

Class: 12th

Subject: Biology

Unit 19: GROWTH AND DEVELOPMENT

Important MCQs:

1. The progressive changes an organism undergoes before acquiring its adult form are called:

- (a) Growth
- (b) Development
- (c) Maturation
- (d) Differentiation

2. Growth is best defined as:

- (a) Temporary increase in size
- (b) Reversible change in structure
- (c) Permanent and irreversible increase in size
- (d) Change in color of organism

3. In plants, growth and development involve:

- (a) Cell division, respiration, photosynthesis
- (b) Cell division, elongation and differentiation** ✓
- (c) Diffusion and osmosis
- (d) Reproduction and germination

4. The growth pattern in plants is known as:

- (a) Closed growth
- (b) Restricted growth
- (c) Open growth** ✓
- (d) Determinate growth



5. The regions where growth occurs in vascular plants are called:

- (a) Nodes
- (b) Meristems** ✓
- (c) Chloroplasts
- (d) Internodes

6. Which cells retain the ability to divide throughout the plant's life?

- (a) Permanent cells
- (b) Guard cells
- (c) Meristematic cells
- (d) Epidermal cells

7. Apical meristems are located at:

- (a) Base of stem
- (b) Tip of roots and shoots
- (c) Middle of internodes
- (d) Surface of leaves

8. The main function of apical meristem is:

- (a) Increase in diameter
- (b) Formation of flowers
- (c) Extension of plant body
- (d) Production of cork cells

9. Intercalary meristems are found:

-
- (a) At the tips of roots
 - (b) At the bases of internodes** ✓
 - (c) Inside the seed
 - (d) Between xylem and phloem

10. The temporary type of meristem is:

- (a) Apical meristem
- (b) Lateral meristem
- (c) Intercalary meristem** ✓
- (d) Cork cambium

11. Lateral meristems are responsible for:

- (a) Increase in length
- (b) Increase in thickness** ✓
- (c) Formation of flowers
- (d) Root hair formation

12. Examples of lateral meristem include:

- (a) Root tip and shoot tip

(b) Vascular cambium and cork cambium

(c) Apical and intercalary meristem

(d) Pith and cortex

13. Primary growth in plants is caused by:

(a) Apical meristem

(b) Lateral meristem

(c) Intercalary meristem

(d) Vascular cambium

14. Secondary growth leads to:

(a) Increase in length

(b) Formation of new leaves

(c) Increase in thickness

(d) Production of fruits

15. During the elongation phase of growth, cells increase in volume mainly due to:

(a) Uptake of water

(b) Increase in DNA content

-
- (c) Loss of turgor pressure
 - (d) Accumulation of starch

16. Growth rate in plants is influenced by:

- (a) Only internal factors
- (b) Only external factors
- (c) Both internal and external factors
- (d) None of these

17. The optimum temperature for maximum plant growth is:

- (a) 0–5°C
- (b) 5–10°C
- (c) 25–30°C
- (d) 35–40°C

18. At a temperature of 35–40°C, the rate of plant growth:

- (a) Becomes maximum
- (b) Slows down
- (c) Stops completely and plant may die

(d) Remains constant

19. Red light affects plant growth by:

(a) Retarding elongation

(b) Favours cell elongation

(c) Enhancing cell division

(d) Reducing photosynthesis

20. Blue light influences growth by:

(a) Enhancing cell division but retarding cell enlargement

(b) Retarding both division and elongation

(c) Increasing both division and elongation

(d) Causing leaf fall

21. The phenomenon by which light duration affects flowering is called:

(a) Phototropism

(b) Photoperiodism

(c) Photosynthesis

(d) Photolysis

22. Oxygen is essential for plant growth because:

- (a) It provides water
- (b) It helps in cell wall formation
- (c) It supports metabolic activities
- (d) It absorbs light energy

23. High concentration of carbon dioxide:

- (a) Increases growth rate
- (b) Retards growth
- (c) Has no effect
- (d) Enhances flowering



StudyNotes360.com

24. Growth of plants ceases completely in the absence of:

- (a) Light
- (b) Oxygen
- (c) Water
- (d) Temperature

25. Indole-3-acetic acid (IAA) is a plant hormone that causes:

-
- (a) Cell division
 - (b) Elongation of cells**
 - (c) Fruit ripening
 - (d) Leaf fall

26. Vitamins in plants are synthesized:

- (a) In the dark
- (b) In the presence of light**
- (c) Only in roots
- (d) Only in seeds

27. The process of formation of specialized tissues from meristematic cells is called:

- (a) Germination
- (b) Differentiation**
- (c) Elongation
- (d) Maturation

28. During differentiation, leaf primordia develop from:

- (a) Cambium

(b) Apical meristematic cells ✓

(c) Pericycle

(d) Xylem

29. The phenomenon in which the apical bud inhibits the growth of lateral buds is called:

(a) Phototropism

(b) Apical dominance ✓

(c) Compensatory effect

(d) Geotropism

30. Auxin produced by the apical bud inhibits lateral bud growth, but this inhibition can be removed by applying:

(a) Ethylene

(b) Cytokinins ✓

(c) Gibberellins

(d) Abscisic acid

31. The branch of biology that studies growth and differentiation of organisms from a fertilized egg is called:

-
- (a) Genetics
 - (b) Morphology
 - (c) Embryology
 - (d) Cytology

32. Development in animals is:

- (a) A reversible sequence of steps
- (b) An ordered and irreversible sequence of steps
- (c) A random process
- (d) Temporary change in structure

33. Fertilization in a chick is:

- (a) External
- (b) Internal
- (c) Artificial
- (d) Absent

34. The shell of the egg is secreted in:

- (a) Oviduct

(b) Ovary

(c) Shell gland (uterus)

(d) Cloaca

35. Artificial incubation of eggs is done at a temperature between:

(a) 25–30°C

(b) 36–38°C

(c) 40–45°C

(d) 20–25°C

36. The chick egg shows a type of cleavage called:

(a) Holoblastic cleavage

(b) Spiral cleavage

(c) Discoidal cleavage

(d) Radial cleavage

37. The morula stage is characterized by:

(a) Presence of a segmentation cavity

(b) Rounded mass of closely packed blastomeres

(c) Splitting of blastoderm layers

(d) Formation of gastrula

38. The blastula stage in chick development is identified by:

(a) The appearance of the blastocoele

(b) Presence of morula cells

(c) Absence of yolk

(d) Formation of the shell

39. During gastrulation, the blastoderm splits into:

(a) Epiblast and endoderm

(b) Ectoderm and mesoderm

(c) Epiblast and hypoblast

(d) Mesoderm and blastocoel

40. The area pellucida in chick blastoderm is:

(a) Opaque region adherent to yolk

(b) Translucent area raised off the yolk

(c) Region of undifferentiated cells

(d) Peripheral dark zone of yolk

41. In chick embryo, mesodermal cells migrate medially and caudally to form:

(a) Neural plate

(b) Primitive streak

(c) Blastocoel

(d) Somites

42. The primitive streak in chick embryo represents:

(a) Neural tube

(b) Dorsal and lateral lips of blastopore

(c) Germ wall

(d) Primitive gut

43. The anterior end of the primitive streak contains:

(a) Primitive groove

(b) Hensen's node

(c) Somites

(d) Coelom

44. The primitive groove is:

- (a) A cavity inside yolk
- (b) A groove formed along the length of primitive streak** ✓
- (c) A depression in the neural plate
- (d) A space between ectoderm and endoderm

45. The local thickening at the cephalic end of primitive streak is called:

- (a) Germ wall
- (b) Hensen's node** ✓
- (c) Blastoderm
- (d) Gray crescent



46. The notochord is formed from cells of:

- (a) Primitive groove
- (b) Hensen's node** ✓
- (c) Epiblast
- (d) Hypoblast

47. The notochord lies beneath:

(a) Endoderm

(b) Ectoderm

(c) Mesoderm

(d) Coelom

48. The lateral plate mesoderm splits into:

(a) Somatic and splanchnic layers

(b) Ectoderm and endoderm

(c) Neural and notochordal layers

(d) Mesoderm and coelom

49. The cavity between somatic and splanchnic mesoderm is called:

(a) Blastocoel

(b) Coelom

(c) Neurocoel

(d) Primitive gut

50. Somites appear in chick embryo after:

(a) 6 hours

(b) 12 hours

(c) 25–26 hours

(d) 40 hours

51. The process of formation of neural tube is known as:

(a) Cleavage

(b) Neurulation

(c) Gastrulation

(d) Fertilization

52. The neural plate forms from:

(a) Mesoderm

(b) Endoderm

(c) Neural ectoderm

(d) Notochord

53. The neural groove is formed along the:

(a) Ventral line

(b) Mid-dorsal line

-
- (c) Lateral surface
 - (d) Cephalic end only

54. The neural tube later develops into:

- (a) Digestive system
- (b) Central nervous system
- (c) Skeletal system
- (d) Circulatory system

55. The cavity inside the neural tube is known as:

- (a) Blastocoel
- (b) Neurocoel
- (c) Coelom
- (d) Primitive gut

56. The primitive gut is derived from:

- (a) Endoderm
- (b) Mesoderm
- (c) Ectoderm

(d) Neural plate

57. According to Hans Driesch's experiment, each cell of the early embryo:

- (a) Has partial genetic information
- (b) Contains complete genetic information** ✓
- (c) Contains only cytoplasmic information
- (d) Cannot develop independently

58. In Spemann's experiment, cell division occurred only in:

- (a) The anucleate half
- (b) The half containing the nucleus** ✓
- (c) The half lacking cytoplasm
- (d) Both halves equally

59. Gray crescent region is important because it:

- (a) Controls gastrulation
- (b) Contains cytoplasmic information essential for development** ✓
- (c) Forms neural plate

(d) Produces yolk

60. Cell differentiation in embryo occurs mainly due to:

(a) Random gene loss

(b) Cytoplasmic segregation and induction

(c) Mutation in nucleus

(d) Disappearance of chromatin

61. The study of how cytoplasmic components influence cell differentiation is related to:

(a) Embryology

(b) Morphogenesis

(c) Cytoplasmic inheritance

(d) Cell division

62. Different cytoplasmic components contain:

(a) Genetic codes

(b) Morphogenetic determinants

(c) Enzymes only

(d) Hormonal receptors

63. In an ascidian egg, yellow cytoplasm gives rise to:

- (a) Notochord
- (b) Gut
- (c) Epidermis
- (d) Muscle cells

64. The gray vegetal cytoplasm in a fertilized egg develops into:

- (a) Neural tube
- (b) Gut
- (c) Epidermis
- (d) Muscles



65. Which scientist performed experiments on Acetabularia to study nuclear control in development?

- (a) Spemann
- (b) Mangold
- (c) Haemmerling
- (d) Darwin

66. The experiment on Acetabularia proved that:

- (a) Cytoplasm alone controls development
- (b) Nucleus determines the structural form** ✓
- (c) Both nucleus and cytoplasm have no role
- (d) Cytoplasm determines genetic type

67. The process by which cells become specialized in structure and function is called:

- (a) Fertilization
- (b) Differentiation** ✓
- (c) Morphogenesis
- (d) Regeneration



68. According to Spemann's experiment, mesoderm has the ability to:

- (a) Produce hormones
- (b) Induce ectoderm to form nervous system** ✓
- (c) Develop into epidermis
- (d) Form blood vessels only

69. The capacity of some cells to evoke a specific developmental response in other cells is known as:

- (a) Differentiation
- (b) Regeneration
- (c) Embryonic induction
- (d) Cell determination

70. The dorsal lip of the blastopore was termed as the primary organizer because it:

- (a) Controlled movement of cytoplasm
- (b) Induced formation of a secondary embryo
- (c) Produced hormones
- (d) Formed only epidermis

71. Aging can be defined as:

- (a) Growth of new tissues
- (b) Negative physiological changes in the body
- (c) Repair of damaged organs
- (d) Increase in body immunity

72. Which of the following is not a common sign of aging?

- (a) Wrinkling of skin
- (b) Increased agility** ✓
- (c) Loss of hair pigment
- (d) Forgetfulness

73. Degeneration of cartilage in joints due to aging results in:

- (a) Osteoporosis
- (b) Arthritis** ✓
- (c) Diabetes
- (d) Paralysis



74. Arteriosclerosis results from:

- (a) Loss of calcium
- (b) Degeneration of elastic tissues in blood vessels** ✓
- (c) Increase in muscle fibers
- (d) Hardening of bones

75. Cells of most tissues divide only a finite number of times; this limits:

(a) Growth and repair

(b) Mutation

(c) Regeneration

(d) Metabolism

76. Which protein becomes cross-linked and less elastic during aging?

(a) Keratin

(b) Actin

(c) Collagen

(d) Myosin

77. The process of aging can be slowed down by:

(a) Smoking

(b) Lack of exercise

(c) Proper nutrition and rest

(d) Starvation

78. The scientific study of aging is called:

(a) Cytology

(b) Gerontology

(c) Morphology

(d) Ontogeny

79. The maximum human lifespan is judged to be about:

(a) 90–100 years

(b) 110 years

(c) 120–125 years

(d) 140 years

80. The goal of gerontology is mainly to:

(a) Stop aging completely

(b) Increase health span

(c) Produce new cells

(d) Prevent regeneration

81. The ability to regrow lost or injured body parts is called:

(a) Growth

(b) Regeneration

(c) Differentiation

(d) Aging

82. Which animal has the greatest power of regeneration?

(a) Salamander

(b) Sponge

(c) Lizard

(d) Earthworm

83. If a lobster loses its pincer claw, it can:

(a) Not regrow it

(b) Regenerate a new claw

(c) Grow a new leg

(d) Die immediately

84. The tail of a lizard can be regenerated because of:

(a) Dedifferentiation of cells

(b) Blood clotting

(c) Photosynthesis

(d) Aging cells

85. In planaria, regeneration occurs due to:

(a) Nerve cells

(b) Muscle cells

(c) Neoblasts

(d) Gland cells

86. In regeneration of salamander limbs, cells at the wound site first:

(a) Die

(b) Dedifferentiate

(c) Reproduce sexually

(d) Stop dividing

87. Regeneration in plants forms the basis of:

(a) Photosynthesis

(b) Transpiration

(c) Vegetative propagation

(d) Fertilization

88. The study of abnormal development is called:

- (a) Cytology
- (b) Teratology** ✓
- (c) Embryology
- (d) Histology

89. Which syndrome results from trisomy of sex chromosomes (XXY)?

- (a) Turner's syndrome
- (b) Down syndrome
- (c) Klinefelter's syndrome** ✓
- (d) XYY syndrome

90. The condition in which an individual has a missing X chromosome (XO) is called:

- (a) Turner's syndrome** ✓
- (b) Klinefelter's syndrome
- (c) Down syndrome
- (d) XYY syndrome

Q4: Exercise Short Questions

(i) What is organizer and inducer substance?

Answer:

- An **organizer** is a group of embryonic cells that direct the development of surrounding cells.
- An **inducer substance** is the chemical produced by these organizer cells that stimulates or influences other cells to develop into specific tissues or organs.

(ii) What is differentiation?

Answer:

Differentiation is the process by which unspecialized cells change into specialized cells with specific structures and functions, such as muscle or nerve cells.

(iii) Define embryonic induction.

Answer:

Embryonic induction is the process by which one group of cells influences the development of another group of cells, leading to the formation of particular tissues or organs.

(iv) Differentiate between growth and development.

Answer:

Growth means an increase in size, number, or mass of cells, while development refers to changes in structure and function that make an organism more complex and mature. Growth is quantitative, but development is qualitative.

(v) What is meristem?

Answer:

Meristem is a region in plants that contains actively dividing cells. These cells are responsible for the increase in length or thickness of plant organs such as roots and shoots.

Important Short Questions:

1. What is embryonic development?

Answer:

Embryonic development is the progressive series of changes that occur in an organism before it attains its adult form.

2. Define growth.

Answer:

Growth is a permanent and irreversible increase in size that occurs as an organism matures.

3. Define development.

Answer:

Development is a programmed series of stages through which an organism passes from a simpler to a more complex form.

4. What is open growth in plants?

Answer:

Open growth means that plants continue to add new organs like leaves, roots, and branches throughout their life.

5. What are meristems?

Answer:

Meristems are young tissues or groups of cells in plants that retain the ability to divide and bring about growth.

6. What are apical meristems and where are they found?

Answer:

Apical meristems are found at the tips of roots and shoots and are responsible for the extension of the plant body (primary growth).

7. What are intercalary meristems?

Answer:

Intercalary meristems are portions of apical meristem located at the bases of internodes. They help in producing leaves and flowers.

8. What are lateral meristems?

Answer:

Lateral meristems are cylinders of dividing cells found in dicots and gymnosperms that increase the thickness of stem and root (secondary growth).

9. What are the phases of growth in plants?

Answer:

The four phases of growth in plants are:

1. Cell division
2. Elongation

3. Maturation

4. Differentiation

10. What happens during the elongation phase of plant growth?

Answer:

During elongation, the cell volume increases up to 150 times due to water uptake, and new cytoplasm and cell wall materials are synthesized.

11. What are the two main factors that influence the rate of plant growth?

Answer:

👉 The rate of plant growth is influenced by external factors (temperature, light, oxygen, carbon dioxide, water, and nutrition) and internal factors (hormones and vitamins).

12. What is the optimum temperature range for maximum plant growth?

Answer:

👉 The optimum temperature range for maximum plant growth is 25°C to 30°C.

13. How does light intensity affect plant growth?

Answer:

👉 Increased light intensity increases the number of cell divisions.

👉 Red light favors cell elongation, while blue light promotes cell division but retards elongation.

14. What is photoperiodism?

Answer:

👉 Photoperiodism is the phenomenon in which the duration of light affects the growth and flowering of plants by inducing or suppressing reproduction.

15. Why is oxygen necessary for plant growth?

Answer:

👉 Oxygen is essential for respiration, which provides energy for metabolic activities needed for plant growth. Without oxygen, growth cannot occur.

16. How does water affect the process of plant growth?

Answer:

👉 Water is necessary for cell elongation and turgidity. In the absence of water, plant growth stops completely.

17. Name two internal factors that influence plant growth.

Answer:

👉 The two main internal factors influencing plant growth are hormones (like auxins) and vitamins.

18. What is differentiation in plants?

Answer:

👉 Differentiation is the process through which unspecialized cells develop into specialized tissues and organs such as xylem, phloem, leaves, and roots.

19. What is meant by apical dominance?

Answer:

👉 Apical dominance is the phenomenon in which the growth of lateral buds is inhibited by the active apical bud due to the influence of the hormone auxin.

20. Which plant hormones are involved in apical dominance, and what are their roles?

Answer:

👉 Auxin inhibits the growth of lateral buds (causing apical dominance), while cytokinin promotes lateral bud growth by releasing them from the inhibitory effect of auxin.

21. What is embryology?

Answer:

Embryology is the study of growth and differentiation undergone by an organism during its development from a single fertilized egg into a complex and independent living being.

22. What is the temperature range required for artificial incubation of chick eggs?

Answer:

For artificial incubation, the eggs are kept at a temperature between 36°C to 38°C, at which the chick completes its development and hatches on the twenty-first day.

23. What is cleavage, and what type of cleavage occurs in bird's egg?

Answer:

- **Cleavage** is a series of mitotic divisions that occur immediately after fertilization.
- In birds, the cleavage is discoidal, confined to a small disc of protoplasm on the surface of the yolk at the animal pole.

24. What is morula, and how is it formed?

Answer:

- **Morula** is a rounded, closely packed mass of blastomeres formed after cleavage.
- It consists of a disc-shaped mass of cells called blastoderm lying close to the yolk.

25. What happens during gastrulation in chick development?

Answer:

- During gastrulation, the blastoderm splits into two layers:
- The upper epiblast (presumptive ectoderm and mesoderm)
- The lower hypoblast (presumptive endoderm)
- This rearrangement marks the beginning of tissue and organ formation.

26. What is the primitive streak, and how is it formed in chick development?

Answer:

👉 The primitive streak is a midline thickening formed by the migration of mesodermal cells from both sides of the blastoderm. It marks the beginning of mesoderm formation and causes the blastoderm to change from circular to pear-shaped.

27. What is Hensen's node?

Answer:

👉 Hensen's node is a local thickening at the anterior end of the primitive streak. It plays a key role in the formation of the notochord and dorsal mesoderm.

28. What is the function of the notochord?

Answer:

👉 The notochord provides support to the developing embryo and acts as a primary organizing center for the formation of the neural tube and vertebral column.

29. What is coelom, and how is it formed?

Answer:

👉 Coelom is a body cavity formed between the somatic and splanchnic layers of the lateral plate mesoderm.

30. What is neurulation?

Answer:

👉 Neurulation is the process in which the neural plate folds to form the neural tube, which later develops into the brain and spinal cord.

31. What is the neural plate, and what does it give rise to?

Answer:

👉 The neural plate is a thickened band of ectoderm formed over the notochord. It gives rise to the neural tube, which develops into the central nervous system.

32. What are anterior and posterior neuropores?

Answer:

👉 The anterior and posterior neuropores are openings at both ends of the neural tube that close later during embryonic development.

33. What did Hans Driesch conclude from his sea urchin experiment?

Answer:

👉 Hans Driesch concluded that each cell of a two-cell stage embryo contains complete genetic information and can develop into a full organism.

34. What were the conclusions drawn by Spemann from his experiments?

Answer:

👉 Spemann concluded that:

1. All cells contain the same nuclear information.
2. The cytoplasm of the gray crescent area contains information essential for development.

35. What are the two ways by which cells undergo differentiation?

Answer:

👉 Cells undergo differentiation through:

1. Cytoplasmic segregation of determinative molecules.

2. Induction or interaction with neighboring cells.

36. What are morphogenetic determinants?

Answer:

Morphogenetic determinants are specific substances present in the cytoplasm that control the development and differentiation of cells into specific tissues or organs during embryonic growth.

37. What is the role of cytoplasm in development?

Answer:

Cytoplasm contains morphogenetic determinants that influence cell differentiation by selecting which genes in the nucleus will be expressed during development.

38. What is embryonic induction?

Answer:

Embryonic induction is the process by which certain cells or tissues influence the development of neighboring cells, causing them to form specific organs or structures.

39. What is aging?

Answer:

Aging is a natural process involving negative physiological changes in the body such as wrinkles, weakness, and reduced immunity.

40. Write any two visible signs of aging.

Answer:

Loss of hair pigment and dryness or wrinkling of skin are two common signs of aging.

41. What is the main cause of arthritis in old age?

Answer:

Arthritis is caused by degeneration of cartilage in the joints.

42. What is arteriosclerosis?

Answer:

Arteriosclerosis is the hardening of blood vessels due to degeneration and loss of elastic tissues in their walls.

43. How does collagen change with aging?

Answer:

During aging, collagen molecules develop more cross-linkages, making tissues harder and less elastic.

44. Name any two factors that can slow down the aging process.

Answer:

Regular exercise and adequate sleep can help slow down the aging process.

45. What is gerontology?

Answer:

Gerontology is the scientific study of aging and the problems of older individuals.

46. What is the maximum human lifespan?

Answer:

The maximum human lifespan is about 120 to 125 years.

47. Define regeneration.

Answer:

Regeneration is the ability of an organism to replace or restore lost or injured body parts.

48. Give two examples of animals that show regeneration.

Answer:

Starfish and salamanders can regenerate their lost body parts.

49. What is the role of neoblasts in regeneration?

Answer:

In flatworms and planaria, neoblasts are unspecialized cells that migrate to the injury site and differentiate into required cell types.

50. How do lizards regenerate their tails?

Answer:

Lizards regenerate their tails through specialized regenerative tissues present in the tail region after it is lost.

51. Define teratology.

Answer:

Teratology is the branch of biology that studies abnormal development and its causes.

52. What are teratogens?

Answer:

Teratogens are environmental factors such as X-rays, toxins, or drugs that cause abnormal development in embryos.

53. What is Klinefelter's Syndrome?

Answer:

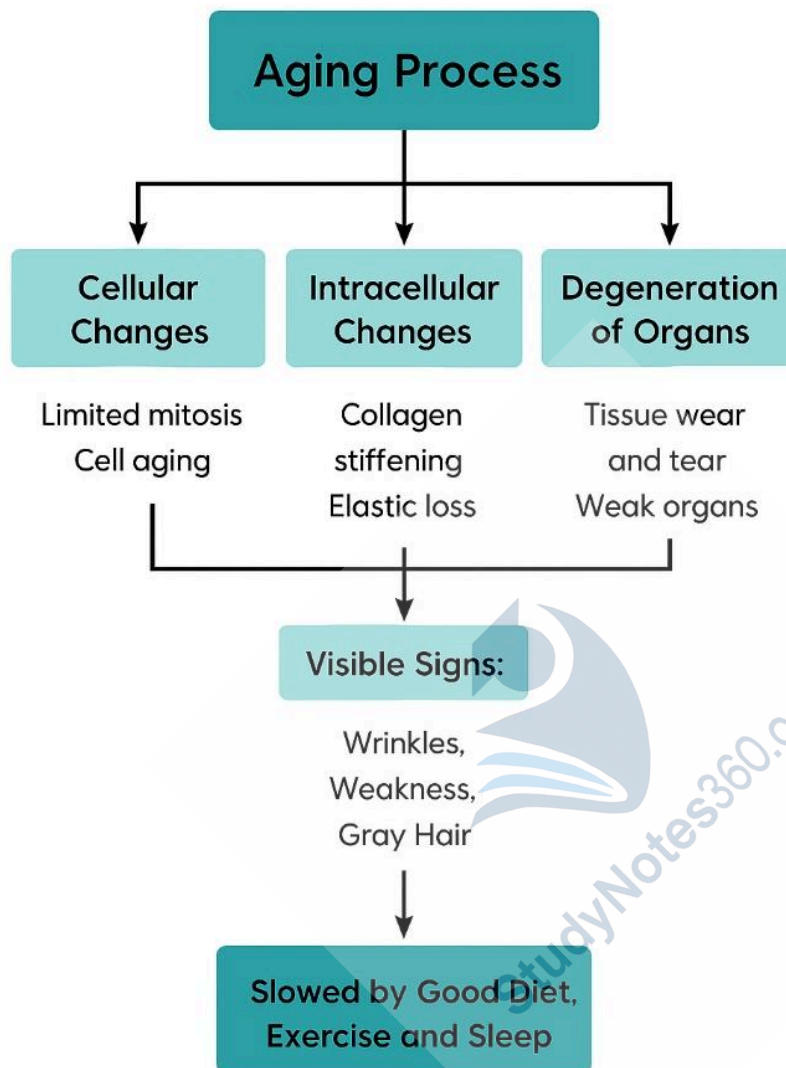
Klinefelter's Syndrome is a chromosomal abnormality (XXY) in males, resulting in trisomy of the sex chromosome.

Q5: Exercise Long Questions:

☀ **Q1: What is Aging? How will you explain this process?**

❖ **Definition:**

Aging is a natural and unavoidable biological process in which the efficiency of the body gradually decreases with time. It is defined as the negative physiological changes that occur in the body as a person grows older, resulting in weakness, slower repair, and decline of organ functions.



◆ **Explanation of the Process:**

The process of aging affects all levels of the body – from cells to tissues and whole organs. It is gradual, continuous, and influenced by both internal and external factors.

1. Cellular Changes:

- Every body cell divides only a fixed number of times.
- When this limit is reached, cells stop dividing, resulting in the loss of growth and repair ability.

For example, in the nervous system, nerve cells (neurons) do not divide again, which causes decline in mental activity and memory during old age.

2. Changes in Intracellular Substances:

- During aging, collagen fibers in connective tissues develop extra cross-linkages, making them hard and less flexible.
- **Similarly**, elastic fibers lose their elasticity, leading to stiffness of joints, wrinkles on the skin, and hardening of arteries (arteriosclerosis).

3. Degeneration of Organs and Tissues:

- As the body ages, many organs undergo degeneration.

For example:

- Arthritis results from degeneration of cartilage in joints.

-
- Arteriosclerosis occurs due to the loss of elasticity in blood vessels.
 - Weakening of muscles, poor vision, and decreased immunity are also common signs.

4. Genetic and Mutational Factors:

- With time, mutations may occur in the DNA of cells, damaging their ability to divide and function properly.
- These mutations lead to cell death and tissue degeneration, accelerating the aging process.

5. Environmental and Lifestyle Factors:

- Unhealthy habits such as smoking, lack of exercise, poor diet, and insufficient sleep speed up aging.
- On the other hand, good nutrition, regular exercise, proper rest, and stress control can slow down the aging process and maintain a healthy life for longer years.

6. Signs of Aging:

Common signs include:

- Wrinkled and dry skin
- Loss of hair color
- Weak eyesight and poor memory

-
- General body weakness
 - Slow healing and reduced immunity

7. Gerontology – The Study of Aging:

- The scientific study of aging is called Gerontology.
- Its aim is not just to increase the lifespan of humans, but to increase the health span, meaning the number of years a person lives in good health and activity.

8. Human Lifespan:

- The maximum human lifespan is estimated to be around 120 to 125 years, though most people live much shorter depending on heredity and lifestyle conditions.

◆ **Summary:**

Aging is a continuous biological process involving the slowing down of body activities and degeneration of tissues. It is caused by limited cell division, genetic changes, and environmental influences. While aging cannot be stopped, it can be slowed by healthy living, proper diet, and regular exercise. Scientists now focus more on improving health during aging rather than simply extending the number of years.

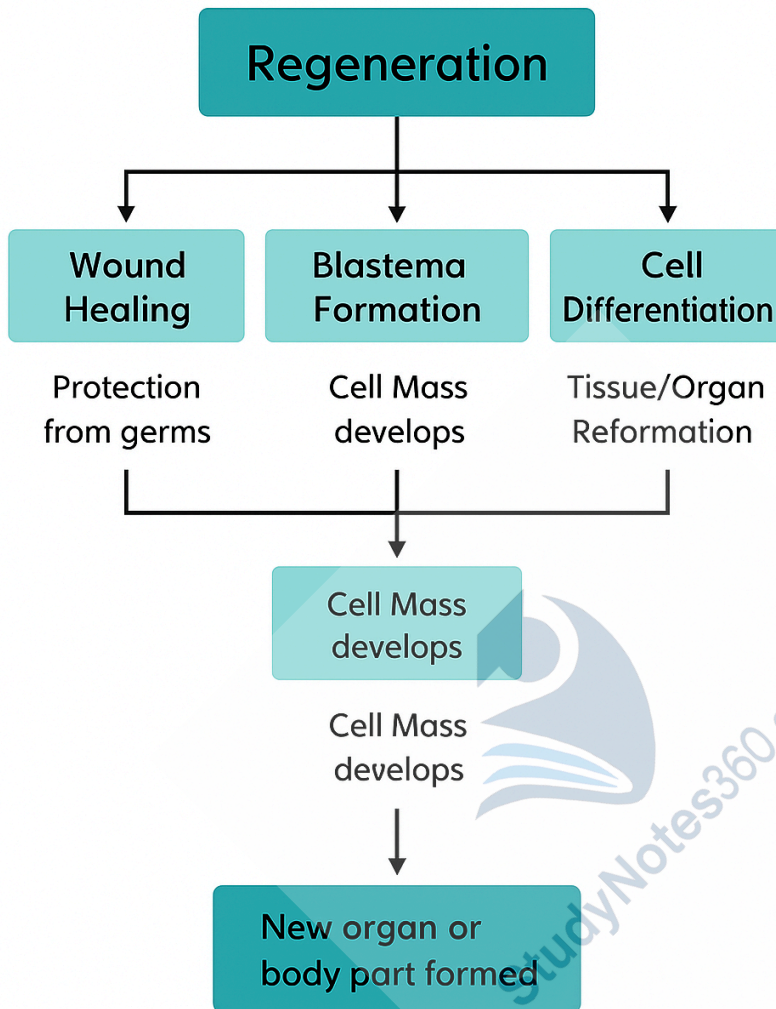
☀ **Q2: What is Regeneration? Why is it so effective in some animals and missing in others?**

❖ **Definition:**

- Regeneration is the biological process through which organisms replace or restore lost or damaged body parts.
- In simple words, it is the ability of living organisms to regrow their lost cells, tissues, or organs.

◆ **Explanation:**

- Regeneration is a natural ability found in almost all organisms to some degree.
- However, the extent and speed of regeneration vary among species – some can regrow entire body parts, while others can only repair tissues.



1. Types of Regeneration:

(a) Morphallaxis:

- The entire body or a major part is formed again from a small remaining portion.

-
- It occurs without much cell division – mainly by reorganization of existing cells.

Example: Hydra and Planaria can regenerate complete organisms from small body fragments.

(b) Epimorphosis:

- Involves cell division (mitosis) at the injured site to replace lost parts.
- A mass of undifferentiated cells called blastema forms at the wound, which later differentiates into new tissues.

Example: Salamander regenerates its lost limb by epimorphosis.

2. Mechanism of Regeneration:

1. Wound Healing:

- The damaged area is first closed by a scab to prevent infection.

2. Formation of Blastema:

- Undifferentiated cells accumulate at the wound site and form a blastema.

3. Cell Division and Differentiation:

-
- The blastema cells divide repeatedly and gradually differentiate into new tissues and organs.

4. Growth and Restoration:

- The newly formed structures grow and develop into the lost organ or part.

3. Why Regeneration is Effective in Some Animals:

Regeneration is highly effective in lower animals due to the following reasons:

Presence of more undifferentiated (stem) cells:

- Animals like hydra, planaria, and salamanders have a large number of unspecialized cells capable of forming any body tissue.

Simple body structure:

- Lower animals have simple body organization and fewer specialized organs, making regeneration easier.

High metabolic and mitotic activity:

- Rapid cell division and active metabolism support quick tissue replacement.

Efficient genetic control:

- Genes responsible for regeneration are fully active in these animals.

4. Why Regeneration is Limited or Missing in Higher Animals (like Humans):

Regeneration is poorly developed or missing in complex organisms because:

High degree of specialization:

- Cells in higher animals are highly specialized and cannot revert to undifferentiated form.

Limited stem cells:

- Humans have fewer regenerative cells; most tissues can only repair, not regrow.

Complex body structure:

- The more complex an organ system is, the harder it is to reconstruct it completely.

Genetic restrictions:

- Some regeneration-controlling genes are inactive or less effective in mammals.

✦ **Q3: Describe in detail the developmental processes of chick.**

❖ **Introduction:**

- The chick (embryo of the hen) is one of the best-studied vertebrates in developmental biology.
- It develops outside the mother's body, within a hard-shelled egg, which provides all the nourishment and protection needed for its growth.
- The entire process from fertilization to hatching takes about 21 days.

1. Fertilization:

- Fertilization in a hen is internal, taking place in the upper part of the oviduct before the egg is covered by albumen and shell.
- The male's sperm fuses with the ovum's nucleus, forming a zygote (fertilized egg).
- Only the germinal disc (blastodisc) on the surface of the yolk undergoes development.

2. Cleavage (Segmentation):

- After fertilization, the zygote undergoes meroblastic cleavage because the yolk is large and prevents complete division.
- Cleavage occurs only in the blastodisc region, forming a disc-shaped blastoderm of several layers of cells on the yolk surface.
- The lower cells (in contact with yolk) are called yolk cells, and the upper layer forms the blastoderm proper.

3. Formation of Blastula:

- The cleavage produces a blastula called discoblastula because it is disc-shaped.
- A small cavity, called the subgerminal cavity, appears beneath the blastoderm.

The blastula now contains two regions:

- **Area pellucida:** Transparent central region (future embryo).
- **Area opaca:** Opaque outer region (extra-embryonic part).

4. Formation of Germ Layers (Gastrulation):

-
- Gastrulation begins with the formation of the primitive streak – a thickened line in the area pellucida.

Cells migrate inward through this streak to form three primary germ layers:

1. Ectoderm – forms skin, feathers, brain, and nerves.
2. Mesoderm – forms muscles, bones, heart, blood vessels, and reproductive organs.
3. Endoderm – forms the digestive tract, liver, pancreas, and lungs.

5. Neurulation (Formation of Nervous System):

- The ectoderm thickens along the midline to form the neural plate.
- The edges of this plate rise and fold to form the neural groove, which eventually closes to form the neural tube.
- The neural tube later develops into the brain and spinal cord.

6. Organogenesis (Formation of Organs):

After the germ layers are established, specific organs begin to form:

-
- **From Ectoderm:** Brain, spinal cord, eyes, and epidermis.
 - **From Mesoderm:** Muscles, bones, heart, kidneys, blood, and reproductive organs.
 - **From Endoderm:** Alimentary canal, lungs, liver, and pancreas.

Thus, the chick embryo gradually acquires the basic body plan of a vertebrate.

7. Formation of Extra-Embryonic Membranes:

Four special membranes form around the embryo to protect and nourish it during development:

1. Amnion:

- Thin, transparent membrane enclosing the embryo in fluid.
- Protects against mechanical shock and drying.

2. Chorion:

- Outermost membrane lying beneath the shell.
- Helps in gas exchange.

3. Allantois:

-
- Acts as a respiratory and excretory organ, storing nitrogenous wastes.

4. Yolk Sac:

- Surrounds the yolk and supplies food to the growing embryo.

8. Development and Hatching:

- The chick embryo continues to grow by using nutrients from the yolk.
- By day 19–20, the chick completely fills the egg and breaks the shell using its egg tooth.
- The chick hatches out on the 21st day, fully formed and capable of independent life.

◆ Summary:

- The chick's development starts with internal fertilization followed by cleavage, blastula formation, gastrulation, and neurulation.
- Three germ layers (ectoderm, mesoderm, and endoderm) give rise to all organs.
- Four extra-embryonic membranes – amnion, chorion, allantois, and yolk sac – protect and nourish the embryo.

- The complete chick develops and hatches on the 21st day of incubation.

☀️ Q4: What is Growth? Discuss Different Phases and Conditions for Growth.

❖ Introduction:

- Growth is one of the most fundamental characteristics of all living organisms.
- It is a permanent and irreversible increase in size, mass, and number of cells in an organism.
- In animals, growth occurs throughout the body up to a certain age, while in plants it continues throughout life due to the presence of meristematic tissues.

🧬 Definition of Growth:

👉 "Growth is an irreversible, permanent increase in size, volume, weight, and number of cells of an organism resulting from cell division and enlargement."

🌿 Examples:

- A seed growing into a large tree.
- A baby growing into an adult human.
- Elongation of roots and shoots in plants.

Phases of Growth:

Growth does not occur at a constant rate. It takes place in three major phases – lag, log (exponential), and stationary phases.

1] Lag Phase (Initial Phase):

- This is the early stage of growth when the organism or cell adjusts to the new environment.
- The rate of growth is slow because of the preparation for active metabolism and division.
- Enzymes and cell structures are synthesized during this stage.

Example:

- When a seed germinates, it first absorbs water and activates enzymes before actual growth begins.

2] Log Phase (Exponential Phase):

- In this phase, the rate of growth becomes very rapid and constant.
- Cells divide quickly, and tissues expand actively.
- This phase shows a geometric or exponential increase in size or number.

- It represents the maximum metabolic activity of the organism.

Example:

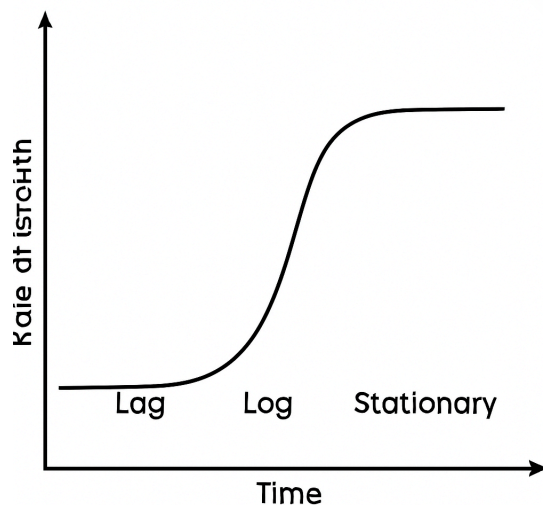
- Rapid elongation of stem and leaves in young plants.

3 Stationary Phase (Mature Phase):

- Growth slows down and finally stops.
- The organism reaches its maximum size or maturity.
- The rate of cell division equals the rate of cell death.
- Differentiation and specialization of tissues dominate in this stage.

Example:

- A fully grown tree or an adult human where body size remains constant.



☀️ **Conditions Necessary for Growth:**

Growth depends on several internal and external factors.

A. Internal Factors:

1. Genetic Makeup:

- Growth pattern is determined by genes inherited from parents.
- **For example**, tall and dwarf plants differ genetically.

2. Hormones:

- In plants, auxins, gibberellins, cytokinins, etc., control cell division and elongation.
- In animals, growth hormone (GH) regulates overall growth and metabolism.

3. Enzymes and Vitamins:

- Essential for metabolic reactions and synthesis of new tissues.

B. External Factors:

1. Water:

-
- Required for turgidity, enzyme activation, and transport of nutrients.
 - Lack of water slows down or stops growth.

2. Light:

- Affects photosynthesis, seed germination, and flowering in plants.

3. Temperature:

- Optimum temperature promotes enzymatic activity and rapid growth.
- Very high or low temperatures may retard growth.

4. Oxygen:

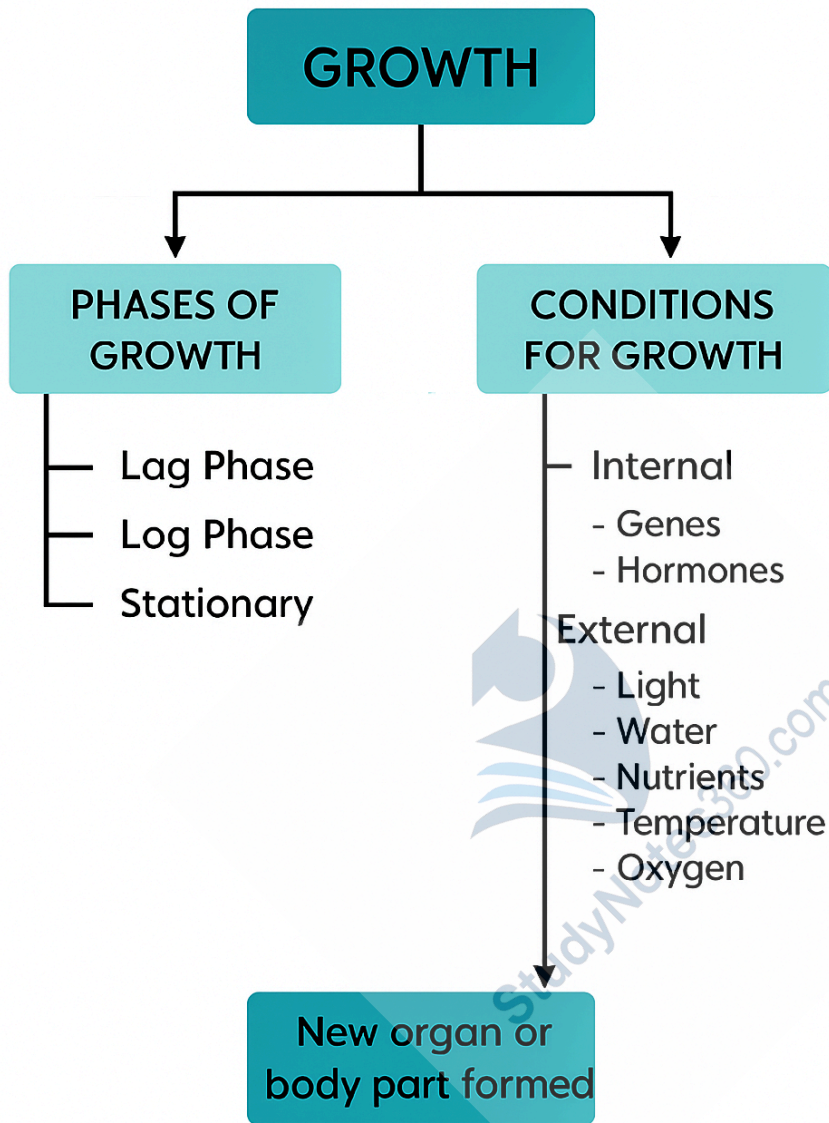
- Essential for respiration to release energy for cell division and enlargement.

5. Nutrients:

- Both macro (N, P, K, Ca) and microelements (Fe, Zn, Cu) are vital for growth.

◆ Summary:

Growth → Permanent, irreversible increase in size and number of cells.



Three Phases:

1. **Lag Phase:** Slow initial growth.
2. **Log Phase:** Rapid and maximum growth.

3. Stationary Phase: Growth stops; maturity achieved.

Conditions for Growth: Depend on both internal (genes, hormones) and external (water, temperature, light, nutrients) factors.

🌟 **Q5: What is Development? Describe the Principles of Development in Detail.**

❖ **Introduction:**

- Development is a continuous biological process that starts from a fertilized egg (zygote) and results in the formation of a complete, functional organism.
- It involves growth, differentiation, and morphogenesis that together lead to the formation of tissues, organs, and systems of the body.

🧬 **Definition of Development:**

👉 “Development is the series of orderly changes that occur in an organism from the zygote stage to its mature form, involving growth, differentiation, and morphogenesis.”

🌿 **Explanation:**

-
- **During development**, the fertilized egg divides repeatedly to form many cells (growth).
 - These cells become specialized to perform particular functions (differentiation).
 - These **specialized cells** then organize into tissues and organs (morphogenesis).
 - **Ultimately**, a complex organism develops from a single cell.

⚙️ **Main Processes Involved in Development:**

1. Growth – Increase in cell size and number.
2. Differentiation – Cells acquire specific structure and function.
3. Morphogenesis – Formation of shape and structure of the organism.
4. Organogenesis – Development of organs from tissues.
5. Aging and Death – Final stages of the developmental cycle.

✚ **Principles of Development:**

Development follows certain universal biological principles that explain how and why an organism develops in a particular pattern.

1 Principle of Continuity:

- Development is a continuous process that begins at fertilization and continues throughout life until death.
- It does not occur in sudden jumps but in gradual stages.

Example: A baby grows into a child, then into an adult – each stage builds upon the previous one.

2 Principle of Sequential Pattern:

- Development occurs in a definite and orderly sequence.
- Each stage of development prepares the individual for the next.

Example: The child first holds up its head, then sits, crawls, stands, and finally walks.

3 Principle of Direction:

Development occurs in two major directions:

a) Cephalocaudal Direction:

-
- From head to tail – meaning organs of the head develop before those of the lower body.

Example: Infants learn to move their head before they can control their legs.

b) Proximodistal Direction:

- From center to periphery – development starts from the central axis and proceeds towards the outer parts.

Example: The arms develop before the hands and fingers.

4) Principle of Differentiation and Integration:

- In the beginning, body movements and cells are generalized and undifferentiated.
- **Later**, they become specialized (differentiated) to perform specific functions.
- **Finally**, these specialized parts integrate to work together harmoniously.

Example: Brain cells, muscle cells, and skin cells all develop from a single zygote but perform different functions.

5) Principle of Individual Differences:

-
- The rate and pattern of development vary from individual to individual.
 - These differences depend on heredity, environment, and nutrition.

Example: Some children learn to walk at 10 months while others at 14 months.

6 Principle of Uniform Pattern:

- Though the rate may vary, the overall pattern of development remains uniform in all normal individuals.

Example: Teeth eruption or puberty follows the same order in all humans.

7 Principle of Interaction between Heredity and Environment:

- Development is the result of both genetic (hereditary) and environmental influences.
- Genes provide the basic framework, while the environment shapes and modifies growth.

Example: A genetically tall child may not reach full height if nutrition is poor.

8 Principle of Maturation and Learning:

-
- Maturation provides the biological readiness for certain skills,
 - while learning refines and perfects those skills through experience.

Example: A child cannot learn to speak until the speech organs are matured.

9) Principle of Predictability:

- Development follows a predictable pattern that helps in estimating the next stage.

Example: The appearance of secondary sexual characters at puberty.

10) Principle of Correlation of Structure and Function:

- Structural development is always accompanied by the development of function.

Example: The nervous system must develop structurally before coordination or thinking can occur.

◆ Summary:

Development → A continuous process from zygote to adult involving growth, differentiation, and morphogenesis.

Main Principles:

1. Continuity
2. Sequential pattern
3. Direction (Cephalocaudal & Proximodistal)
4. Differentiation and Integration
5. Individual differences
6. Uniform pattern
7. Heredity and environment interaction
8. Maturation and learning
9. Predictability
10. Correlation of structure and function

Important Long Questions:

☀ Q1: Define growth and development in plants. Describe the different phases of growth.

❖ Definition of Growth:

- Growth in plants is a permanent and irreversible increase in size, mass, or volume of a plant body.

-
- It occurs as a result of cell division, cell elongation, and cell differentiation. Growth can be measured in terms of increase in length, area, volume, or weight.

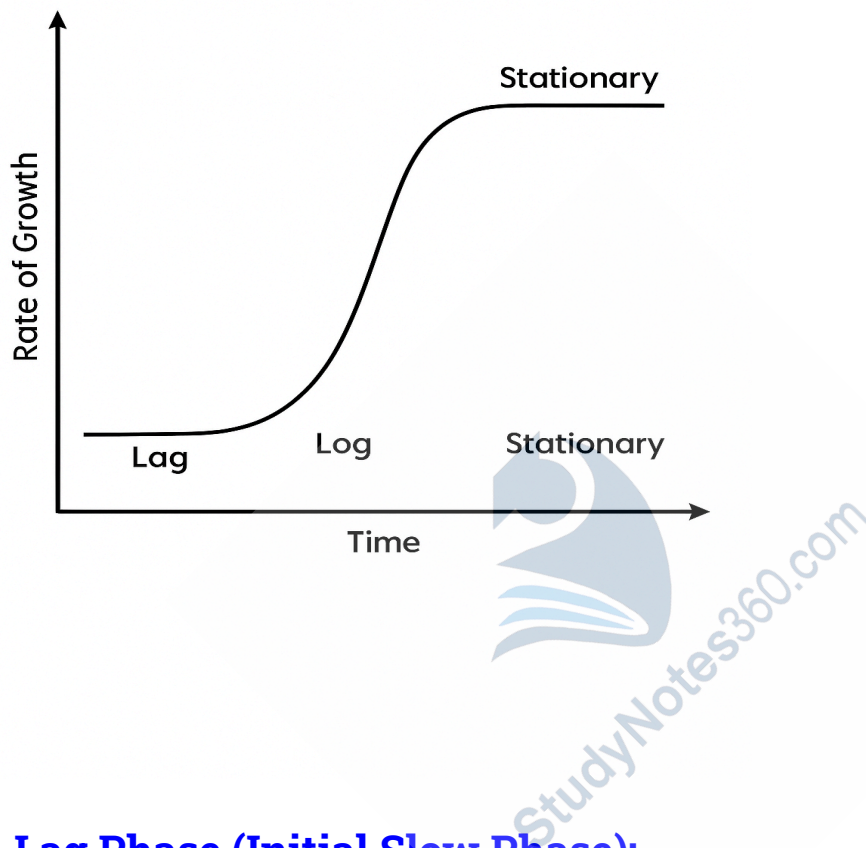
❖ **Definition of Development:**

- Development is the progressive series of changes by which a plant passes from a simpler form to a more complex and mature stage.
- It involves differentiation of cells, formation of tissues and organs, and specialization of functions.

◆ **Phases of Growth:**

Plant growth does not occur at a constant rate. It passes through three distinct phases, which together form the growth curve or sigmoid curve (S-shaped curve).

Sigmoid Growth Curve



1. Lag Phase (Initial Slow Phase):

- This is the beginning phase of growth.
- The rate of growth is very slow because cells are preparing for division.
- During this phase, metabolic activities are high but cell division is limited.

Example: When a seed germinates, it takes some time before rapid growth starts.

2. Log or Exponential Phase (Rapid Growth Phase):

- In this phase, the rate of growth becomes maximum and constant.
- Cells divide rapidly, and the plant body increases rapidly in size.
- It represents the most active period of growth, where cell division and elongation are both very high.

Example: Rapid elongation of roots and shoots in young seedlings.

3. Stationary or Maturation Phase:

- In this phase, the rate of growth slows down and becomes steady.
- Cells stop dividing and begin to differentiate into permanent tissues.
- Growth almost ceases, but development continues, leading to maturation and specialization of organs.

Example: Fully grown leaves and stems entering the mature stage.

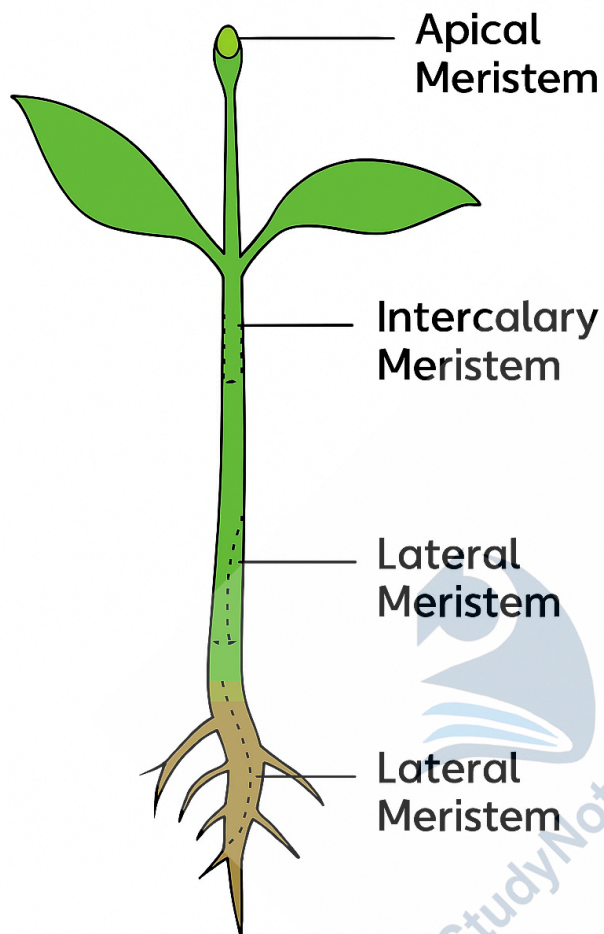
☀ Q2: What are meristems? Describe their types and functions.

❖ **Definition of Meristems:**

- Meristems are groups of undifferentiated, actively dividing cells found in specific regions of plants.
- These cells are responsible for the formation of new tissues and organs, and they maintain the continuous growth of plants throughout their life.

Characteristics of Meristematic Cells:

- Cells are small, thin-walled, and densely cytoplasmic.
- Nuclei are large, and vacuoles are either absent or small.
- Cells divide rapidly without differentiation.
- Found in growing regions such as tips of roots, shoots, and sides of stems.



◆ Types of Meristems and Their Functions:

1. Apical Meristem:

- **Location:** At the tips of roots and shoots.
- **Function:** Responsible for primary growth, which increases the length of the plant.

-
- Produces new cells that form leaves, flowers, and branches.
 - It ensures vertical growth of the plant.

Example: Root and shoot tips in all higher plants.

2. Intercalary Meristem:

- **Location:** At the base of internodes or leaves, and sometimes between mature tissues.
- **Function:** Helps in regeneration of lost parts and contributes to elongation of plant organs.
- It is temporary in nature and becomes inactive after some time.

Example: Found in grasses, wheat, and sugarcane (helps them regrow after cutting).

3. Lateral Meristem:

- **Location:** Along the sides of roots and stems (in dicots and gymnosperms).
- **Includes vascular cambium and cork cambium** (phellogen).
- **Function:** Responsible for secondary growth, which increases the diameter or thickness of plant organs.

- Forms **secondary** tissues such as secondary xylem (wood) and secondary phloem.

Example: Growth in thickness of tree trunks and roots.

Importance of Meristems:

- They are the growth centers of the plant body.
- Allow continuous formation of new organs (open growth).
- Help in healing of wounds and regeneration.
- Play a vital role in primary and secondary growth.

◆ **Summary:**

Meristems are the driving force behind plant growth and differentiation.

- Apical Meristem → Increases length (Primary Growth).
- Intercalary Meristem → Regeneration and internodal elongation.
- Lateral Meristem → Increases thickness (Secondary Growth).

★ **Q3: Define primary and secondary growth in plants. How do they differ from each other?**

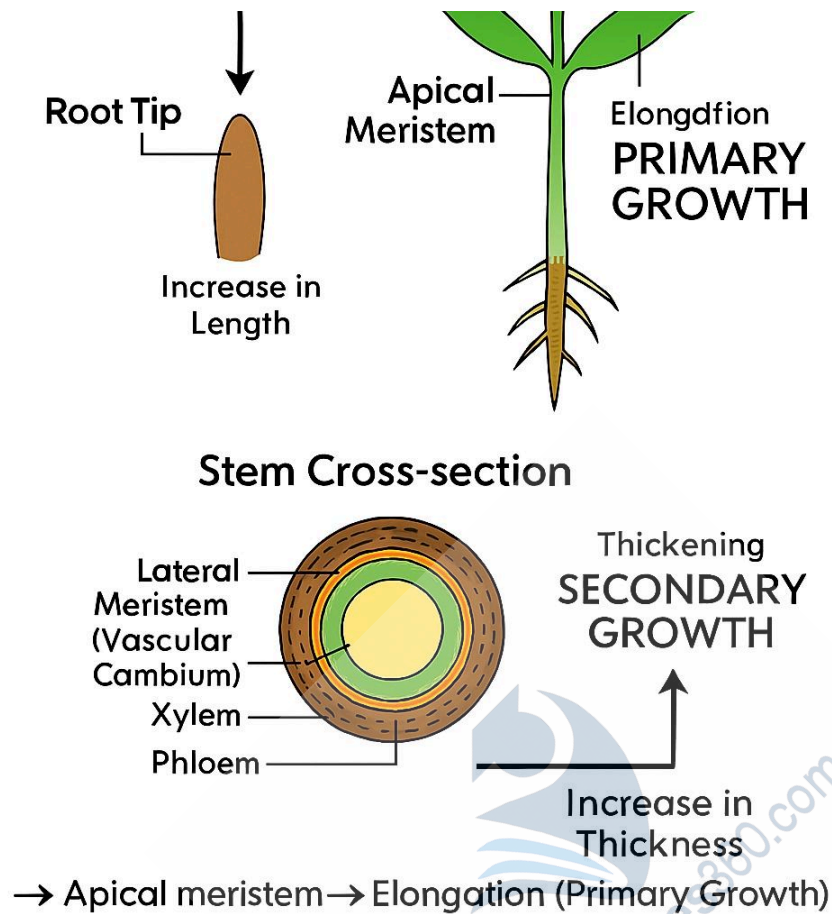
❖ **Definition:**

Primary Growth:

- Primary growth refers to the increase in length of the plant body. It occurs due to the activity of apical meristems present at the tips of roots and shoots. This growth produces primary tissues, helping the plant to elongate and form new organs such as leaves and branches.

Secondary Growth:

- Secondary growth refers to the increase in thickness or girth of the plant body. It takes place due to the activity of lateral meristems, mainly the vascular cambium and cork cambium. This growth forms secondary tissues like wood and bark, which strengthen the plant and provide support.



◆ Explanation:

1. Apical Meristem and Primary Growth:

- Apical meristems are found at the tips of roots and shoots.
- They consist of actively dividing cells that continuously add new cells to the growing regions.
- **As a result**, the plant increases in height and the roots grow deeper into the soil.

-
- Primary growth mainly occurs in herbaceous plants and young parts of woody plants.

Example: The elongation of root tips and shoot tips in plants like maize, wheat, and pea.

2. Lateral Meristem and Secondary Growth:

- Lateral meristems occur along the sides of stems and roots.
- They include vascular cambium and cork cambium, both responsible for producing new layers of cells around the plant.
- Vascular cambium forms secondary xylem (wood) and secondary phloem, while cork cambium produces protective outer layers (bark).
- This process increases the diameter of stems and roots and is most common in dicots and gymnosperms.

Example: The thickening of tree trunks in mango, pine, or neem due to cambial activity.

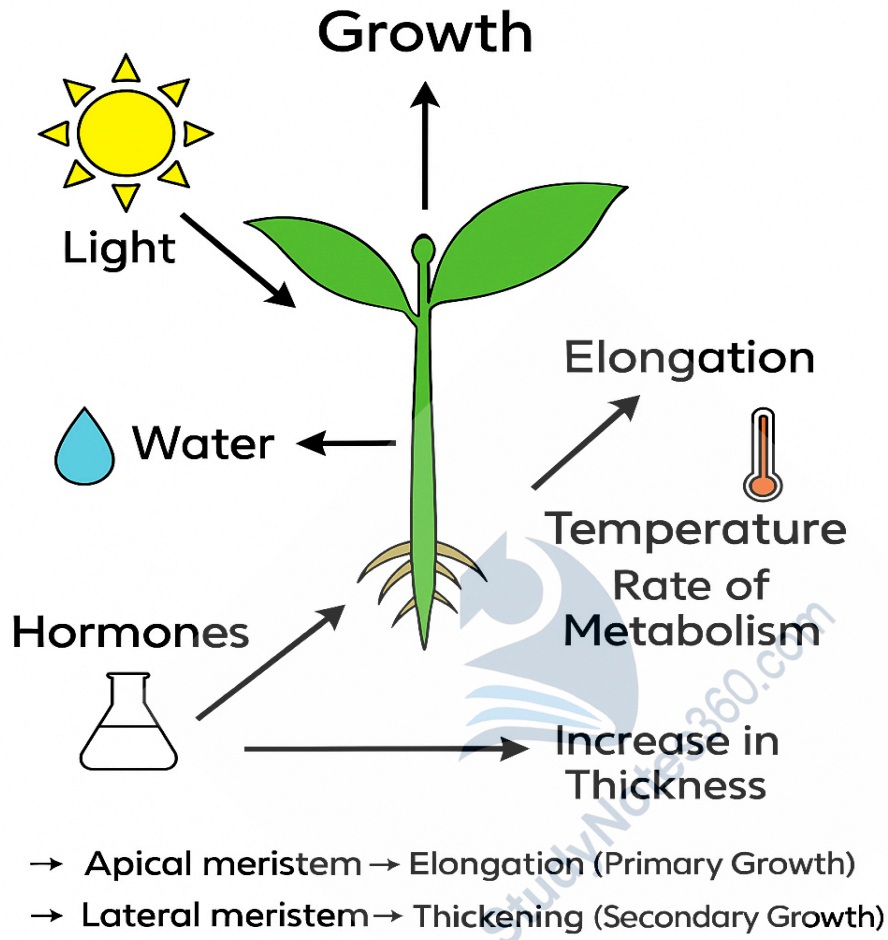
◆ Difference in Concept:

-
- Primary growth helps plants grow upward and downward, while secondary growth helps them grow sideways.
 - **In other words**, primary growth gives height, and secondary growth gives strength.

☀ **Q4: What are the external and internal factors affecting plant growth? Explain the role of each factor.**

❖ **Introduction:**

- Plant growth is influenced by both external (environmental) and internal (physiological) factors.
- **External factors** act from outside the plant, while **internal factors** work within plant cells to regulate growth and development.



A) External Factors Affecting Growth:

1) Temperature:

- Temperature influences the rate of metabolic activities and enzyme functions.

-
- Growth rate increases with temperature between 0°C–35°C, with an optimum at 25–30°C.
 - Very low temperatures (5–10°C) slow down growth, while above 40°C, enzymes are destroyed and growth stops.

Example: Most tropical plants show faster growth at moderate warm temperatures.

2 Light:

- Light affects growth through intensity, quality, and duration.
- Red light promotes elongation, while blue light increases cell division but reduces elongation.
- **Photoperiodism:** The duration of light exposure controls flowering and reproduction in plants.

Example: Sunflower and maize require specific light durations to bloom.

3 Oxygen:

- Oxygen is essential for respiration that provides energy for growth.
- Lack of oxygen reduces metabolism and stops cell division.

-
- Excess oxygen, however, can also slow down growth.

4 Carbon Dioxide:

- CO₂ is necessary for photosynthesis, which supplies food and energy for growth.
- A moderate concentration promotes growth, but very high levels inhibit it.

5 Water:

- Water is required for cell elongation and maintaining turgor pressure.
- It also serves as a medium for the movement of nutrients and hormones.
- In the absence of water, growth stops completely.

6 Nutrition:

- Nutrients provide energy and building materials for new cells.
- Deficiency of essential minerals (like nitrogen, potassium, and phosphorus) retards growth.

Example: Nitrogen deficiency causes yellowing of leaves and stunted growth.

B) Internal Factors Affecting Growth:

1 Hormones (Phytohormones):

- Growth hormones control cell division, elongation, and differentiation.
- Auxins (like IAA) promote elongation,
- Cytokinins stimulate cell division,
- Gibberellins increase stem growth,
- Abscisic acid and ethylene regulate dormancy and fruit ripening.

2 Vitamins:

- Vitamins are organic compounds that act as growth regulators.
- They are synthesized within the plant in the presence of light.
- In dark conditions, deficiency occurs, and plant growth is reduced or stops.

Example: Vitamin deficiency in seedlings grown in darkness causes weak and pale growth (etiolation).

◆ Summary of Growth Factors:

- **External factors:** Temperature, light, oxygen, CO₂, water, and nutrition.

- **Internal factors:** Hormones and vitamins.

☀️ **Q5: What is differentiation in plants? Explain the stages of differentiation with examples.**

❖ **Introduction:**

- In plants, growth is always accompanied by differentiation – a process in which unspecialized cells of the meristem become specialized to perform particular functions.
- It is through differentiation that plants develop various tissues, organs, and systems such as roots, stems, leaves, xylem, and phloem.

❖ **Definition:**

- 👉 Differentiation is the process by which meristematic (undifferentiated) cells become specialized in structure and function to form permanent tissues and organs of the plant.
- It gives rise to different types of cells like parenchyma, collenchyma, sclerenchyma, xylem, and phloem.

◆ **Importance of Differentiation:**

- Helps in the formation of specialized tissues.

-
- Enables the plant to perform various physiological functions efficiently.
 - Leads to the formation of organs like leaves, stems, and roots.
 - Plays a vital role in plant development and adaptation.

Stages of Differentiation in Plants:

Differentiation in plants occurs in five main stages – from the embryo to the formation of mature tissues.

1 Stage 1 – Formation of Embryo:

- Differentiation begins during embryogenesis (formation of the embryo inside the seed).
- The embryo is formed after fertilization and represents the earliest stage of plant differentiation.
- The embryo contains basic parts that later give rise to the root, shoot, and cotyledons (seed leaves).

Example:

- Zygote → Embryo in bean or maize seed.

2 Stage 2 – Recognition of Apical Meristems:

- Within the embryo, two main meristems become visible:
- Shoot apical meristem (gives rise to shoot system)

- Root apical meristem (gives rise to root system)
- These meristems remain active throughout the life of the plant and are responsible for primary growth.

Example:

- Root and shoot tips of a germinating seed.

③ Stage 3 – Formation of Cambium (Secondary Meristem):

- As the plant matures, cambium appears between xylem and phloem tissues.
- It is responsible for secondary growth, i.e. increase in thickness of stems and roots.
- The cambium cells divide to form secondary xylem and phloem.

Example:

- Vascular cambium in woody plants like neem or mango.

④ Stage 4 – Development of Primordia:

- Primordia are the first visible signs of new organs (buds or roots).
- Leaf primordia and root primordia appear as small bulges of cells.

-
- These cells are already “committed” to becoming a specific organ.

Example:

Formation of leaf primordia at the tip of the shoot apical meristem.

5 Stage 5 – Formation of Fully Differentiated Tissues and Organs:

- Finally, the cells develop into fully specialized tissues such as xylem, phloem, cortex, pith, epidermis, and mesophyll.
- Each cell type performs its specific function (e.g. xylem transports water, phloem transports food).
- The plant now has a complete structural organization with functional parts like roots, stems, and leaves.

Example:

- Differentiation of xylem vessels and sieve tubes in vascular bundles.

◆ Summary of Stages:

1. Formation of embryo

2. Recognition of apical meristems

3. Formation of cambium

4. Development of primordia

5. Formation of specialized tissues and organs

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

Author: Muhammad Asghar

Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

Copyright & Usage Policy

© 2025 Muhammad Asghar. All rights reserved.

No part of these notes may be reproduced, redistributed, or used for commercial purposes without explicit written permission from the author. These notes are intended solely for personal study and educational use.