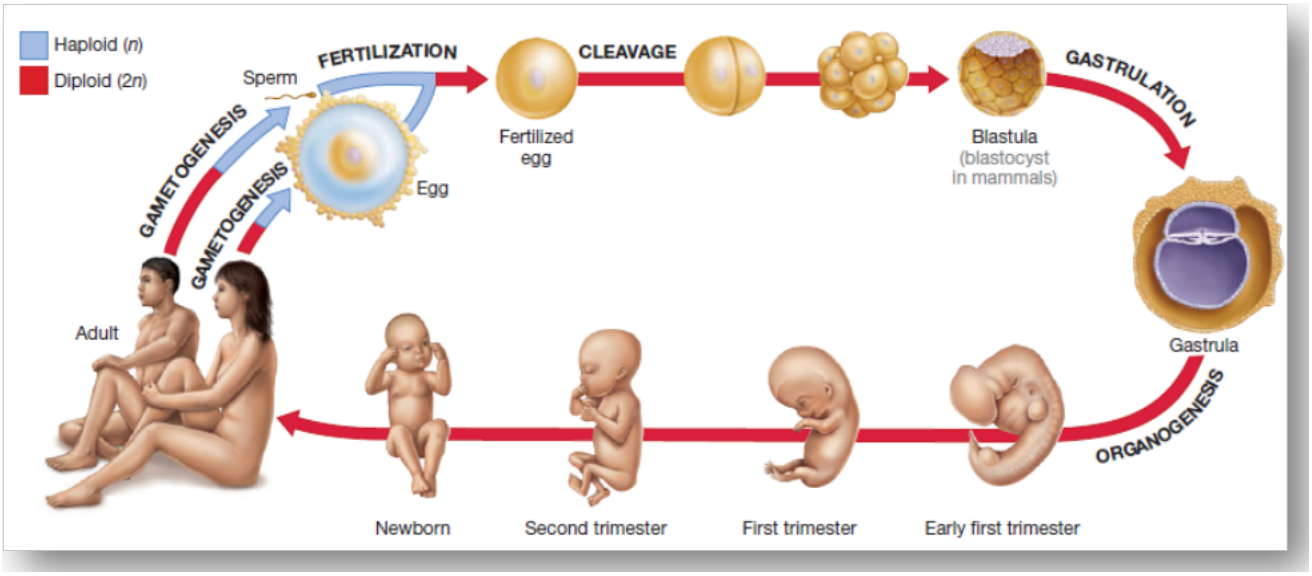
THEME: GROWTH IN PLANTS AND ANIMALS

TOPIC: GROWTH AND DEVELOPMENT IN PLANTS AND ANIMALS

COMPETENCE: *You should be able to understand how, throughout its life, an organism goes through changes in size.*

PICTURES:





KEY WORDS

- Growth
- Development
- Mitosis
- Germination
- Dicots
- Monocots
- Cell enlargement
- Cell differentiation
- Cell division
- Hypogeal
- Epigeal
- Epicotyl
- Hypocotyl

LEARNING OUTCOMES

You should be able to;

- Distinguish between the terms growth and development
- Appreciate that mitosis leads to increase in size and weight in animals
- Understand the internal and external structure of a seed
- Conduct experiments on conditions necessary for seed germination
- Identify the roles of water, oxygen and temperature in the process of germination
- Identify and describe the types of seed germination in monocots and dicots

INTRODUCTION

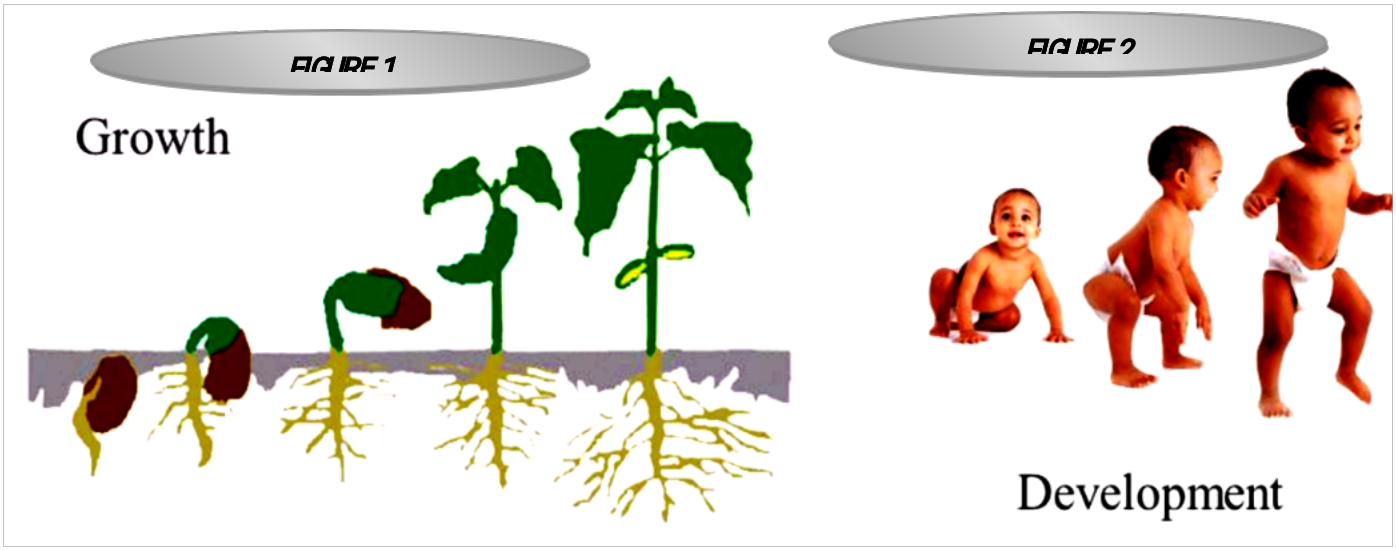
There is always a progression from childhood to adult hood. The physical appearance of an individual during child hood differs much from when one is an adult. Imagine the way you looked at the age of 2 years and now when you are an adolescent. Much has changed. This is reflected in terms of your height, weight, size. These changes are irreversible and therefore we can use the term “growth” to imply these changes. Growth is not confined to only animals but plants also undergo growth. They do experience these irreversible changes in size, weight and height collectively known as growth. Farmers always plant maize, bean seeds among others in the garden which later sprout into enlarged mature plants bearing structures such as leaves, stems and others which were not part of the planted seeds. This is termed as growth. development on the other hand is a qualitative characteristic which can’t be measured. It is the increase in the complexity of an organism.

CONCEPTS

- Distinguish between growth and development
- Mitosis and growth
- Internal and external structure of seed
- Experiments on conditions necessary for seed germination
- Role of water, oxygen and temperature in germination process
- Types of seed germination in monocots and dicots

1. Distinguish the terms growth and development

ACTIVITY



From "*figure 1*" of the sprouting bean plant it is illustrated that the bean seed in a few days started to sprout out of the soil. Some changes are noticeable in the advancement of the planted seed into a mature bean plant

- ✓ Can you identify at least four examples of such changes from figure 1
- ✓ Are these changes reversible or irreversible?
- ✓ Are the changes measurable or can't be measured?
- ✓ Can such changes occur in both living and non living things?
- ✓ Can such changes identified above be classified as growth or development?
- ✓ Suggest any two reasons for your classification above.
- ✓ What are some of the factors which may affect the identified changes?

However in figure 2, it is evident that this child has reached a certain stage of maturity and he has started to gain a particular ability.

- ✓ Looking keenly, what is that ability gained by the child?
- ✓ Can such ability be quantified or it is qualitative?
- ✓ Is it conclusive that this is development?

NOTES

From the above activity it is evident that growth ***is a permanent irreversible increase in size, height or weight of an organism*** while development is ***increase in the complexity of an organism.***
Growth can be measured for example height as an element of growth is measurable "4cm, 6cm, 10cm, etc" however, development is only qualitative and not measured for example "the ability of the baby to transform from crawling to walking" is not a measurable feature but rather qualitative.

Growth is affected by certain factors. These control growth and include

A: external factors

- *Availability of nutrients*
- *Temperature*
- *PH*
- *Water*
- *Oxygen*
- *Light intensity*

B: internal factors

- *Hormones*
- *Genetical / gene factors*

EXERCISE

1. Summarize the major differences between growth and development

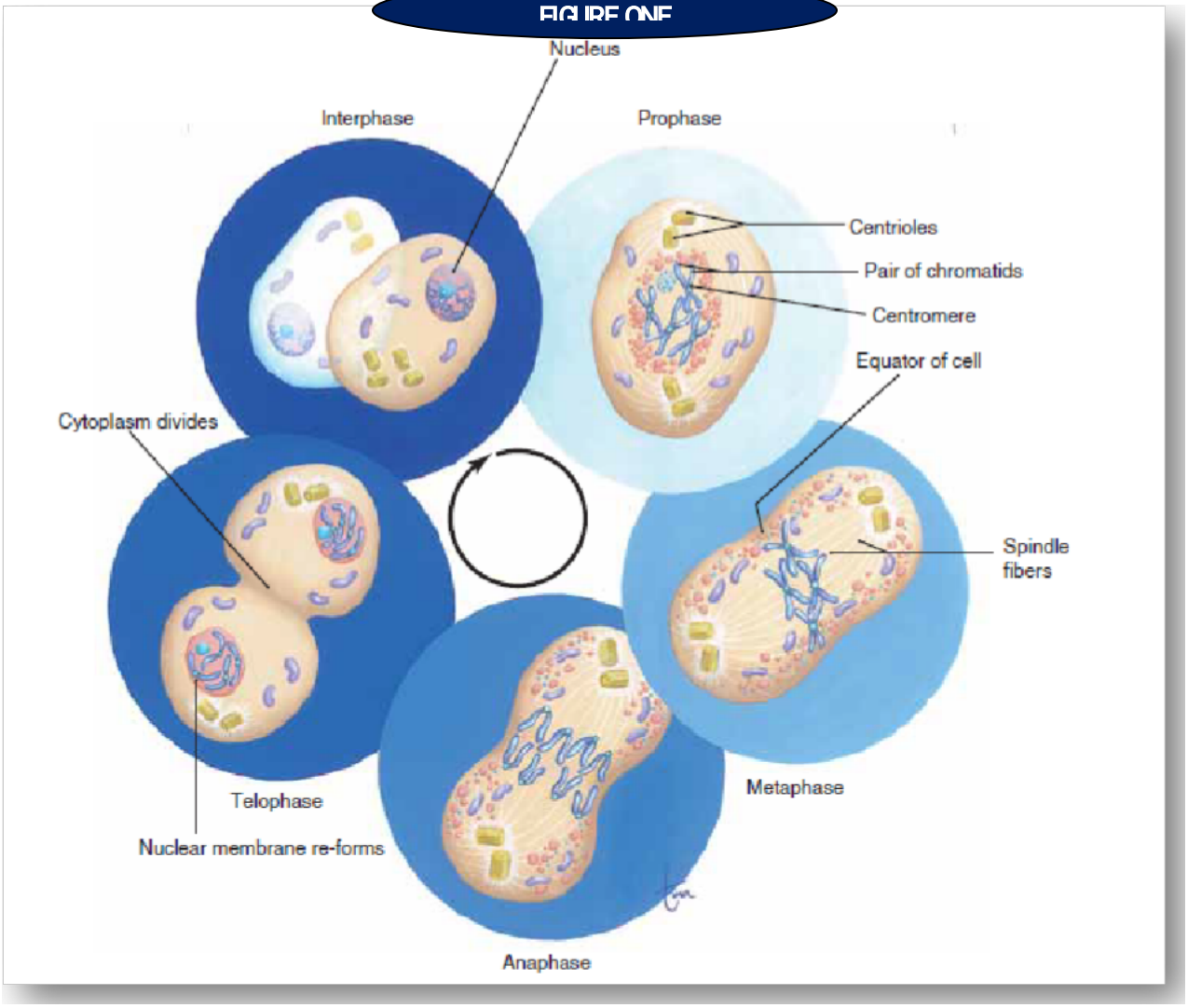
2. Classify the following as either examples of growth or development

A 12 year old boy after following the same diet for one year gained 3 kg in weight	
A tree in well watered garden increases in height by 10 cm and in width by 1 cm	
A fertilized egg of mammal gives rise to relatively undifferentiated cells of the embryo.	

2. mitosis and growth

ACTIVITY

FIGURE ONE



Questions:

- Briefly outline the key events that occur in each stage of mitosis as illustrated in "***figure 1"*** above

1. Interphase
2. Prophase
3. Metaphase

4. Anaphase
5. Telophase

NOTES

For growth to occur, cells must increase in number such that the overall size of an organism can increase hence growth. Cells increase in number by existing cells “parental cells” dividing to give rise to new many other cells “daughter cells”. Mitosis is one of the processes that lead to growth because it is responsible for cell division. A number of phases are involved in mitosis. ***The figure below summarizes what happens in mitosis.***

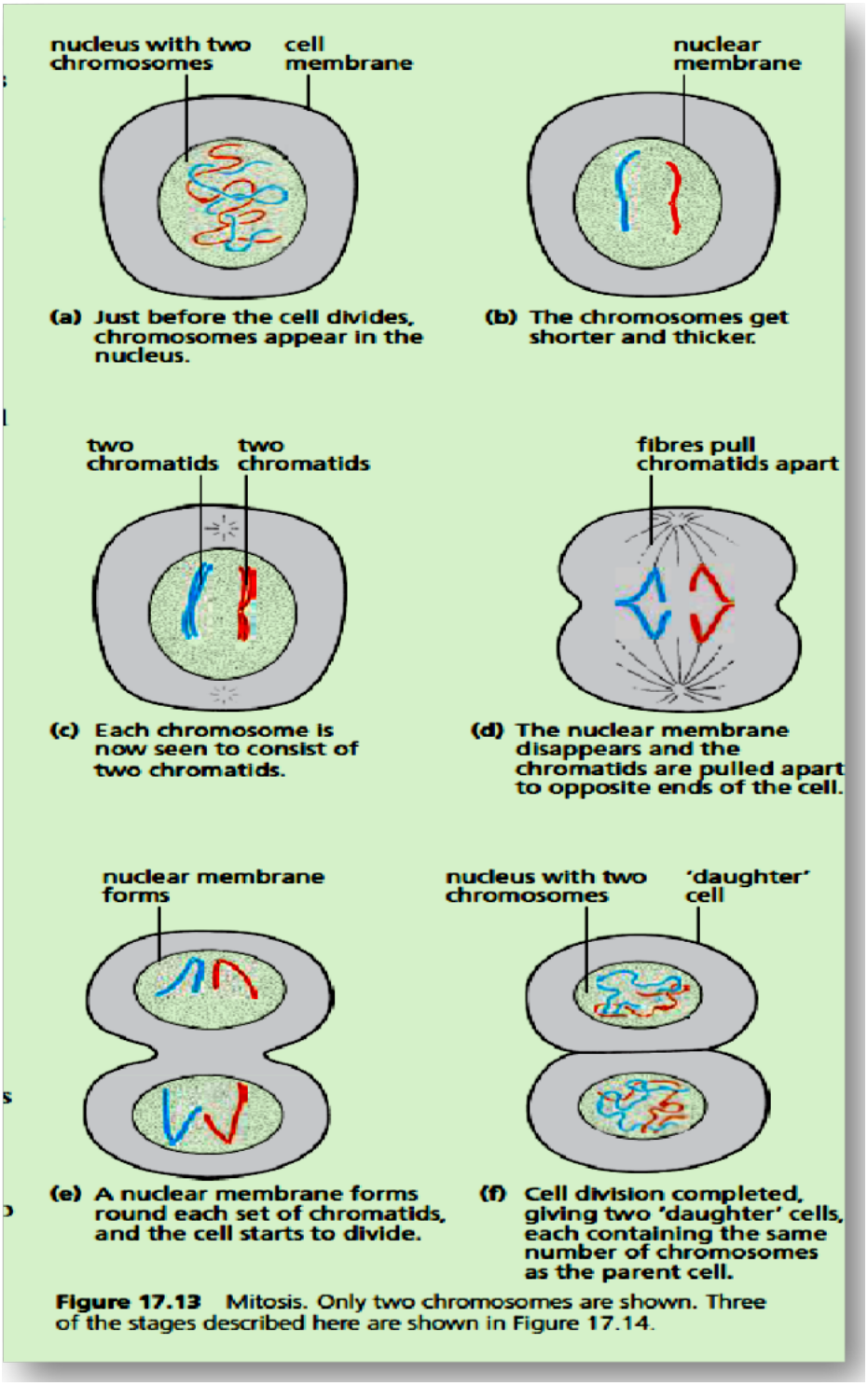


Figure 17.13 Mitosis. Only two chromosomes are shown. Three of the stages described here are shown in Figure 17.14.

Importance /significance of mitosis

- ✓ Growth as it increases the number of cells in the body
- ✓ Basis for a sexual mode of reproduction
- ✓ Replacement of damaged/dead cells in the body. Existing cells divide by mitosis to provide additional cells ensuring that each cell is genetically identical

EXERCISE

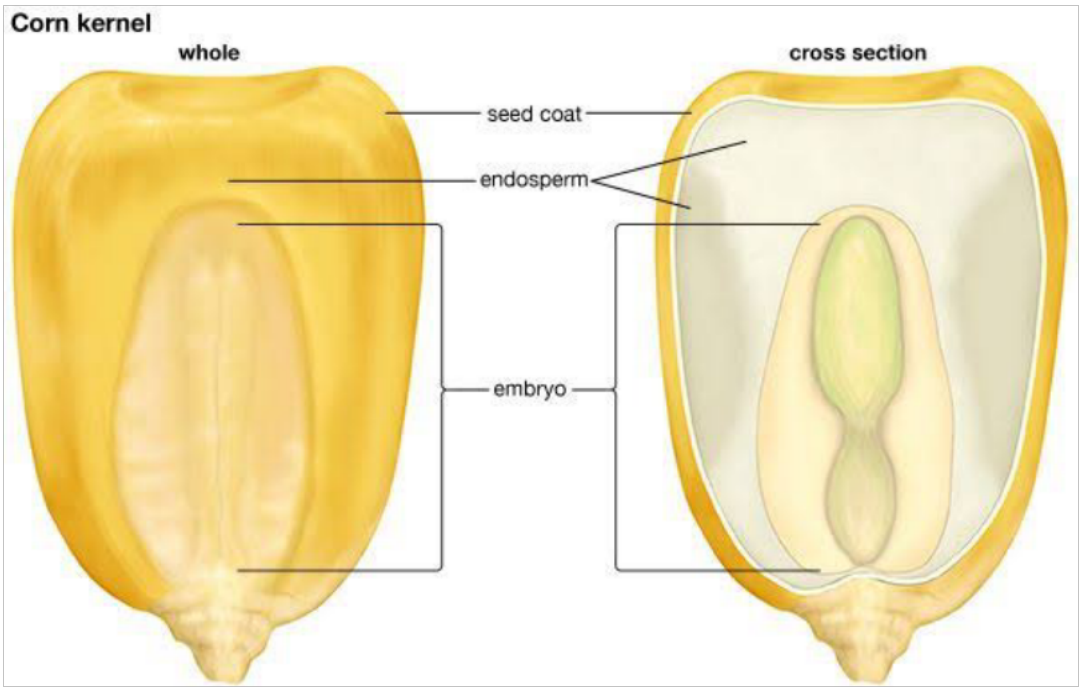
1. What is the role of mitosis in growth?

2. Briefly describe the stages involved in mitosis.

3. Internal and external structure of seed

ACTIVITY:

MAIZE SEED



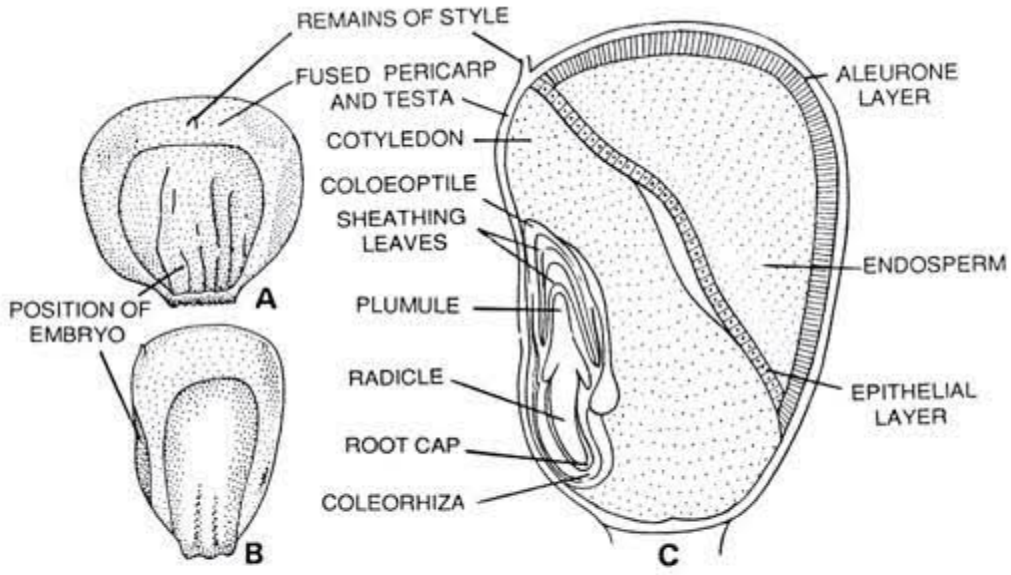
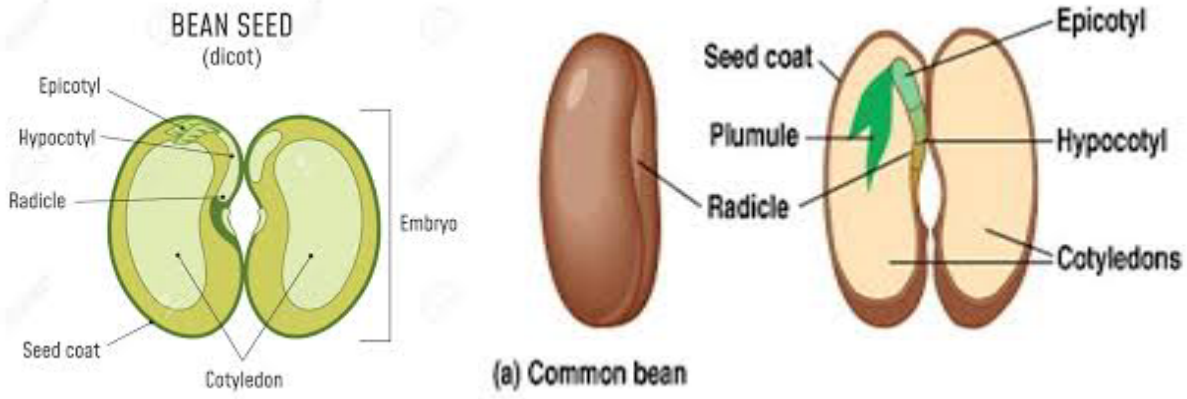


Fig. 34.74. Structure of maize grain. A, grain illustrating of external characters; B, grain as seen from lateral si… …al structure.

BEAN SEED



Questions;

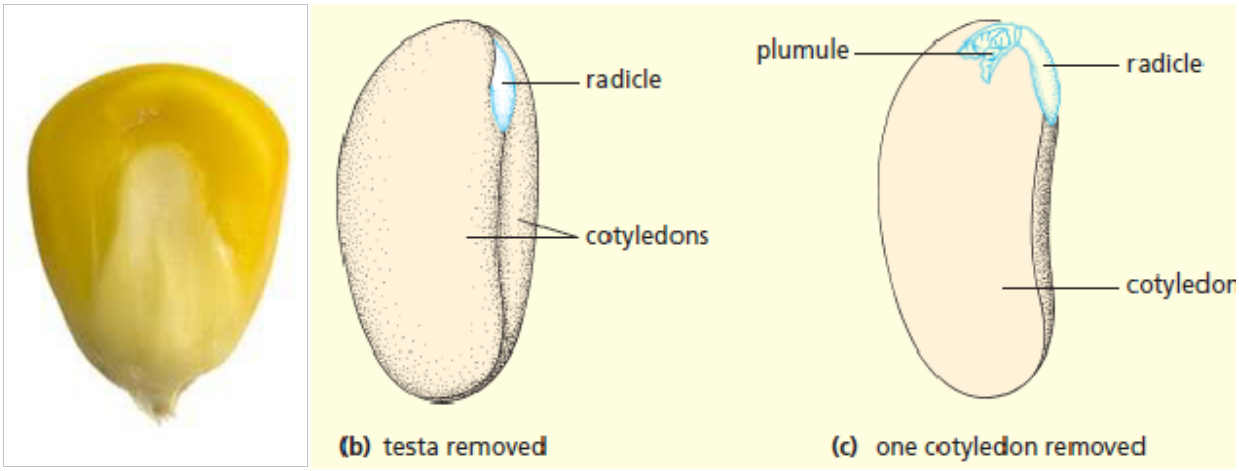
- ✓ Identify some of the observable differences between the seed structures
- ✓ Are there some features common to both the maize seed and bean seed?
- ✓ Identify parts present in maize seed but not in bean seed.
- ✓ With a reason, which of the two seed structures represents
    - i. Mocotyledons
    - ii. Dicotyledons
- ✓ From which part of the flower do seeds develop from?
- ✓ What are the functions of some of the labeled parts?

NOTES:

A seed develops from a fertilized ovule of a flower. Therefore it is defined as a fertilized ovule. It has one scar called hilum. It has been clearly noted from the figures that some seeds have two cotyledons like that of the bean seed while others have only one cotyledon such as the maize grain.

The seeds with two cotyledons are classified under dicotyledons. "***di***" means two. Therefore such seeds have two cotyledons.

The seeds with one cotyledon are classified under monocotyledons. "***Mono***" means one. Therefore such seeds have one cotyledon.



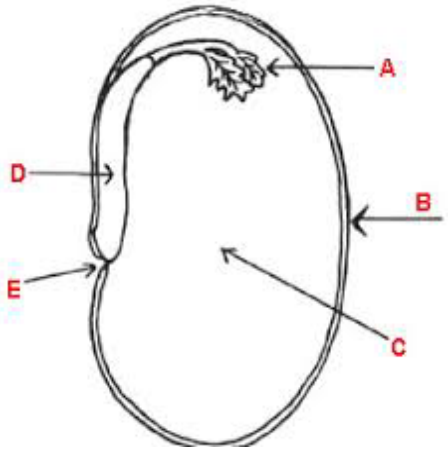
A seed consists of a tough coat or testa enclosing an embryo which is made up of a plumule, a radical and one or two cotyledons. In favorable conditions, the seed can grow and become a fully independent plant bearing flowers and other structures

Below is an outline of the functions of the parts of the seed as earlier discussed.

- ✓ **Coleoptile:** It is the plumule sheath that offers protection to the plumule.
- ✓ **Coleorhiza:** It is the radicle sheath that offers protection to the radicle.
- ✓ **Cotyledon:** It provides food to the whole seed. It contains stored food like starch, proteins and liquids for the initial growth of the embryo during germination.
- ✓ **Endosperm:** Stores food especially starch for the embryo.
- ✓ **Hilum:** It's a scar of attachment left by the seed to the fruit wall. *It is the feature that distinguishes seeds from fruits.*
- ✓ **Micropyle:** It is a narrow opening into the seed through which water, mineral salts and oxygen enter during germination. It is also the opening through which the radicle comes out of the seed.
- ✓ **Plumule:** it develops into the shoot of a plant.
- ✓ **Radicle:** It develops into primary root of the plant.
- ✓ **Testa:** It protects the inner parts of the seed from mechanical injury, heat from the environment and from fungal and bacterial attack.

EXERCISE

1. The figure below shows the structure of a seed. Study it carefully and answer the questions that follow.



i. Name the parts labeled A, B, C, D and E

ii. What is the function of parts labeled A and E

2. In the space provided below, make a labeled drawing of the internal structure of maize grain

3. What distinguishes the figure above from a fruit?

4. Experiments on conditions necessary for germination
Role of water, oxygen and temperature in germination

ACTIVITY:

- ❖ You are required to carry out the following projects in groups of ten

Project one;

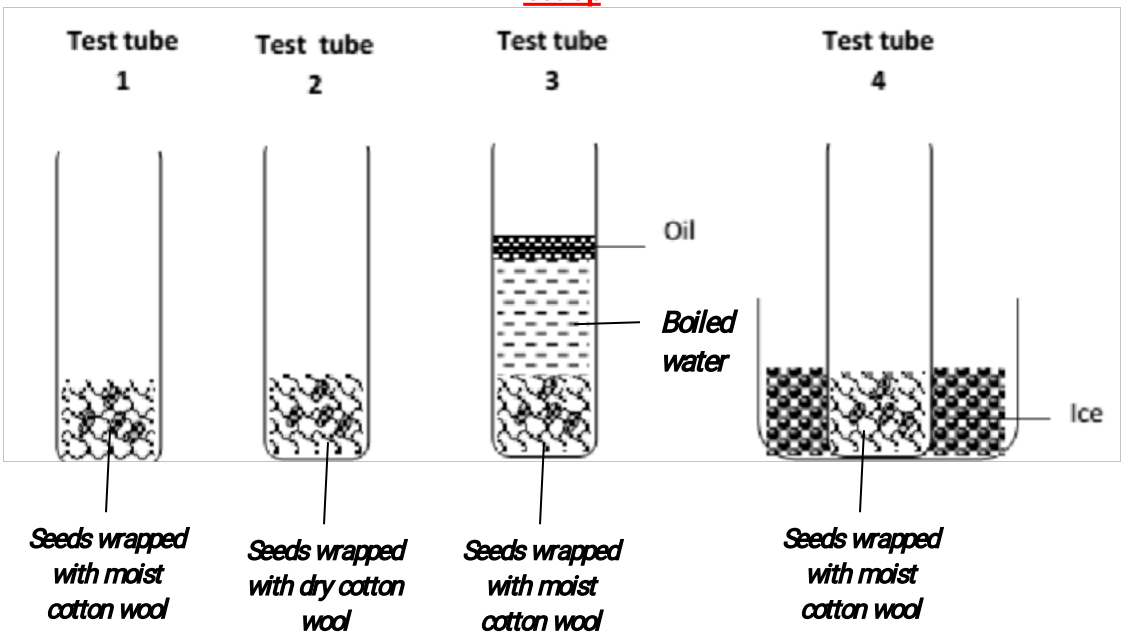
Apparatus needed;

4 test tubes, Cotton wool, bean seeds, Oil and Water.

Procedure:

- ✓ Arrange and label four test tubes 1, 2, 3 and 4
- ✓ To test tube 1 add moist cotton wool, seeds and leave test tube open.
- ✓ To test tube 2 add dry cotton wool, seeds and leave test tube open.
- ✓ To test tube 3 add seeds, boiled cooled water and a layer of oil.
- ✓ To test tube 4 add seeds, moist cotton wool, ice and leave test tube open.
- ✓ Leave all test tubes for 3 days.

Set up



Questions:

- ✓ **After the three days, what observations you can draw from each test tube?**
- ✓ **What are the possible explanations for your observations above?**
- ✓ **What is the significance of;**
    - *i. Using boiled water in test tube 3*
    - *ii. Adding a layer of oil on top of the boiled water in test tube 3*
- ✓ **What is the effect of ice on the results obtained in test tube 4?**
- ✓ **What is the use of the cotton wool?**
- ✓ **What conclusion can you draw from the project above on conditions necessary for seed germination**
- ✓ **Identify the conditions necessary for germination to occur**
- ✓ **Suggest a suitable aim/title of the project work above**

Project two;

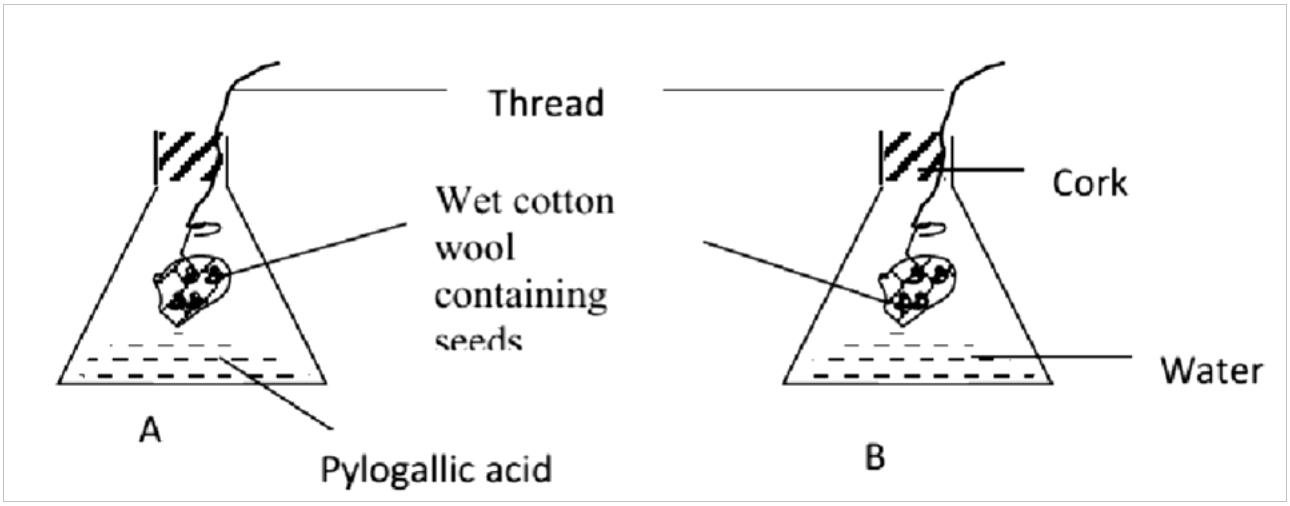
Apparatus needed;

2 conical flasks, 2 corks, Water, Cotton wool, bean seeds and Pyrogallic acid.

Procedure:

- ✓ Pour some water in one conical flask and some pyrogallic acid in another conical flask.
- ✓ Wrap some seeds in wet cotton wool and suspend the cotton wool in the flasks using a thread.
- ✓ Fix the threads using a cork.
- ✓ Leave the set up for three days

Set ups



Questions:

- ✓ After the three days, what observations can you draw from each cornical flask A and B?
- ✓ What are the possible explanations for your observations above?
- ✓ What is the effect of pyrogallic acid on the results obtained in cornical flask A?
- ✓ What is the use of the cotton wool?
- ✓ What conclusion can you draw from the project above on conditions necessary for seed germination
- ✓ Suggest a suitable aim/title of the project work above.

NOTES:

It has been noted that the conditions necessary for germination from the experiments above include;

- ➢ **Water/ moisture**
- ➢ **Warmth/ optimum temperature**
- ➢ **Oxygen/ air**

- ❖ **Water**

Seeds in **test tube 2** were wrapped with a cotton wool and the tube left open hence supplying air (oxygen). The cotton wool as earlier discussed provides warmth. However the cotton is dry implying water is not present. Oxygen and warmth were therefore present but water absent. The seeds therefore never germinated due to lack of water.

Roles of water for the process of germination

Below are some importances of water during germination;

- It activates the enzymes within the seed to hydrolyze the stored food.
- It softens the seed coat/testa, swells and burst.
- It dissolves the stored food.
- It is a medium in which all the chemical and enzymatic reactions proceed.
- It is a medium of transport of the dissolved food substances to the developing shoot and root of the new plant.

❖ **Oxygen**

It should be noted that pyrogallic acid placed in cornical flask A in "**project 2"** absorbs oxygen. Therefore seeds wrapped with a wet cotton wool and suspended in flask A are not supplied with air/ oxygen. These seeds didn't germinate after the three days though they were supplied with water from the wet cotton used and warmth as a result of the cotton wool. This shows that oxygen is also a necessity for seeds to germinate.

Roles of oxygen for the process germination

Germination is a growth process which requires energy. Therefore oxygen is necessary for the process of respiration, the oxidation of food to provide energy required for growth.

❖ **Warmth/ optimum temperature**

Ice placed "**test tube 4"** lowers the temperature beyond the optimum required for germination of the seeds. Therefore these seeds couldn't germinate.

Role of warmth in germination

Suitable temperature is important for the enzyme controlled reactions in the cotyledon of the germinating seed. At low temperatures, the enzymes are inactive and at high temperatures, they are denatured hence no germination. Germination will require an optimum temperature which varies from 10° c-50° c for most tropical seeds.

EXERCISE

1. Describe an experiment to show that each of the following conditions is necessary for germination

   i. Oxygen

   ii. Warmth

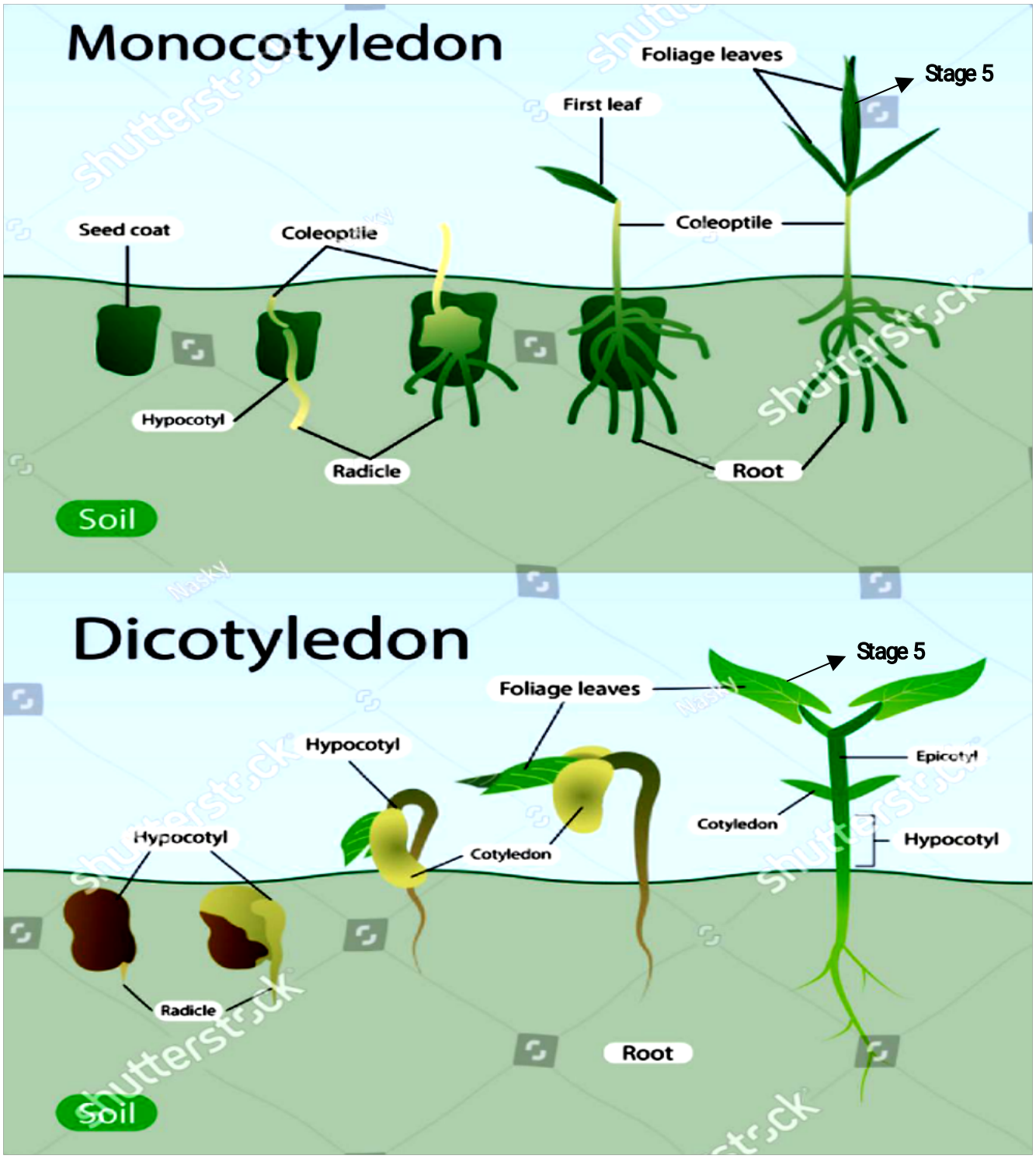
   iii. Optimum temperature

2. Suggest the roles of each condition above for the process of germination

3. Briefly outline the changes which occur in a seed during germination

5. Types of seed germination in monocots and dicots

ACTIVITY:



From the figures above, use three descriptive words to summarize the term germination.

From the observation of the figure for the "monocotyledon,"

- ✓ Stating whether above the ground/ below the ground, what is the position of the cotyledon at ***stage 5?***
- ✓ What could have caused the cotyledon to attain the position stated above?

- ✓ Using either hypogeal germination/ epigeal germination. ***"Hypo means below, epi means above and geal means ground/earth"*** state the type of germination which occurs in monocotyledons.
- ✓ State at least two examples of plants in which such a type of germination occurs.

From the observation of the image for the "dicotyledon,"

- ✓ Stating whether "above the ground/ below the ground," what is the position of the cotyledon at ***stage 5?***
- ✓ What could have caused the cotyledon to attain the position stated above?
- ✓ Using either hypogeal germination/ epigeal germination. ***"Hypo means below, epi means above and geal means ground/earth"*** state the type of germination which occurs in dicotyledons.
- ✓ State at least two examples of plants in which such a type of germination occurs

NOTES

Germination as noted from the figures above can be defined as the growth and development of an embryo of a seed into a seedling or a young plant under favorable conditions.

There are some Greek words you must familiarize yourself with in order to understand the concept of seed germination that is to say hypogeal, epigeal, epicotyl, and hypocotyl.

- ✓ **Hypo means below**
- ✓ **Epi means above**
- ✓ **Geal means ground/earth**
- ✓ **Cotyl means cotyledon**
- ✓ **Epicotyl therefore means part above cotyledon**
- ✓ **hypocotyl therefore means part below cotyledon**

The type of germination in which the cotyledon remains below the ground is therefore referred to as **hypogeal germination**. This is observed in the image for monocotyledons. It has been noted that for the cotyledon to remain below the ground, the part above the cotyledon **"epicotyl"** must elongate faster than the part below the cotyledon **"hypocotyl"** such that it pushes it below the ground

The type of germination in which the cotyledon is raised above the ground is therefore referred to as **Epigeal germination**. This is observed in the image for dicotyledons. It has been noted that for the cotyledon to remain below the ground, the part below the cotyledon **"epicotyl"** must elongate faster than the part above the cotyledon **"hypocotyl"**

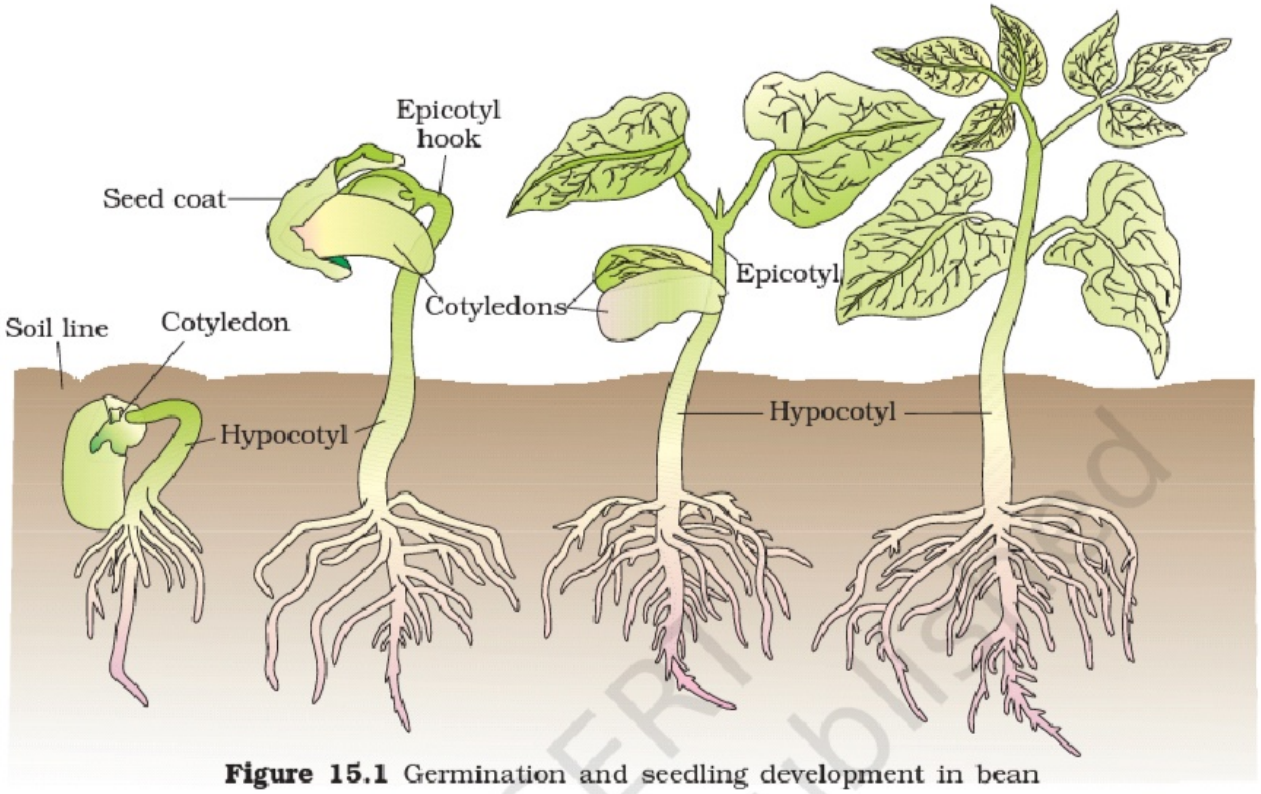
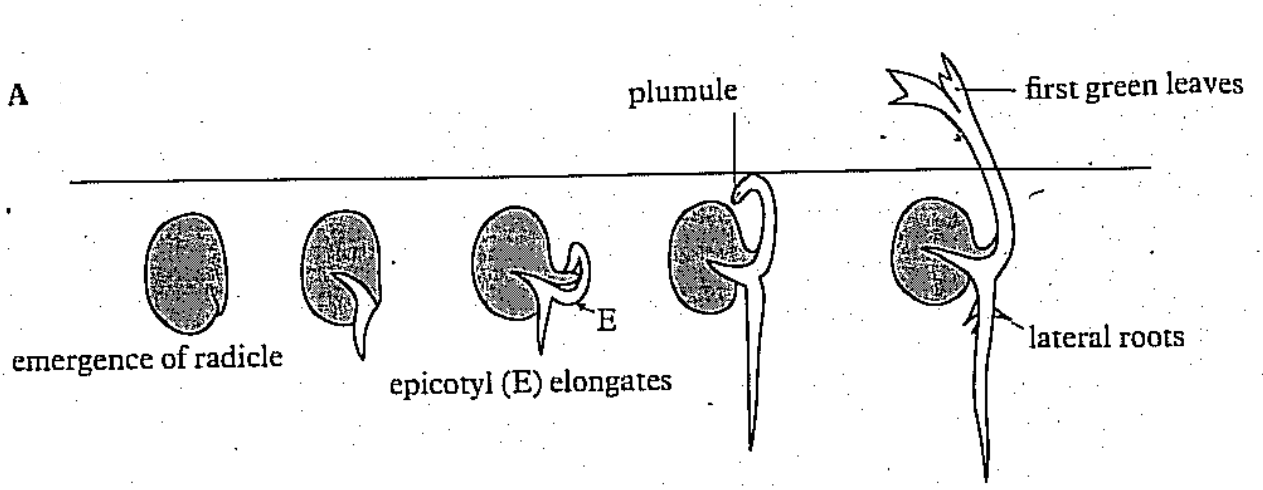
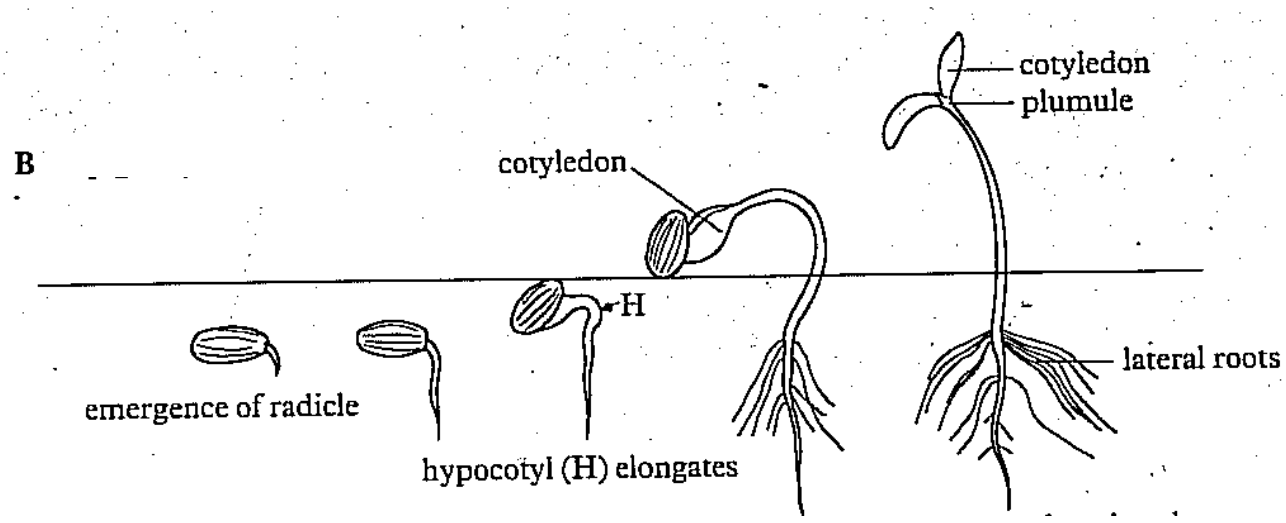


Figure 15.1 Germination and seedling development in bean

EXERCISE

1. The figures A and B below show the different types of germination in plants. Study them and answer the questions that follow.





a. Identify the type of germination represented by figures A and B

b. Suggest two reasons for each type of germination identified

c. Briefly describe what happens in each figure to cause the type of germination identified

2. What is the role of the following parts of the seed during the process of germination

i. Epicotyl

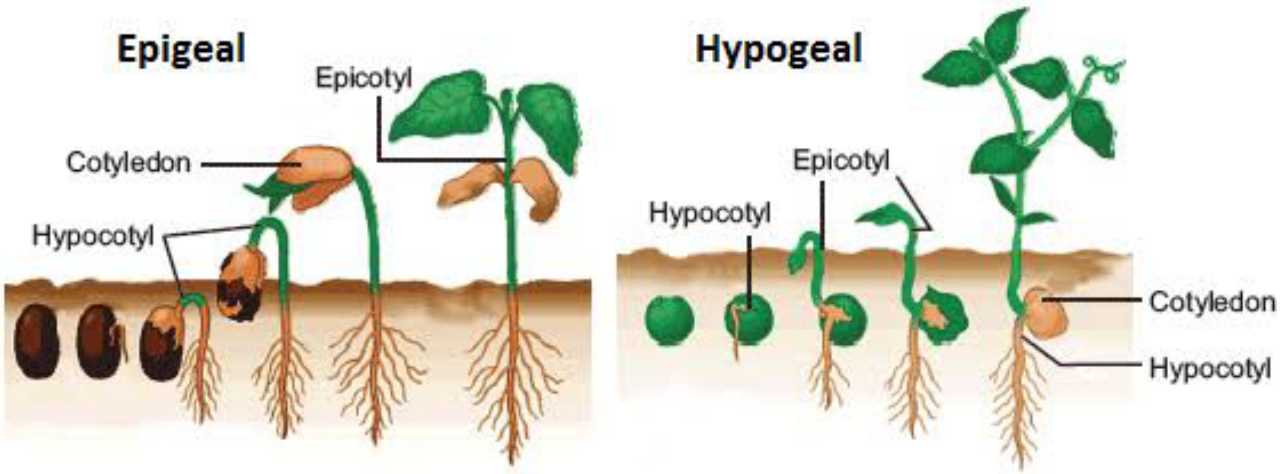
ii. Hypocotyl

iii. Cotyledon

iv. Radicle

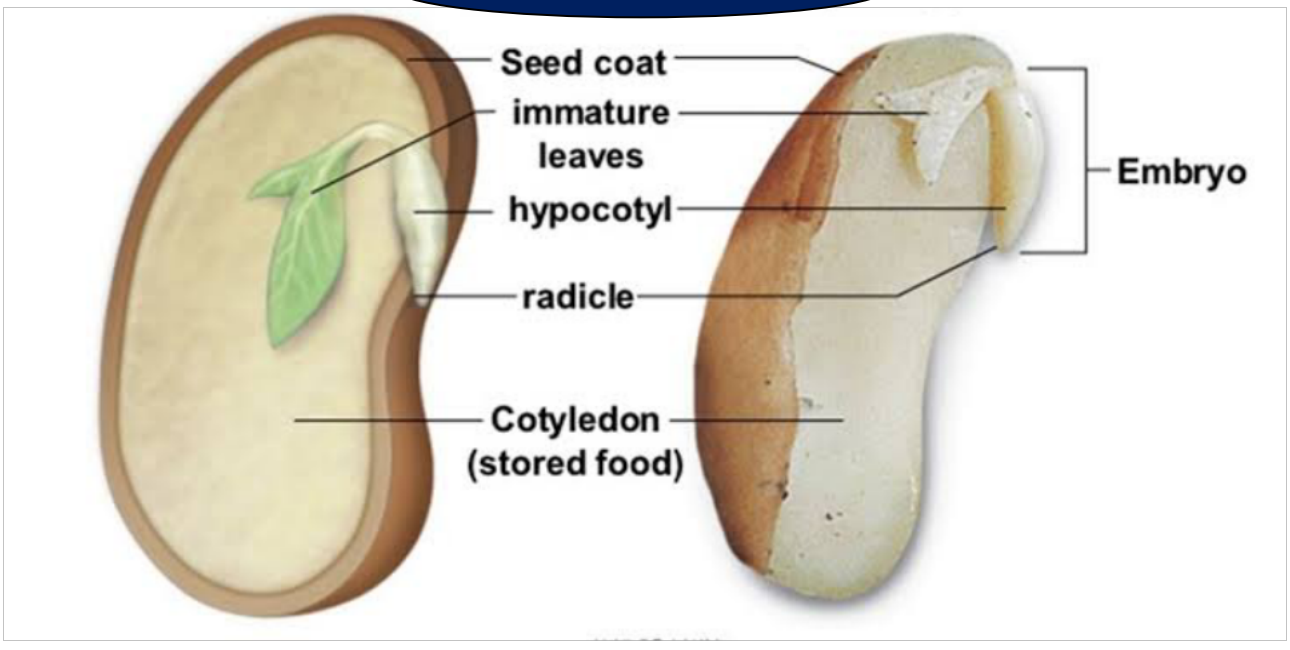
ACTIVITY OF INTERGRATION

FIGURE ONE



- ✓ From figure one, outline at least three conclusions you can draw about the types of germination?
- ✓ In epigeal germination, what causes the cotyledon to be raised out of the soil?
- ✓ In hypogeal germination, what causes the cotyledon remain in the soil?
- ✓ With evidence from figure 1, what is the advantage of epigeal germination over hypogeal germination?

FIGURE TWO



- ✓ From figure 2, note down three conclusions about the structure of monocotyledonous seeds?
- ✓ What is the function of each labeled part?
- ✓ Can you differentiate the above figure 2 with that of the dicotyledonous seed?

FIGURE THREE



- ✓ With suitable reasons, suggest whether figure 3 shows growth or development
- ✓ Which changes can you notice from figure 3 from left to right of the figure three
- ✓ With evidence from figure 3, how can you differentiate growth and development?

FIGURE FOUR

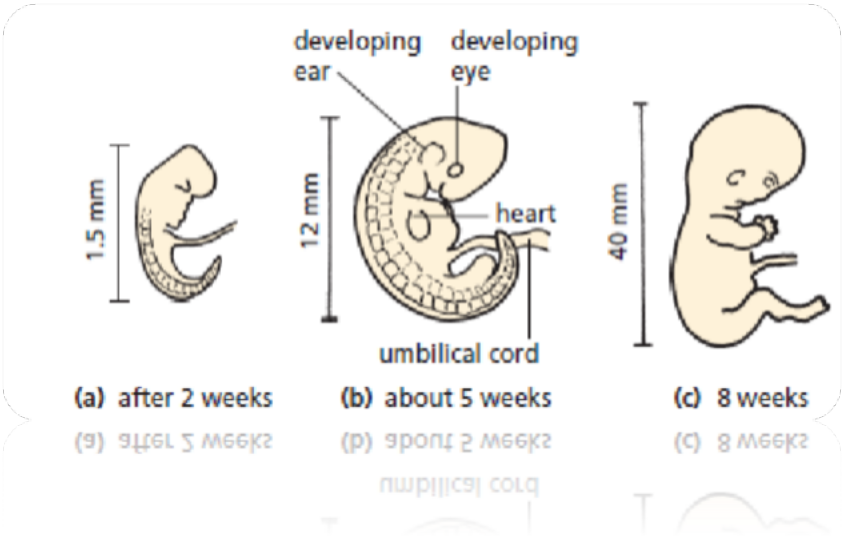
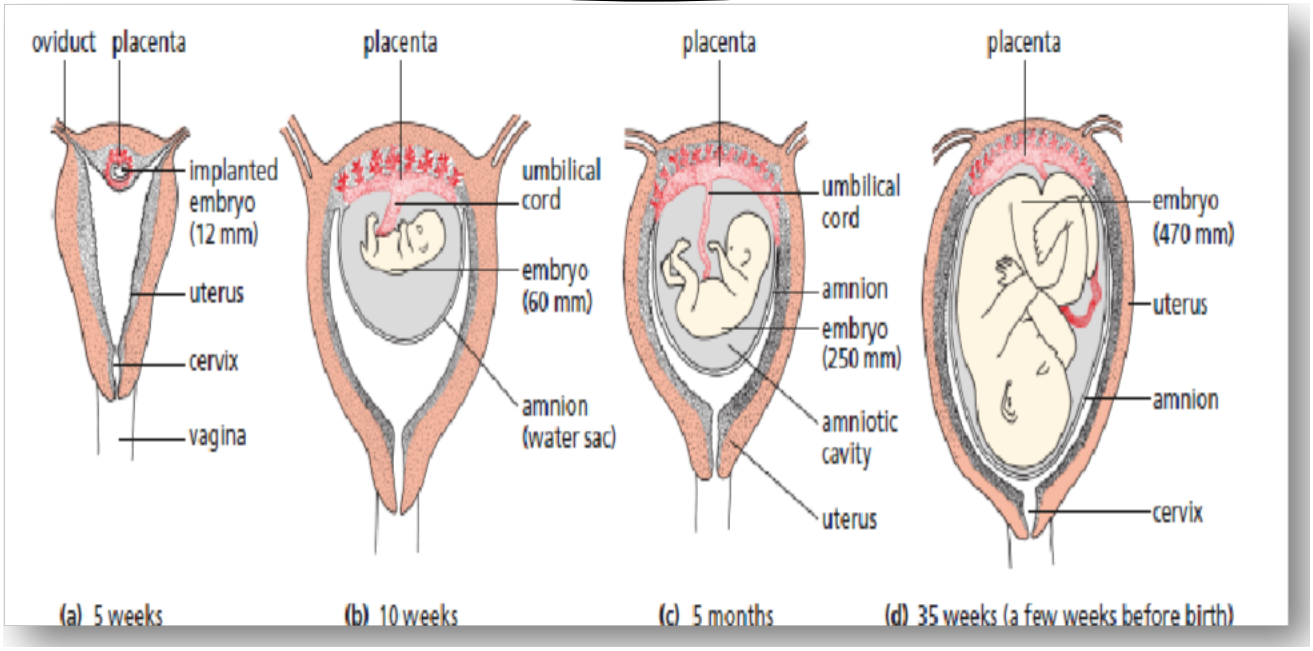


FIGURE FIVE



Figures 4 and 5 show the changes in size (mm) of the human embryo from 2 weeks to 35 weeks. On each figure the age and size of the developing embryo are stated.

a) Copy and complete the following table:

Age/weeks	Size/mm
0 0	
2	
5	

8	
10	
20	
35	

b) Use the data in your table to plot a graph to show the changes of size of the embryo with age.
c) Are changes in size of the embryo as noted in table above reversible or irreversible?
d) State whether the above changes indicate growth or development. Justify your answer.

TOPIC SUMMARY

- Humans, plants and other living organisms undergo irreversible changes in size, weight and height. These changes are collectively called "growth" and they can be measured.
- Development is not a term to mean growth. It refers to increase in complexity of an organism. Development occurs at a certain level of maturity and it is not a measurable factor.
- Mitosis is responsible for growth. mitosis is a form of cell division in which a parental cell divides to form daughter cells each genetically identical to the parent cell.
- The seed is a fertilized ovule. It germinates and develops into a fully mature plant. The seed is comprised of structures such as the seed coat (testa), hilum, cotyledon, endosperm, embryo among others.
- Seeds with one cotyledon are called monocotyledonous seeds while those with two cotyledons are called dicotyledonous seeds
- Plants such as maize undergo hypogeal germination in which the cotyledon remains below the ground while others like beans undergo epigeal germination in which the cotyledon is raised above the ground.

Meaning of terms used in germination

- ✓ **Hypo means below**
- ✓ **Epi means above**

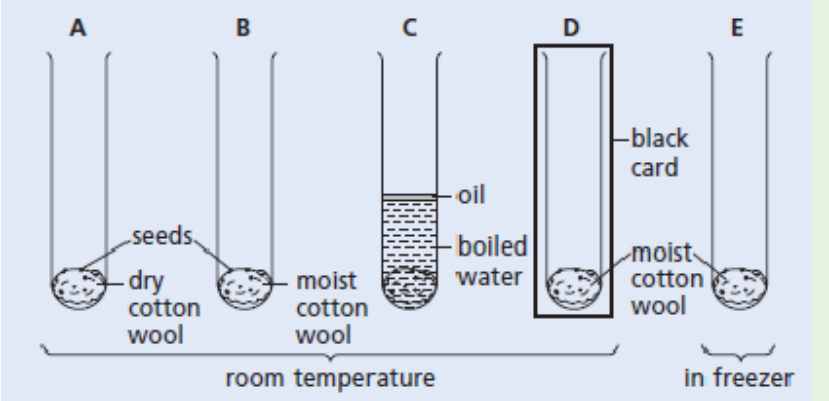
- ✓ **Geal means ground/earth**
- ✓ **Cotyl means cotyledon**
- ✓ **Epicotyl therefore means part above cotyledon**
- ✓ **hypocotyl therefore means part below cotyledon**

❖ Hypogeal germination occurs due to rapid elongation of the epicotyl while epigeal germination occurs due to rapid elongation of the hypocotyl

END OF TOPIC ASSESSMENT

1. During germination of the broad bean, how are the following parts protected from damage as they are forced through the soil:
   i. The plumule
   ii. The radicle
2. List all the possible purposes for which a growing seedling might use the food stored in its cotyledons.
3. At what stage of development is a seedling able to stop depending on the cotyledons for its food?
4. What do you think are the advantages to a germinating seed of having its radicle growing some time before the shoot starts to grow?
5. Describe the natural conditions in the soil that would be most favorable for germination.
   i. How could a gardener try to create these conditions?
6. The diagram shows an experiment to investigate the conditions needed for germination. Tubes A,

B, C and D are at room temperature and tube E is in a freezer.



i. State **three** of the environmental conditions this experiment is investigating.

ii. Predict in which tubes the seeds will germinate.

7. Nuclear and cell division happen during germination.

i. Name the type of nuclear division that takes place during the growth of a seedling.

ii. State how the number of chromosomes in each of the new cells compares with the number of chromosomes in the original cells.

8. Describe the significance of the process of mitosis in growth.

GLOSSARY

1. **Cell differentiation:** This involves specialization of cells to suit particular functions.
2. **Cell division:** This involves increase in the number of cells mainly as a result of mitosis.
3. **Cell enlargement (expansion):** This is the permanent increase in the cell size as a result of uptake of water or synthesis of living materials.
4. **Chromosome:** This is a thread like structure found in a cell nucleus,
5. **Coleoptile:** It is the plumule sheath that offers protection to the plumule.
6. **Coleorhiza:** It is the radicle sheath that offers protection to the radicle
7. **Cotyledon:** The part of the seed which contains stored food like starch, proteins and liquids for the initial growth of the embryo during germination
8. **Development:** This is the increase in complexity of an organism
9. **Dicots:** These are plants with two cotyledons

10. **Endosperm:** The part of the seed which stores food especially starch for the embryo
11. **Epicotyl:** this is the part above the cotyledon
12. **Epigeal:** this is the type of germination in which the cotyledon is raised above the ground
13. **Germination:** This is the growth and development of an embryo of a seed into a seedling or a young plant under favorable conditions.
14. **Growth:** this is the permanent increase in the size of organism
15. **Hilium**: It's a scar of attachment left by the stalk of the ovule to the ovary wall. It is used to distinguish a seed from a fruit.
16. **Hypocotyl:** this is the part below the cotyledon
17. **Hypogeal:** this is the type of germination in which the cotyledon remains in the ground.
18. **Micropyle**: It is a narrow opening into the seed through which water, mineral salts and oxygen enter during germination.
19. **Mitosis:** this is the type of cell division where the parental cell divides to form two daughter cell each with the same number of chromosomes as the parent cell
20. **Monocots:** these are one cotyledon bearing plants.
21. **Plumule:** this is the part of the seed that develops into the shoot system
22. **Pyrogallic acid:** this is a substance that can absorb oxygen
23. **Radicle:** this is the part of the seed that develops into the root system
24. **Seedling**: this is a young plant
25. **Testa:** this is the outer covering of the seed which protects the internal parts from mechanical damage

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