FORM FOUR BIOLOGY

GROWTH

Biology

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INTRODUCTION

GROWTH

- Is an irreversible/permanent increase in size and dry mass (weight) of an organism
- Growth in unicellular organisms like bacteria can be referred as the increase in population
- Growth is a characteristic feature of living things

DEVELOPMENT.

- Refers to the changes in the complexity of an organism.
- It involves differentiation and formation of various tissues that perform specialized functions

THE DIFFERENCE BETWEEN GOWTH AND DEVELOPMENT

GROWTH	DEVELOPMENT
Growth refers to increase in size, height, weight etc.	Development refers to improvement in the functioning of the body process
Easily measured and observed	Cannot be measured easily
It is limited. Starts with birth to reach the maximum at maturity	A continuous, unending process all through life.
Quantitative change	Qualitative and Quantitative change

POSITIVE GROWTH.

- This is the growth which occurs when the rate of cell increase is higher than the rate of cell loss
- The rate of anabolism is higher than the rate of catabolism

NEGATIVE GROWTH

- This is the growth which occurs when the rate of cell increase is lower than the rate of cell loss
- In this the rate of anabolism is lower than the rate of catabolism

IMPORTANCE OF GROWTH IN LIVING THINGS

i. Life usually starts as a single cell e.g a human zygote (fertilized egg) give rise to billions of different cells etc.
ii. During growth and development the cells divide and enlarge giving rise to a more complex and elaborate multicellular organism.

iii. Growth give rise to various cells specialized in various specific functions.

Examples; - Red blood cells carry oxygen

- White blood cells fight pathogens
- Palisade cells carry out Photosynthesis
- Guard cells close and open stomata etc.

iv. This specialization brings about effectiveness and organisms are therefore able to adapt different environments.

v. During growth sexual organism in mammals develop with fully developed sex organs, an organism is capable of reproduction and hence perpetuation of the species.

vi. Growth brings about cell replacement and enlargement

STAGES OF CELLULAR GROWTH

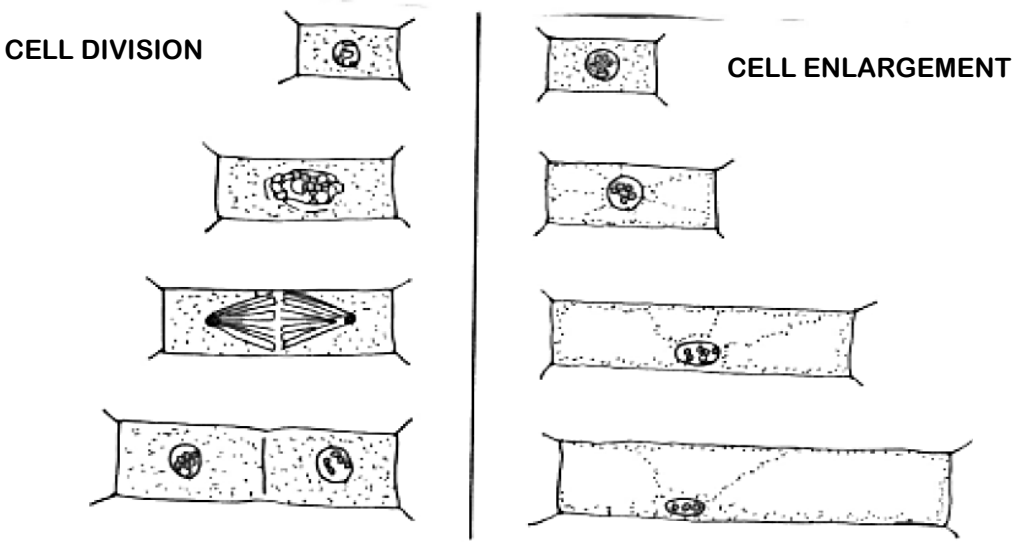
You have already learnt that growth of an organism is always associated with growth of cells. This growth of cells occurs in three successive stages as follows

i. **Cell division :** This is the increase number of cells due to mitosis

ii. **Cell enlargement:** The size of individual cell increases after cell division due to increase in the volume of its protoplasm

iii. **Cell differentiation:** In this stage, structure of the cells changes to perform specific functions. And similar type of cells having same functions form a group, which is known as tissue

Differentiation – This is the process in which generalized cells specialize into specific functions



FACTORS AFFECTING PLANT GROWTH

Generally plant growth is influenced by a number of factors both external and internal.

EXTERNAL GROWTH FACTORS

External factors are those factors present in the environment that affect the growth of the plants directly or indirectly.

(i) Light

- Light is important for the process of photosynthesis.
- Besides photosynthesis, light is also essential for seed germination, growth of seedling, differentiation of various tissues and organs, and reproduction.
- When plants grow in dark, they become tall, yellowish and weak, and the leaves are very small.

(ii) Temperature

- Some plants grow in cold climate and some in hot climate.
- The optimum temperature required for growth of plants ranges between 28-30°C, but it may occur in the temperature range of 4-45°C.
- All metabolic activities of plants are directly affected by variation of temperature. A very low temperature causes injuries to the plant due to chilling and freezing, and very high temperature stops its growth.

(iii) Water

- Plant absorbs water by its roots, use it in photosynthesis and other biochemical processes and some of it is lost through transpiration.

- For proper growth of plants a particular quantity of water is required.
- Both deficiency and excess of water retards the growth of plants.

(iv) Food and mineral nutrients

- Quality and quantity of food substances will automatically affect growth.
- For growth to occur in living things, food must be broken down to release energy.
- In areas where nutrients and water are adequate, competition is reduced and population increases. In case of shortage of nutrients and water, competition sets in and most individuals die.
- There are different mineral nutrients required for optimum plant growth. These nutrients are classified as either macroelements or micronutrients.
  Macroelements are those nutrients required by plants in high doses while
  Microelements are the nutrients required in small quantities. Examples of
- Macronutrients include nitrogen, potassium, magnesium, calcium, phosphorous and sulphur.
- Micronutrients include iron, zinc, molybdenum, manganese, boron, copper, cobalt and chlorine.

(v) Carbon dioxide and oxygen:

- The oxygen and carbon dioxide in the air are of particular important to the physiology of plants.
- Oxygen is essential in respiration for the production of energy that is utilized in various growth and development processes.
- Carbon dioxide is a raw material in photosynthesis. However, a high concentration of carbon dioxide reduces growth because of its effect on the closing of stomata, and maintenance of dormancy.

(vi) Soil condition:

- The characteristics of soil play a big part in the plant's ability to extract water and nutrients.
- If plants are to grow to their potential, the soil must provide a satisfactory environment for plant growth.
- Plant growth is influenced by the soil properties such as texture or structure, salinity, acidity, waterlogging, or compaction.

(vii) Pests and Diseases

- Plant pests, weeds and harmful substances released by roots (allelopathy) affect plant growth drastically.
- Weeds compete with plants for moisture, nutrients, and light.
- Root knot nematodes reduce absorption, so more fertilizer is necessary.
- All of these have negative impacts on plant growth and development.

(viii) Pollutants

- Pollutants can affect plant growth. Many pollutants composed of poisonous gasses (such as carbon monoxide, sulphur dioxide, hydrogen fluoride, hydrogen sulphide) are capable of restraining growth, even bringing plants to death.
- Pollutants from household or industrial wastes are also able to restrain plant growth

(ix) Humidity

- Humidity, also referred to as relative humidity, is the amount of water vapour in the air at a given temperature, and is expressed as a percentage.
- This means that at 20% relative humidity, 20% of any given volume of air will consist of suspended water molecules.
- Humidity levels are especially important in allowing the plant to carry on with its metabolic processes at desired rates.
- The ideal relative humidity for propagation ranges between 80% and 95% for seeds and cuttings, and in the region of 60% outdoors for budding, grafting and seedbed methods.
- Seed germination is faster at higher humidity levels, as is the case of cuttings.

INTERNAL FACTORS

- In addition to the external factors as discussed above, there are some substances produced in the plant body itself, which affects the growth of the plant.
- These are called **plant hormones** or **phytohormones** or **growth hormones** and hereditary factors

(i) HEREDITARY FACTORS

- Heredity factors are internal factors that affect the growth of plants. They affect the physical appearance and the size of a plant
- Hereditary units called genes are found in chromosomes inside the nucleus of all plant cells.
- These units control the various characteristics of plants such as flower colour number of floral parts, growth pattern and so on. Genes are passed from parents to off spring. For example, tall plants produce tall offspring and short plants produce short offspring.

(ii) HORMONES

- A **phytohormone** is an organic substance produced in a small quantity in one part of plant body and capable of moving to other parts to influence the growth of that part.
- The following are examples of plant hormones which may affect growth in plants

(i) Auxin

- Auxin is a growth promoter, generally produced by the growing apex of stem and root of the plants.
- It helps in the elongation of shoot and root tips behind apical meristem.

Functions of Auxin hormone

- It promotes cell elongation;
- It suppresses the growth of lateral bud
- It delays fall of leaves.

(ii) Gibberellin

- It is produced in embryos, roots, and young leaves and it enhances growth.

Functions of Gibberellins

- It helps in elongation of stems in some specific plants. By using gibberellin the height of the dwarf plants can be increased.
- It breaks dormancy of seeds and buds.
- It induces parthenocarpy (Formation of seedless fruits without fertilization

(iii) Cytokinins

- Cytokinins are synthesized in root apex, endosperm of seeds, young fruits etc. where cell division takes place continuously.

Functions of Cytokinins

- They stimulate cell division, cell enlargement and differentiation.
- They prevent aging of plant parts.
- They inhibit apical dominance and help in growth of lateral buds.

(iv) Ethylene

- Ethylene is a gaseous hormone. It is found in ripening fruits, flowers and leaves.

Functions of Ethylene

- It induces ripening of fruits.
- It promotes senescence and abscission of leaf, flowers, etc.
- In cells it only increases the width not the length.

(v) Abscissic acid

- Abscissic acid also known as Dormin is a naturally occurring growth inhibitor found in wide variety of plant. It is synthesized in leaves.

Functions of Abscissic acid:

- It induces dormancy of buds and seeds as opposed to Gibberellin, which breaks dormancy.

- It promotes the senescence of leaf, i.e., fall of leaves happen due to Abscissic acid.
- It inhibits seed germination and development

FACTORS AFFECTING GROWTH IN ANIMALS (EG. HUMAN BEING)

EXTERNAL FACTORS

(i) Food and water
- Food is very important for growth of organisms.
- All living organisms need food for their growth
- The foods are broken down and undergo respiration to generate energy for growth
- The shortage of food will decrease the growth rate

(ii) Space
- Organisms usually compete for breeding sites, shelters, against predators and harsh environmental conditions
- Lack of enough space results in accumulation waste products which can be harmful to the organisms thus growth rate may be affected

(iii) Accumulation of toxic wastes
- High concentration of poisonous substances such as ammonia, carbon dioxide and sulphur dioxide can affect the lives and growth of individuals

(iv) Diseases
- Diseases usually affects the growth rate of individuals
- Diseases result into physical deterioration of body cells resulting to poor growth
- Therefore the diseased organisms the growth becomes poor while undiseased organism the growth rate is high

(v) Respiratory gases
- Oxygen is very important for the life of animals because it is used as a raw material for respiration
- Lack of oxygen to animals may result into death due to suffocation

(vi) Predators and parasites
- A predator is an organism which kills other organisms for food
- A prey is an organism which is killed by a predator
- A parasite is an organism that obtains its nutrients from the tissues of other living organisms
- An increase in number of predators decreases the number of preys
- A parasite may cause diseases, transmit diseases, deprive the host food or damage the host cells

(vii) Climate

- Climatic conditions of an area is among of the factors affecting growth of organisms
- These conditions includes rainfall, humidity and temperature
- These factors may affect the physiological processes of the body which also will affect growth

INTERNAL FACTORS

These are the factors which are associated with genetic make-up of an organism plus all the other processes which take place in the organism's body. These factors include the following:

(i) Hereditary factors (genes)

- An organism's physical development is strongly affected by their genes inherited from their parents.
- Parent's genes predetermine the limits of an individual's height and other characteristics including the variability in eye colour, hair colour, body composition, and skin tone.
- Therefore the proper functioning of genes may lead to proper growth of an organism

(ii) Growth hormones

- Human growth is affected by biochemical products such as hormones.
- Hormones are regarded as growth-promoting substances.
- Probably all the endocrine glands influence growth.
- Most of the hormones are secreted by the endocrine glands and play a significant role in regulating the pattern of growth and development as per instructions of the genes.
- Examples of human hormones and their actions are as follows:
  - ***Somatotrophin***: The most important hormone controlling growth
  - ***Thyroid hormone***: This hormone plays a vital role throughout the whole period of growth. The activity of the thyroid decreases gradually from birth to adolescence. In low secretion of the hormone, skeletal maturity, dental maturity and growth of the brain are all affected. .
  - ***Testosterone:*** produced by the testicle, is important in stimulating growth and it is responsible for the greater growth of muscles.
  - ***Gonadotropins***: Gonadotropins are responsible for the growth of the ovaries and testis, and later on, the secretion of

estrogens and testosterone responsible for the growth and development of secondary sex characters.

DIFFERENT PATTERNS OF GROWTH

(i) Allometric growth

- This is the pattern of growth where by different parts of the body of an organism grow at different rates
- Example growth in human being and plants

(ii) Isometric growth

- This is the pattern of growth where by all body organs grow at the same rate
- Example growth in fish

(iii) Diffuse growth

- This is the pattern of growth which takes place all over body of an organism
- Example growth in animals

(iv) Localized growth

- This is the pattern of growth which takes place in a certain regions only
- Example growth in plants takes place in roots and shoot tips

(v) Determinate (limited) growth

- This is a pattern of growth in which an organism stop growing at certain age
- Example growth in mammals and annual plants

(vi) Indeterminate (unlimited) growth

- This is the pattern of growth in which organisms continue to grow throughout their life
- Example growth in perennial plants and reptiles

(vii) Intermittent growth

- This is the pattern in which growth takes place in a series of stages called **instars**
- Example growth in arthropods like insects

MEASUREMENT OF GROWTH

Growth can be estimated by measuring any suitable parameter of an organism at suitable interval of time as follows

1. **Total fresh weight**
    - This method involves weighing the whole organism
    - Fresh weight is influenced by the changes in water content of the body and therefore do not give accurate results
2. **Dry weight**
    - This method involves killing the organism and heating it at 110°c to a constant weight
    - This method is more accurate since it indicates the increase in weight is due to synthesis of different materials without a regard to water content

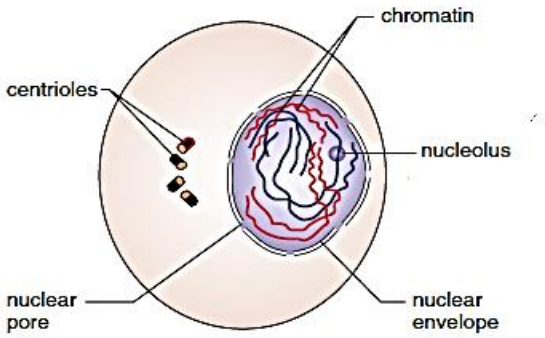
MITOSIS AND GROWTH

- **Mitosis** is a cellular division taking place in somatic (body) cells resulting to two diploid daughter cells
- **Mitosis** is nuclear division that produces *two daughter cells, each with the same number and kinds of chromosomes as the parental cell, the cell that divides*.
- Therefore, following mitosis, the parental cell and the daughter cells are genetically identical.

PHASES/STAGES OF MITOSIS

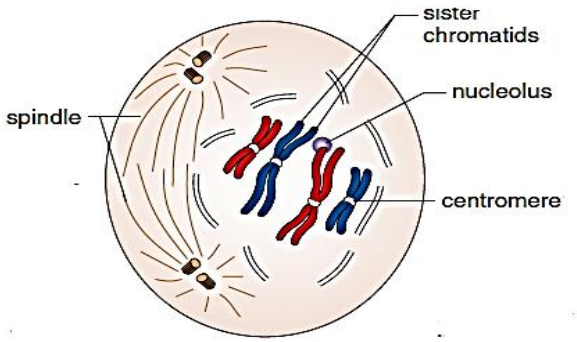
- Before a dividing cell enters mitosis, it undergoes a period of growth called interphase.
- About 90 percent of a cell's time in the normal cell cycle may be spent in interphase

  INTERPHASE
- This is the phase in which a cell prepares itself for division. The following events takes place
- The DNA replicates
- Each chromosome exist as a pair of chromatids joined together at a centromere
- The centrioles replicate
- The chromosomes are thin and thread –like structures
- The cell increase in size



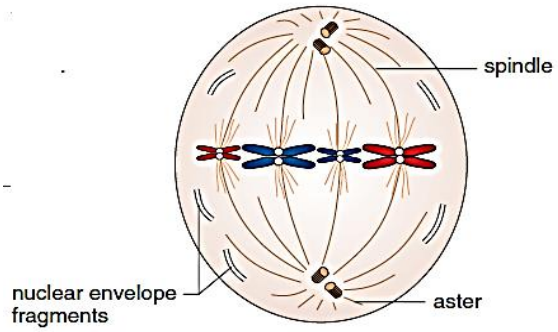
(i) Prophase

- This is the first and the longest stage of mitosis which involves the following processes
- The chromosomes shorten, thicken and become visible
- Centrioles move to the opposite poles of a cell
- The spindle fibres are formed
- At the end of this phase the nuclear membrane disintegrate
- The nucleolus disappear
- Each chromosome is seen to consist of two chromatids held together by a centromere
- The centrioles move to the opposite poles of a cell



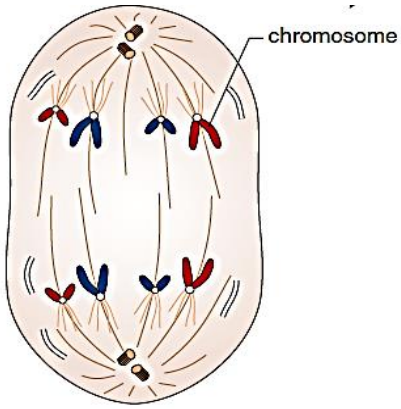
(ii) Metaphase

- The chromosomes are attached to the spindle fibres
- The chromosomes align at the equator of spindle fibres
- The nuclear membrane disappears completely



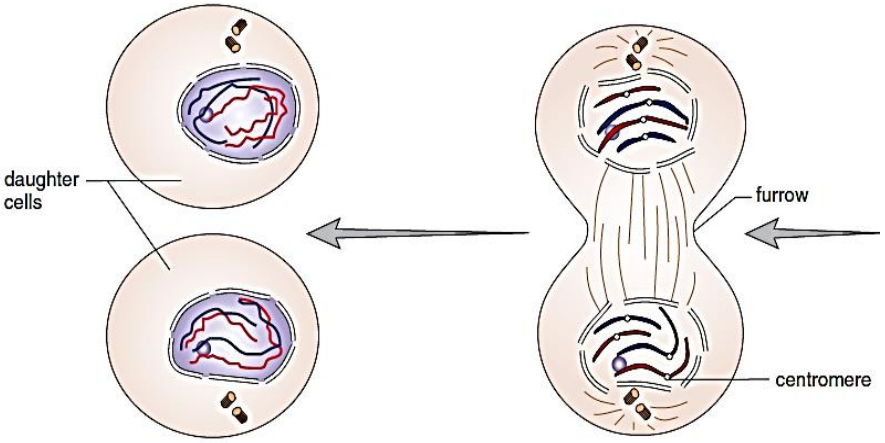
(iii) Anaphase

- During this phase the chromosomes splits into two sister chromatids
- The spindle fibres contract and thus pulling the sister chromatids to the opposite poles
- The sister chromatids are separated
- The separated chromatids are pulled to the opposite poles of the centrioles

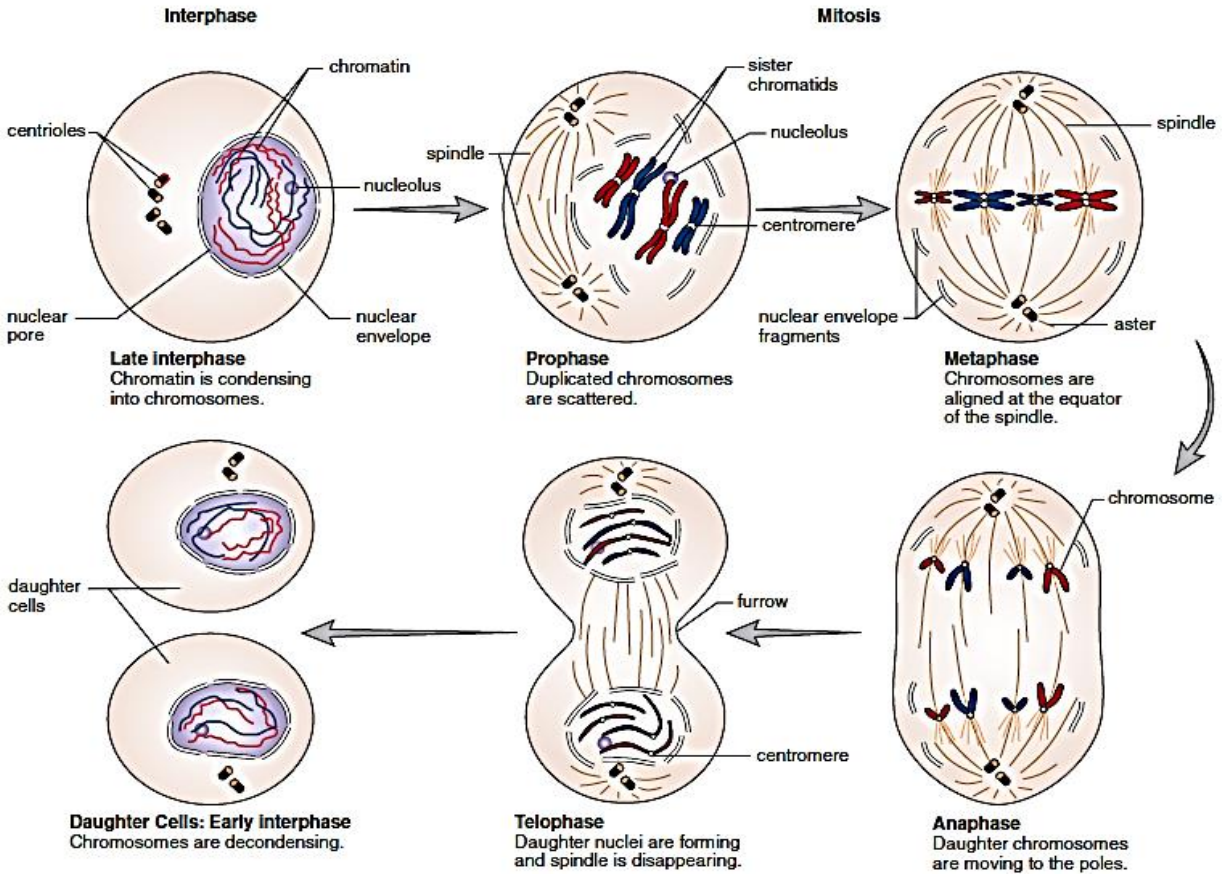


(iv) Telophase

- This is the last stage of mitosis
- The nucleolus reappear and nuclear membrane forms
- The spindle fibres disappear
- The chromatids lengthen, uncoil and become invisible
- The chromatids reach the opposite poles of a cell
- In animal cell the cell start to constrict across the middle through the process called **cytokinesis**
- In plant cells, a cell wall is formed across the middle of a cell



Summary on the stages of mitosis



THE SIGNIFICANCE OF MITOSIS

(i) It maintains the genetic stability of organisms

- Mitosis produces two nuclei which have the same number of chromosomes as the parent cell

- Since these chromosomes were derived from parental chromosomes by the exact replication DNA

(ii) It facilitates growth

- The number of cells within an organism increases by mitosis which is the basis of growth in multicellular organisms

(iii) It provides the replacement of cells

- Replacement of cells and tissues also involves mitosis
- Cells are constantly dying and being replaced
- An obvious example being in the skin

(iv) It provides regeneration some body organs

- Some animals are able to regenerate the whole parts of the body
- Example legs in crustaceans, arms in starfish, missing body parts in planaria

(v) It is a means of asexual reproduction in some organisms

- Mitosis is the basis of asexual reproduction
- Asexual reproduction is the production of new individuals of a species by one parent organism
- Many species undergo asexual reproduction

THE DIFFERENCE BETWEEN MITOSIS IN PLANT CELL AND ANIMAL CELL

MITOSIS IN PLANT CELL	MITOSIS IN ANIMAL CELL
No centrioles present	Centrioles present
No aster forms	Aster form
Cell division involves the formation of a cell plate	Cell division involves furrowing and cleavage of cytoplasm
Occurs mainly at meristems	Occurs in tissues throughout the body

THE DIFFERENCE BETWEEN MITOSIS AND MEIOSIS

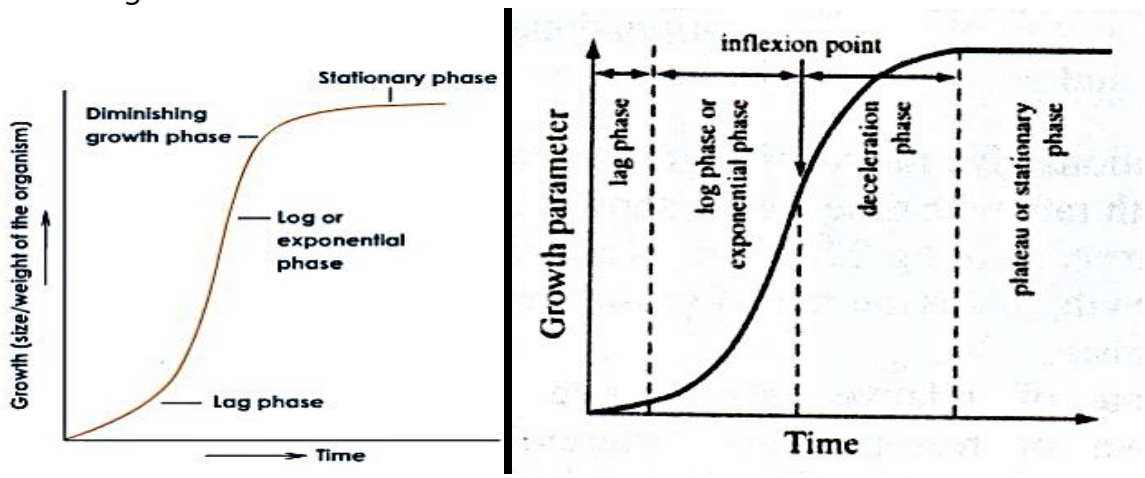
MEIOSIS	MITOSIS
Takes place in reproductive cells to form gametes	Takes place in body cells during growth and tissue repair
Homologous chromosomes associate one another	No association of homologous chromosomes
Results into variation due to chromosome recombination	Does not result into variation. All are like the parents
It results into four haploid daughter cells	It result into two diploid daughter cells
It takes place into two phases (meiosis I and meiosis II)	Involves only one phases

THE SIMILARITIES BETWEEN MITOSIS AND MEIOSIS

- Both involve diploid parent cells
- Both consist of interphase, prophase, metaphase, anaphase and Telophase
- In metaphase individual chromosomes line up along the equator
- Both meiosis and mitosis are types of cell division in which one cell give rise to more than one cell
- Both require spindle fibres to move the chromosomes around

GROWTH CURVE

- When a growth parameter such as height or height or mass is plotted against time, a growth curve is obtained
- The usefulness of this curve is that it shows the overall growth pattern and the extent of growth



PHASES OF GROWTH

(i) Lag phase

- Lag phase is a period when the rate of growth is very slow, during the stage the number of cell dividing through mitosis are few
- It lasts for short period of time

(ii) Log phase /exponential phase

- This is the second phase of growth in which growth proceeds exponentially
- During this phase the rate of growth is directly proportional to the number of cells present in an organism

(iii) Decelerating phase

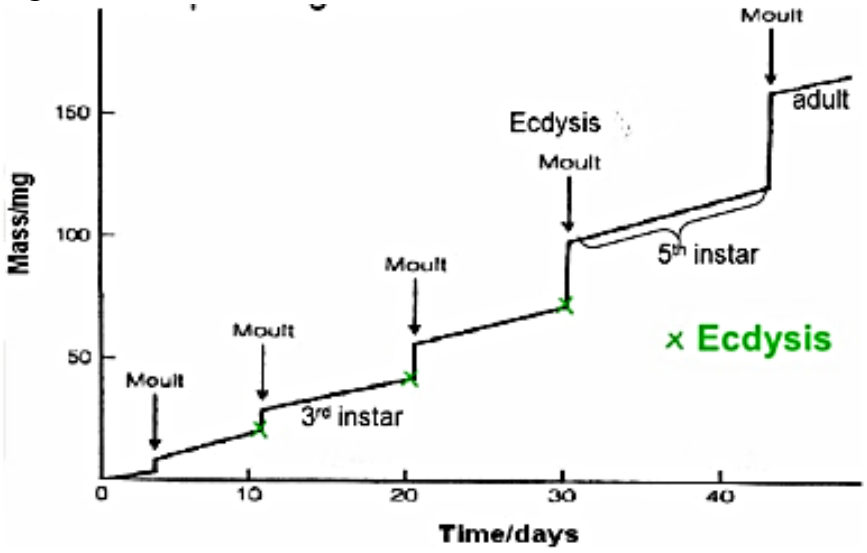
- This is the third phase of growth
- This phase involves the decline in the rate of growth as maturity is approached because the rate of cell division decrease.

(iv) Stationary/plateau phase

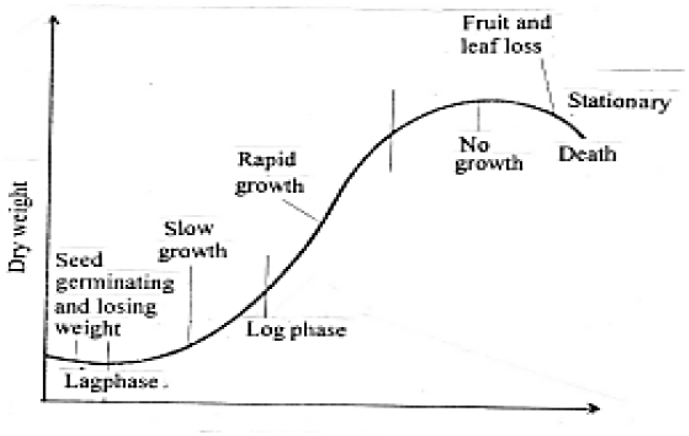
- This is the last phase of growth
- This phase marks the period of no further growth of the organism
- The organism has attained maturity, new cells are formed only to replace those worn out or dead cells

GROWTH CURVE IN ARTHROPODS

- Not all organisms show smooth sigmoid growth curve
- Animals such as insects exhibit intermittent growth
- This is because in these animals growth occurs at interval when the animals have moulted
- When new skeleton has been formed there is appreciable increase in size as a result of growth



GROWTH CURVE IN PLANTS



GROWTH AND DEVELOPMENT IN HUMAN BEING

- Human beings, like other organisms show growth and development
- Human beings show diffuse, allometric and limited growth
- Development includes growth, differentiation and tissue regeneration

NB:

Growth and development in human being can be categorized into two as follows

1. Pre-natal development

- This is the development of human being before birth
- Pre-natal development takes 9 months from fertilization to birth

2. Post-natal development

- This is the development of human being after birth
- This stages involves several physiological, psychological and behavioral changes of the body

THE STAGES OF HUMAN POST–NATAL GROWTH AND DEVELOPMENT

(i) Childhood (0 -10 years)

- This is the period from birth to sexual maturity
- Childhood has several stages like neonatal, older baby, toddler, early childhood, late childhood and pre-adolescence
- This is characterized by the following
  - They have limited capacity of seeing objects
  - There is rapid increase in weight and height
  - A young child cannot walk, stand or sit
  - At the age of two years they can speak, walk and sit

(ii) Adolescence (10 -19years)

- This is the transition stage from childhood to adulthood
- In this stage the human being attain puberty
- PUBERTY – is the period of sexual maturation in human being
- Boys and girls different characteristics of development which are called secondary sexual characteristics
- Normally girls reach adolescence earlier than boys

(iii) Adulthood (20 – 60 years)

- This is the stage in which the human is physiologically, psychologically and physically mature to make families
- From 18-25 years is considered to be the mark of reproductive age hence the reproductive capacity is at higher level)
- Middle adulthood begins from 40-50 years
- For women in the age above 45 years attain **menopause**
- A man continue to be reproductive up to old age but some reproductive powers decrease, sperm production decrease and he frequency of orgasm decrease

(iv) Old age (above 60 years)

- This is the age of senescence
- In this stage there is gradual decrease in the ability of a person to function
- Ageing takes place in this stage
- AGEING - Refers to the physical deterioration of an individual as a result of old age
- The progressive decline of biological function with age is called **senility**

PHYSIOLOGICAL, PSYCHOLOGICAL AND BEHAVIORAL CHANGES ASSOCIATED WITH GROWTH AND DEVELOPMENT

- In each of the above stages, various physiological, psychological and behavioural changes take place.
- The changes that occur in each stage are explained in detail below

(i) Childhood

Physical and physiological changes

- At neonatal stage the babies are helpless but can do a number of things such as crying, moving their arms, legs and head
- Neonates can see only for a short distance, they can also hear, smell and feel
- And the rate of heart beat is very high
- At six months a baby can completely control its movement and sit

- At 7 months the baby can learn to crawl. Also the teeth are formed
- From 9 to 12 months the baby starts to walk
- At the age between 1 to 3 years the following takes place
  - The brain develops by 90%
  - The rate of heart beat is reduced to 90-110
  - The immune system becomes mature
  - The baby can see everything that adult can see
  - All the 20 milk teeth appear by the age of 2.5 to 3 years

Behavioural and psychological changes

- At early stages the babies express their feelings mainly through crying to show hunger, thirst, pain, tiredness and sickness
- At the age from 6 to 12 months, the baby responds to his or her name and other words that are familiar to him
- Social development also occurs at this period. For example at 9 months a baby can distinguish strangers from familiar people
- At 1 years he/she understands and obeys simple commands like 'come'
- At 12 to 14 months, the child uses gestures to express his/her feelings
- At 15 to 18 months, a child feeds him or herself, address others with greetings, climbs onto furnitures
- At the age from 4 to 6 years, the child is very curious and imaginative
- He/she also understands right and wrong and can speak fluently. Also can tell her/his age and simple story
- From 7 to 9 years a child can assume simple responsibilities
- Also the child become very social and likes to socialize and belong to groups
- Children at this age can listen to peer's opinion but still value the opinions of their parents
- At the age from 10 to 11 years children prefer friends of the same sex
- They also start to become independent from the family

(ii) Adolescence

Physical and physiological changes

- Rapid growth of height and weight
- They become energetic and active
- Development of secondary sexual characteristics as follows

  Secondary sexual characteristics in males

- Hairs grow in armpits and pubic areas
- Development of beards
- Enlargement of sex organs
- Development of deep voice
- Some develop of pimples
- Shoulders and chest become wide

Secondary sexual characteristics in females

- Growth of hairs in armpits
- Girls start to get menstrual flow
- Enlargement of breasts
- Widening of pelvic girdles
- Enlargement of uterus, vulva, hips and buttocks
- Development of high pitched voice

Psychological and behavioural changes at puberty

- Positive personality development including opportunity various social skills such as empathy, sharing, leaderships by peers and academic motivation
- When adolescence is not handled properly, negative influences such as experimentation with drugs, alcoholism and stealing may develop
- Onset of puberty is also characterized by sexuality and sexual desire

(iii) Adulthood

Physical and physiological development

- Growth stops, only maintenance of body parts takes place
- At this stage, people are in their best physical conditions that is, very strong, energetic, have good memory capacity, sharp senses and stamina
- At late adulthood hairs start to turn grey, skin start to loose elasticity, women reach menopause and their desire to have sex is reduced

Behavioural and psychological changes

- People at this stage are very ambitious and want to succeed
- They are selective in terms of choosing occupations and partners
- They have a desire to be socially independent

(iv) Old age

Physical and physiological changes

- The ability to focus on objects, smells and hearing decreases
- Hair turns grey and thin as a result of reduced production of hair pigment. Some develop baldness
- Kidney functioning slows down
- Elasticity of the skin decreases
- Weakening of bones
- Loss of sexual desire

FACTORS THAT AFFECT PHYSICAL DETERIORATION IN HUMAN BEING

i. **Smoking**
- Smokers suffer more illnesses such as cancer than non-smokers.
- Smoking can cause lung cancer, cardiovascular disease, Chronic Obstructive Pulmonary Disease (COPD), and stroke.
- Smoking leads to premature balding, skin wrinkling and osteoporosis.
- Osteoporosis is a condition in which bones become thin and fragile, leading to fractures, stooped posture, breathing problems and back pain.

ii. **Alcoholism**
- The ability to metabolize alcohol decreases with age.
- Prolonged use of alcohol leads to damage of the central nervous system and brain and increases the risk of heart stroke and breast cancer for women.
- Alcoholism also increases the frequency of illnesses as it weakens the immune system and causes kidney failure and osteoporosis.

iii. **Drug abuse**
- Drug abuse weakens the immune system and causes premature aging. It thus reduces life span.

iv. **Stress**
- Stress may cause heart problems and high blood pressure.
- It also causes impairment of the immune system, thus making a person sick often. Other problems that may result from stress are failure to sleep (insomnia), fatigue, ulcers, headache etc

v. **Inactivity**
- Sedentary work and inactivity such as spending a long time watching TV or doing office work that involves sitting most of the time results in being overweight and its associated risks. It also shortens life span

- People who are inactive have more chances of developing health problems such as obesity and high blood pressure than those who are active.

vi. **Poor diet**

- Poor diet includes both underfeeding and overfeeding.
- Underfeeding causes malnutrition which reduces life span.
- Overfeeding leads to obesity and diabetes. Obesity and diabetes cause premature aging.

vii. **Diseases and infections**

- Pathogens produce toxins that accelerate deterioration.
- They also deprive our bodies of the necessary nutrients needed for good health.

viii. **Chemicals and radiations**

- Some chemicals such as those found in cosmetics, medicines, insecticides, pesticides, foodstuffs and sprays may have adverse effects on the human body.
- These chemicals speed up deterioration or shorten life span. Some radiations, for example X-rays, may affect our lives by killing body cells or causing deadly diseases like cancer.

ix. **Werner's syndrome**

- Werner's syndrome is a very rare disease that causes rapid ageing after puberty, such that a 20 or 30 year old person may look several decades old.
- It is caused by gene mutation and is named after a German scientist, Otto Werner, who described the syndrome

SERVICES REQUIRED TO MEET THE NEEDS OF EACH STAGE OF GROWTH AND DEVELOPMENT

i. Services required to meet the needs of children

- Children need complete nutrition. They need to feed on food rich in proteins, vitamins, minerals, carbohydrates, fibres and fats in the required amount
- Children should be protected against illness and injury especially through immunization
- Children need a home where they can live, be nurtured and be protected against harsh environmental conditions such as cold and rain
- They should be kept clean all the time

- The children need exercises and rest to improve their muscular activities

ii. Services required to meet the needs of adolescents

- They require healthy food for their growing bodies
- They also require peaceful home, security, emotional support and counselling
- Also they need to do physical exercises and social skills that will help them resist temptations from peers

iii. Services required to meet the needs of the elderly

- Older people need healthy for to strengthen their immune system and reduce the rate of body deterioration
- They should also need clean and comfortable clothing and a place to do light physical exercises
- They also need love, care and support to reduce anger, loneliness and stress

GROWTH AND DEVELOPMENT IN FLOWERING PLANTS

- Growth in flowering plants starts from the seeds when they germinate under favourable conditions to adult plants
- Localized growth takes place in flowering plants
- **Localized growth** – is the growth which takes place in specialized structures only.

Growth in plants involves the following processes

i. Embryogenesis – this is a part of embryo development from the zygote to embryo
ii. Vegetative development – this involves the germination process and development of vegetative plants
iii. Reproductive development – this involves flowering, pollination and fertilization

THE STRUCTURE OF SEEDS

- A seed is a small embryonic plant enclosed in in a covering called the seed coat, usually with some food store
- The seed contains three main parts which are seed coat, embryo and endosperm (nutrient storage tissues)

1. SEED COAT (TESTA)
    - This is the outer most layer of a seed with waxy cuticle
    - It is a protective covering that form around the fertilized ovule
    - It is hard and water resistant
    - The testa has a pole called **Micropyle**

- The **Micropyle** allows water and air to get in and out of a seed

FUNCTIONS OF TESTA

- It prevents the embryo from dehydration
- It protects the embryo against physical/mechanical damage
- It protects the embryo from insects, bacterial and fungal infections
- It protects the embryo during seed dispersal

2. EMBRYO
   - This is a rudimentary plant within the seed
   - It consists of the following structures

i. Radicle
   - This is the lower portion of the embryo axis which develop into roots during germination

ii. Plumule
   - This is the upper portion of embryo axis which develop into shoot during germination
   - It emerges after the radicle during germination

iii. Cotyledons
   - These are leaf like appendages of the embryo containing food materials
   - The number of cotyledons in angiosperms determines the classes in taxonomy where class monocotyledonae having one cotyledon and class dicotyledonae having two cotyledons

iv. Hypocotyl
   - This is the portion of embryo axis lying immediately below the cotyledon
   - This plays important role in epigeal type of germination
   - In epigeal germination, due to rapid elongation of the hypocotyl region, the cotyledons are pushed upwards and above the ground level

v. Epicotyl
   - This is the portion of embryo axis lying immediately above the cotyledons
   - It plays an important role in hypogeal type of germination
   - In hypogeal germination due to the rapid elongation of the hypogeal region, the Plumule is pushed upwards making the cotyledon to remain in the soil

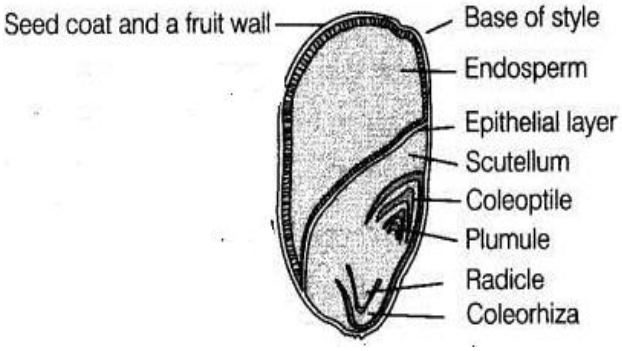
vi. Coleoptile

- This is the structure which covers the Plumule

vii. Coleorhiza

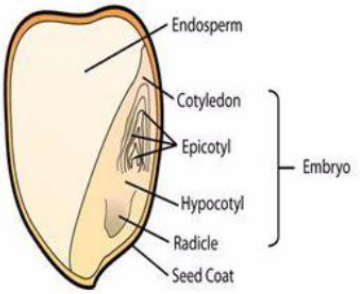
- This is t

INTERNAL STRUCTURE OF MAIZE GRAIN

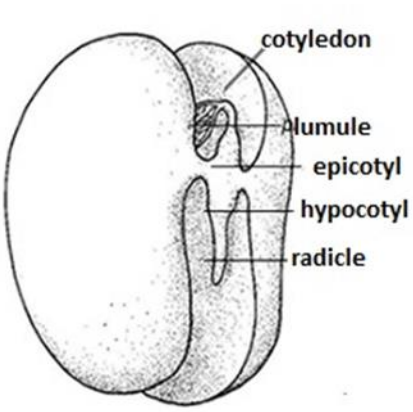


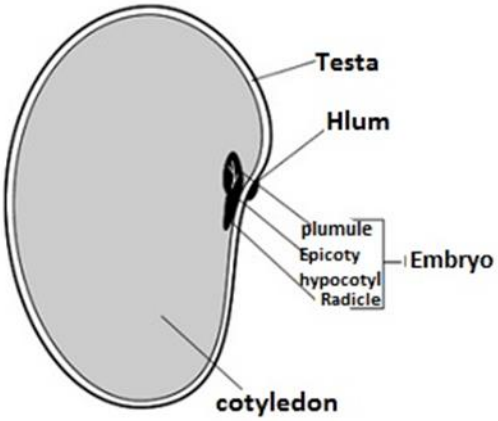
Parts:

1. Seed coat
2. Endosperm
3. Embryo
   a. Cotyledon
   b. Epicotyl
   c. Hypocotyl
   d. Radicle



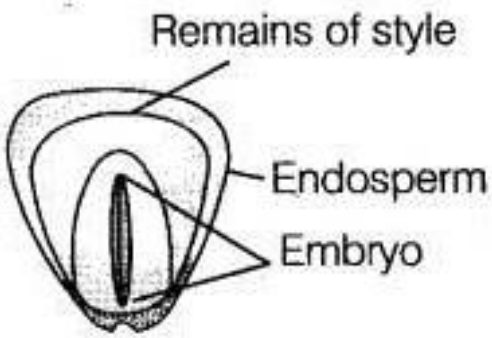
INTERNAL STRUCTURE OF BEAN SEED

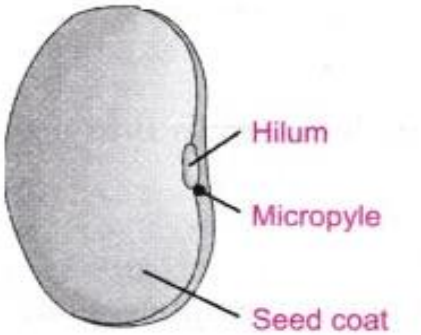




EXTERNAL STRUCTURE OF BEEN SEED

EXTERNAL STRUCTURE MAIZE GRAIN





3. ENDOSPERM (NUTRIENT STORAGE TISSUES)
   - Nutrients in the seed are stored in the structures called endosperm
   - Endosperm is a compact tissue lacking intercellular spaces which store starch, hemicellulose, proteins, oils and fats

SEED GERMINATION

- Germination is the development of seeds into seedling OR
- Is the process of an embryo of a seed to develop into adult plant OR
- Is the regrowth of the embryo after a period of dormancy

THE PROCESS/STAGES OF GERMINATION

- The process of germination takes place through main stages as follows
  i. Imbibition(absorption of water)
     - Imbibition is the process in which the seed absorbs water
     - The water soften the testa and causing it rupture and thus permits the embryo to emerge
     - Imbibition activates seed metabolism such as hydrolysis of stored food
  ii. Activation of metabolism
     - As a result of imbibition the metabolic activities and enzymes are activated
     - Metabolic activities such as respiration and protein synthesis takes place
     - Also hydrolysis of food substances takes place as follows

Protein $\xrightarrow{\text{Proteases}}$ amino acids

Carbohydrates $\xrightarrow{\text{Carbohydrases}}$ sugars

Lipids $\xrightarrow{\text{Lipases}}$ fatty acids + glycerol

  iii. Growth of the embryo
     - This is the last stage of germination which is characterized by presence of cell division resulting to the emergence of shoots and roots

- The roots develop from radicle, emerges through the micropyle and grows downwards due to geotropism
- The shoots develop from the Plumule and grows upwards due to negative geotropism
- In epigeal germination the cotyledon is pushed above the soil surface
- In hypogeal germination the cotyledon remains within the soil

CHANGES WHICH OCCUR DURING SEED GERMINATION

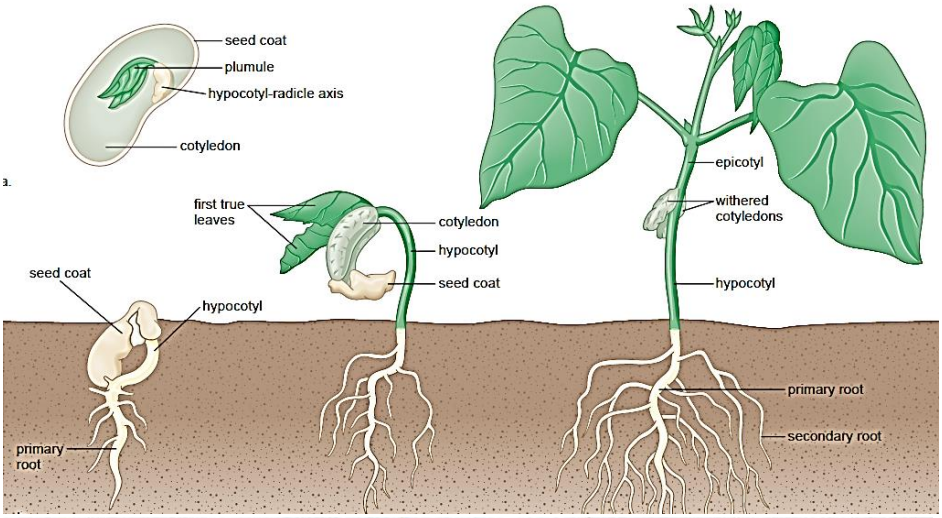
i. Germination is triggered by the entry of water into the seed through the micropyle
ii. Water soften the testa. The cells become turgid causing the rupture of the testa
iii. The water dissolves the food substances so that they can be transported to the growing parts
iv. Energy released during respiration is used for growth
v. The proteins stored in the seed are broken down into amino acids. these amino acids are used to synthesize the cellular components
vi. The radicle develops into the roots and grows downward while the Plumule develop into shoot and grows upwards
vii. In hypogeal germination the cotyledons remain in the soil while in epigeal germination the cotyledons are pushed above the soil surface

TYPES OF SEED GERMINATION

- In flowering plants two types of germination are found.
- They are: (a) Epigeal germination; and (b) Hypogeal germination

(a) Epigeal Germination

- Epigeal originates from the words (**epi** = which means above; **geo** = which means earth)
- This is the type of germination in which the cotyledons are pushed above the soil surface
- The epigeal germination is caused by rapid elongation of hypocotyl region hence pushing the cotyledon above the soil surface
- Examples of seeds undergoing epigeal germination are beans (*Phaseous vulgaris*), cucumber, soya beans



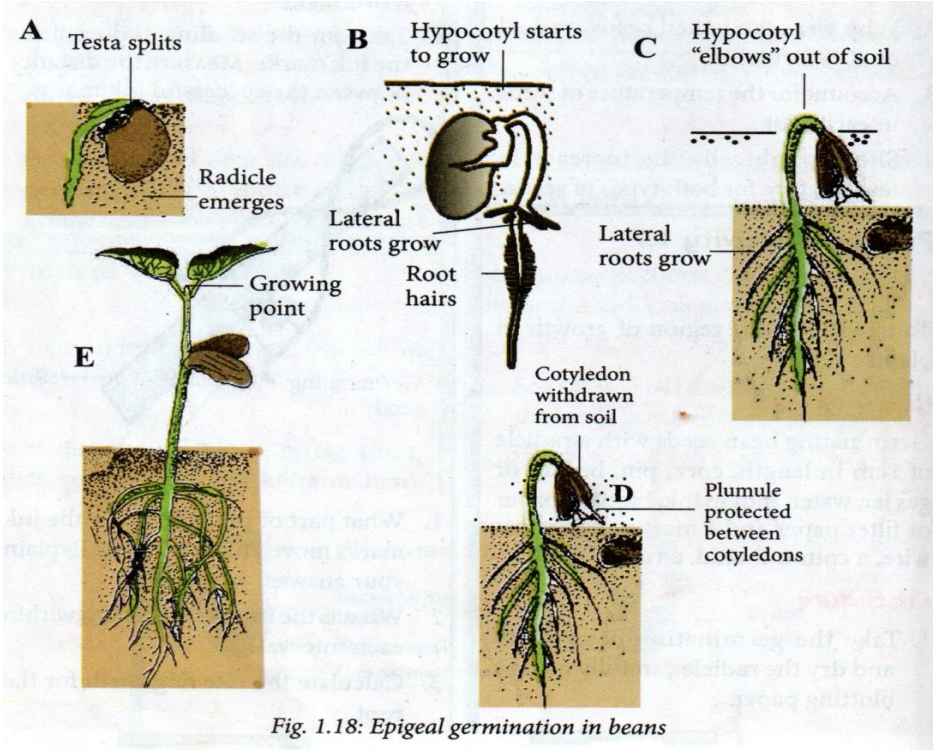
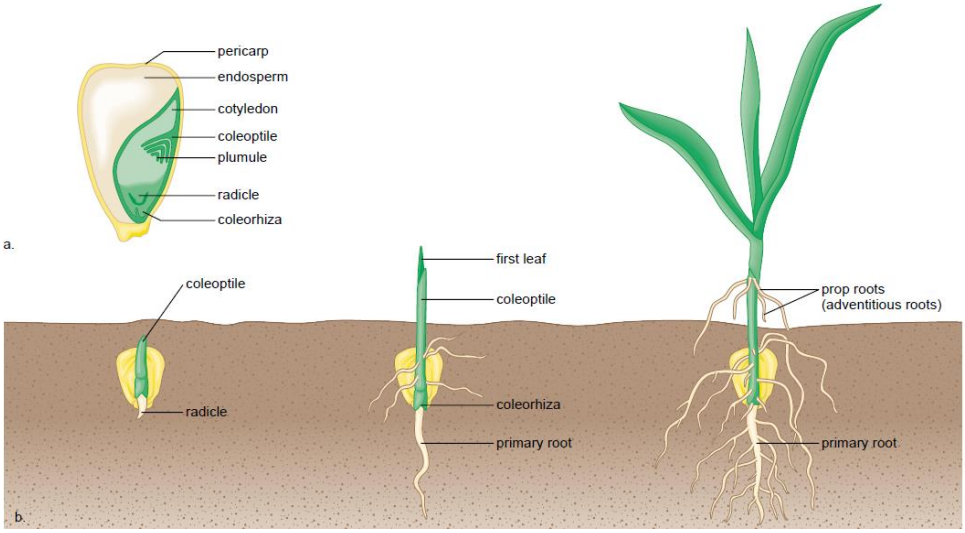


Fig. 1.18: Epigeal germination in beans

(b) Hypogeal Germination

- Hypogeal originates from the words (**hypo** = which means below, **geo** = which means earth)
- This is the type of germination in which the cotyledon remains within the soil
- This is caused by rapid elongation of epicotyl region making the Plumule to be pushed upward
- Examples of seeds undergoing hypogeal germination are avocado, mangoes, wheat, maize, rice etc



THE DIFFERENCE BETWEEN EPIGEAL AND HYPOGEAL GERMINATION

EPIGEAL GERMINATION	HYPOGEAL GERMINATION
1. In this type of seed germination the cotyledons come out of the soil, e.g., Castor.	1. The cotyledons remain inside the soil (e.g. Pea).
2. The cotyledons are brought out of the soil by the excessive growth of the hypocotyl.	2. The hypocotyl does not elongate much. Instead, the epicotyl grows and takes the plumule above the soil.
3. The terminal region of the hypocotyl is curved to protect the plumule and cotyledons from friction of the soil.	3. The terminal part of the epicotyl is curved in order to reduce damage to plumule by friction from soil particles.
4. The plumule remains enclosed and protected by cotyledons till it comes out of the soil.	4. There is no such provision.
5. The cotyledons become green and function as the first leaves of the seedling for photosynthesis	5. The cotyledons do not take part in photosynthesis.

THE CONDITIONS NECESSARY FOR SEED GERMINATION

- For a seed to germinate the following conditions must be present
  EXTERNAL (ENVIRONMENTAL) FACTORS

i. Water
   - Water is a solvent required for enzymatic activities.
   - Water enters the seed through the micropyle. The water softens the testa thus allowing the seed to take in water.
   - The osmotic pressure in the seed causes water to enter the seed by osmosis.
   - Pressure is created in the swollen seed, rupturing the softened testa.

   The seeds require water for the processes outlined below:

   (a) Activation of enzymes: When seeds are formed, most plants store a food reserve with the seed, such as starch, proteins, or oils. This food reserve provides nourishment to the growing embryo. When the seed imbibes water, hydrolytic enzymes are activated and break down these stored food resources into metabolically useful chemicals.

   (b) Most seeds need enough water to moisten them. The uptake leads to the swelling and the breaking of the seed coat, which enables the embryo to emerge from the cotyledon(s).

   (c) Water is used to dissolve food substances. The food needs to dissolve so as to diffuse or get transported to the growth parts of the embryo in the seed.

   (d) Water is needed for the development of the cell sap vacuoles. Large cell sap vacuoles contribute to the increase in the size of cells, hence growth

ii. Oxygen
   - Oxygen is required by the germinating seed for metabolism.
   - It is used in aerobic respiration, the main source of the seedling's energy until it grows leaves.
   - Respiration produces energy for processes like cell division and transport of food to growing regions.
   - Oxygen diffuses into the seed through the micropyle.
   - The softened testa later allows oxygen to diffuse directly into the tissues.

iii. Optimum temperature
   - Temperature affects cellular metabolic activities and growth rates.
   - Many seeds germinate at temperatures ranges of about 5 - 40°C.
   - Temperature is an important requirement for activation of enzymes.

- The enzymes in the seed work best at optimum temperature since they are denatured by high temperatures and inhibited by extremely low temperatures.

iv. Light
- The requirement of light for germination varies from plant to plant.
- In most of the seeds light is not an essential factor for germination. But in some cases like lettuce and tobacco light is absolutely essential.
- Some plants need darkness while others need light in varying degrees.
- Light or darkness can be an environmental trigger for germination and is a type of physiological dormancy.
- Most seeds are not affected by light or darkness, but many seeds, including species found in forest settings, will not germinate until an opening in the canopy allows sufficient light for growth of the seedling.

INTERNAL CONDITIONS/ FACTORS NECESSARY FOR SEED GERMINATION

i. Hormone
- Besides the above external factors, hormones also control germination of seeds. Some roles played by hormones are as follows.
- Gibberellins can induce germination in some cases even in complete darkness
- Auxin, Cytokinins and Ethylene can break dormancy in many seeds and initiate germination.

ii. Enzymes
- These are biological catalyst used to speed up the rate of metabolic activities
- Enzymes play a vital role during germination in the break down and oxidation of food
- The insoluble food is converted into a soluble form by the enzymes
- Enzymes are also necessary for the conversion of hydrolyzed products to new plant tissues

iii. Viability
- **Seed viability** - This is the ability of a seed to germinate
- A viable seed - Is a seed with the ability of germinating under favourable conditions
- Only seeds whose embryos are alive and healthy will be able to germinate ad grow

- Seeds stored for a long periods usually lose their viability due to depletion of their food reserves and destruction of their embryos by pests and diseases

FACTORS AFFECTING THE VIABILITY OF SEEDS

- Seed maturity
- Nature of a testa
- Availability of moisture
- Temperature
- Light intensity
- Storage condition

SEED DORMANCY

- This is the failure of a seed to germinate
- Dormancy is a resting period when seeds undergo no growth and have reduced cell activity

CAUSES OF SEED DORMANCY

- Freezing of a seed
- Immaturity of the embryo
- Hardness of a testa
- Presence of chemical inhibitors such as Abscissic acid
- Absence of necessary conditions for seed germination like water, optimum temperature and oxygen

WAYS OF BREAKING SEED DORMANCY

- Mechanical removal or softening the testa. This involves rubbing the seeds through the sand and burning some seeds like jacaranda which have hard testa to burst open the testa
- Supplying all necessary conditions for seed germination like water, oxygen and optimum temperature
- To ensure the maturity of the seed
- To ensure the presence of growth hormones such as gibberellins

- Removal of germination inhibitors. Example drying tomato seeds to remove abscisic acid

ADVANTAGES OF SEED DORMANCY

- Allows the embryo to develop
- Allows the time for seed dispersal
- Helps the seeds to avoid unfavourable conditions such as drought, extreme temperature etc
- Helps in the storage of seeds for future use

GROWTH REGIONS IN PLANTS/SEEDLING

- In plants, growth and development takes place in certain localized regions called **meristems**.
- The meristems are located at the tip of the shoots and tips of the roots and they are called **apical meristems**
- In the meristems the active division and differentiation occur

MERISTEMS (MERISTEMATIC TISSUES)

- These are plant tissues specialized for division to provide growth

TYPES OF MERISTEMS

(i) Apical meristems
- These are meristems which are found in the root and shoot tips
- They are responsible for primary growth, giving rise to primary plant body
- They result into increase in length of a plant

(ii) Lateral meristems
- These are meristems located laterally in older parts of a plant in the cambium
- They are responsible for secondary growth
- They result in increase in girth(thickness) of a plant

(iii) Intercalary meristems
- These are meristems located between the nodes and permanent tissues
- Allow growth in length in the internodes
- They also result into increase in length

PRIMARY GROWTH

- This refers to the increase in length of the shoot and root
- The increase in length is brought about by cell division, cell elongation and cell differentiation

(i) Cell division
- The meristematic cells undergo mitotic division
- One of the daughter cells formed remain meristematic and continue to divide
- The other daughter cell absorbs water and expands and does not divide

(ii) Cell elongation
- This is the increase in length of a cell
- The cells behind the tip draw in water and absorb water by osmosis
- This help to develop the vacuole and expand resulting to cell elongation

(iii) Cell differentiation
- This is the process in which the cell are specialized for specific functions
- The elongated cells undergo maturation to form specialized tissues such as vascular tissues and parenchyma tissues
- In the stem the apical meristem give rise to leaf primordium which will develop into leaves and apical buds
- The cells in the zone of maturation are arranged in circles to form vascular tissues
- The cells between the epidermis and vascular bundles are called **parenchyma cells**
- in the roots the apical meristem is protected by the root cap
- some of the cells differentiate into roots hairs, which provide the surface area for absorption of water and mineral salts

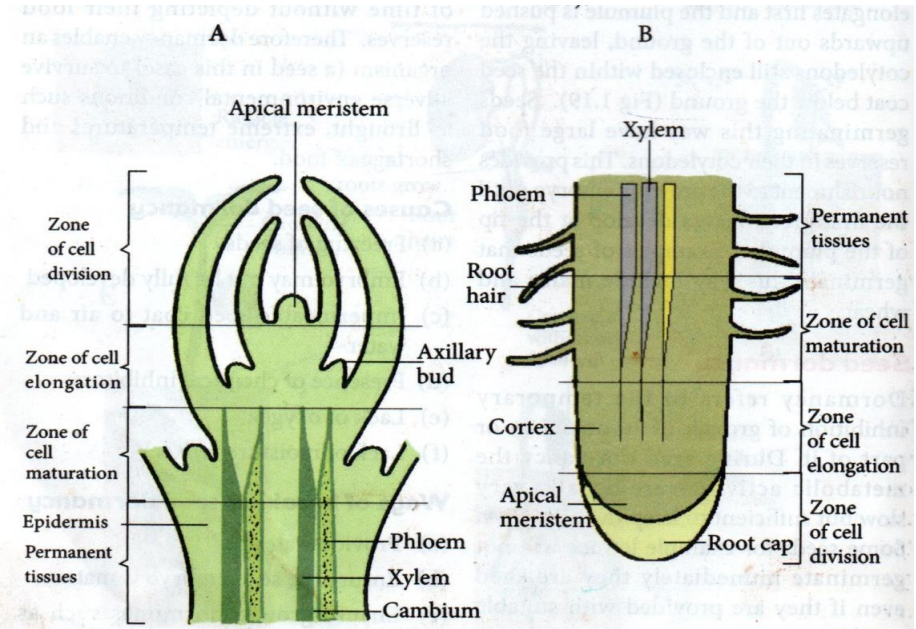
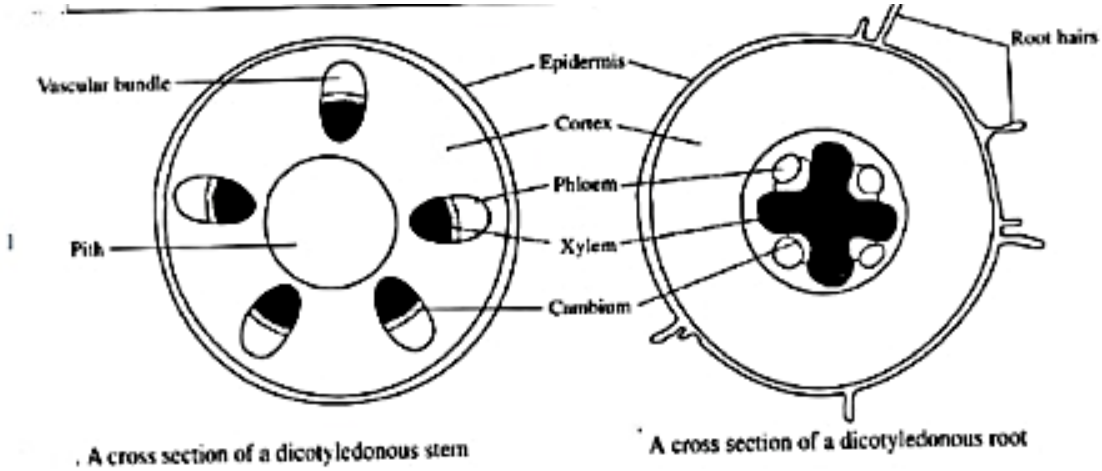
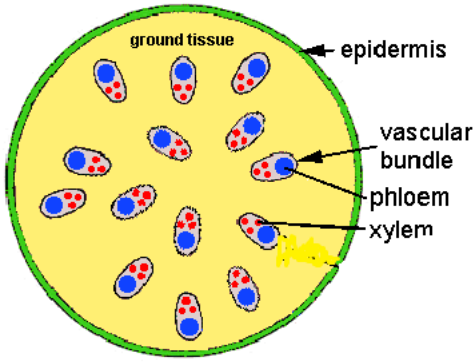
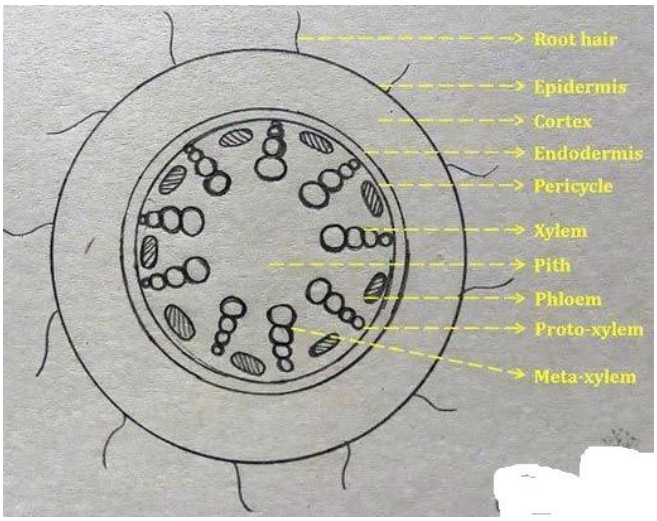


Fig. 1.20: Longitudinal sections of meristematic regions of (A) a shoot tip and (B) root tip





Monocot stem



Monocot root

SECONDARY GROWTH

- This refers to the increase in thickness(girth) of woody stem and roots
- Secondary growth does not occur in herbaceous, annuals and biennials
- The cells between the xylem and phloem form the vascular cambium
- The vascular cambium retain the ability to divide by mitosis to form the secondary xylem and phloem
- The increase in diameter of the stem is called secondary growth or secondary thickening

APICAL DOMINANCE

- This refers to the inhibition of the development of the lateral buds by the terminal buds
- This is because the apical bud contains high concentration of Auxin hormone

THE DIFFERENCE BETWEEN GROWTH IN ANIMALS AND PLANTS

GROWTH IN ANIMALS	GROWTH IN PLANTS
(i) Diffuse growth takes place (ii) Broken parts like limbs cannot regenerate (iii) Growth leads to a compact shape	(i) Localized growth takes place (ii) Broken parts like branches can regenerate (iii) Growth leads to a branched shape

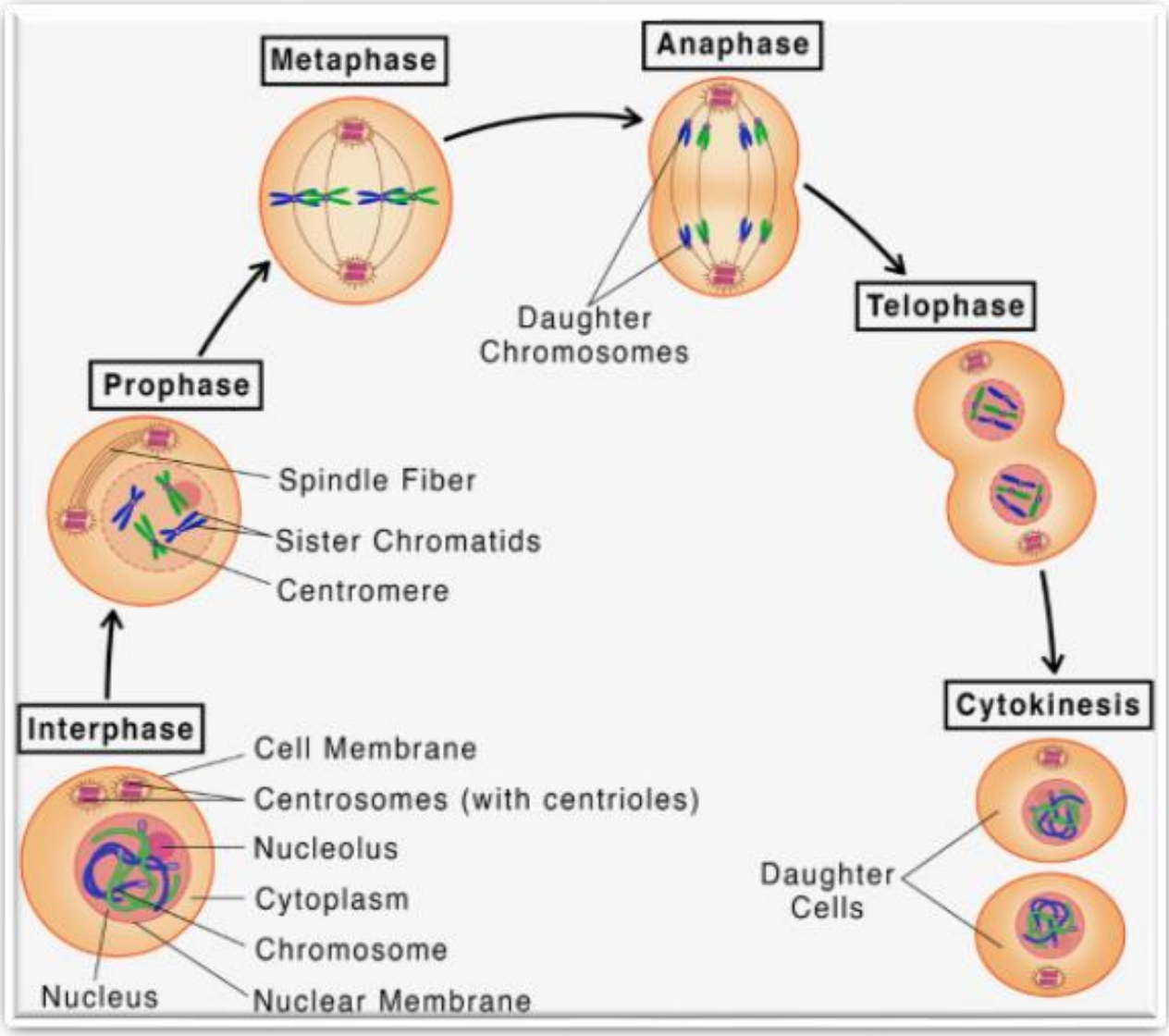
REFERENCE

Mustapha A. J et.al (2008), New essentials of biology book 4, Nyambari Nyangwine publishers

Mwaniki J.M and Geofrey G.G (2013), Fundamentals of biology Form 4 new edition, Long horn publishers

Oxford (2013), Biology for secondary schools form 4, oxford university press

Taylor D.J et.al (2016), Biological science third edition, Cambridge university press


Metaphase
Anaphase
Daughter
Chromosomes
Telophase
Prophase
Spindle Fiber
Sister Chromatids
Centromere
Cytokinesis
Interphase
Cell Membrane
Centrosomes (with centrioles)
Nucleolus
Cytoplasm
Chromosome
Nuclear Membrane
Nucleus
Daughter
Cells