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Growth & development

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Introduction

- **Growth: in living organisms may be** defined as an irreversible increase in the number and size of a cell, organ or whole organism, related to change in size & mass .
- **Development: referring to the sum of** all changes that an organism undergo through its life cycle from seed germination ,and through growth, maturation, flowering, and senescence .

Growth

- Growth is regarded as one of the most fundamental and conspicuous characteristics of a living being.
- Generally, growth is accompanied by metabolic processes (both anabolic and catabolic), that occur at the expense of energy.
- Therefore, for example, expansion of a leaf is growth.

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Types of Growth:

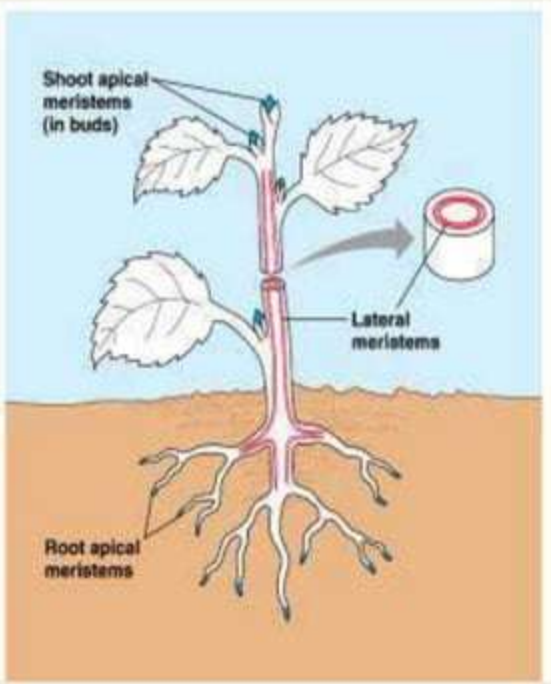
Classified by Developmental Stages

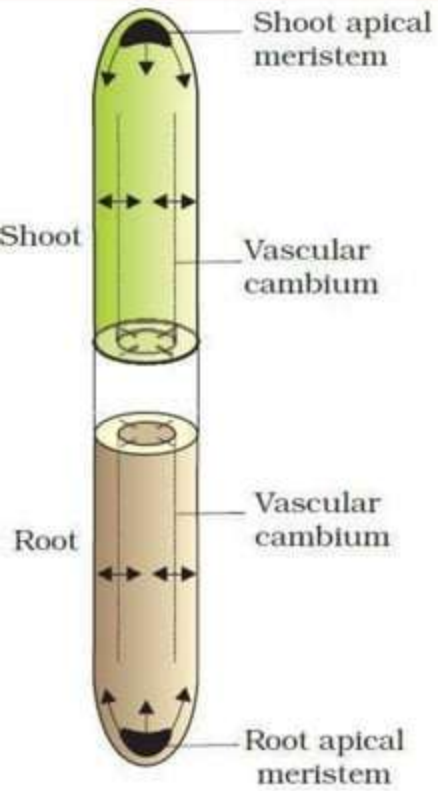
1. Primary growth:

- Apical meristems extend roots and shoots by giving rise to the primary plant body

2. Secondary growth:

- Lateral meristems add girth by producing secondary vascular tissue and periderm.





Diagrammatic representation of locations of root apical meristem, shoot aplical meristem and vascular cambium. Arrows exhibit the direction of growth of cells and organ

Measurement of Growth

It can be measured in terms of:

- **Increase in length or growth** – in case of stem and root.
- **Increase in area or volume** – in case of leaves and fruits.
- **Increase in the number of cells** – in algae, yeast and bacteria.


Types of Growth & Development
Vegetative Phase
Reproductive Phase
Carbohydrate Utilization
Accumulation or storage of carbohydrates

Vegetative growth

Three important processes

Cell division

Cell enlargement

Cell differentiation ((initial stages)

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Reproductive Growth Phase

1. Maturation of tissues manufactured during vegetative phase
2. Production of growth regulators
3. Development of flower buds, flowers, fruit and seed, or the development of storage organs
4. Relatively little cell division occurs
5. Most of the carbohydrates are accumulated in the fruit, seed or storage organs

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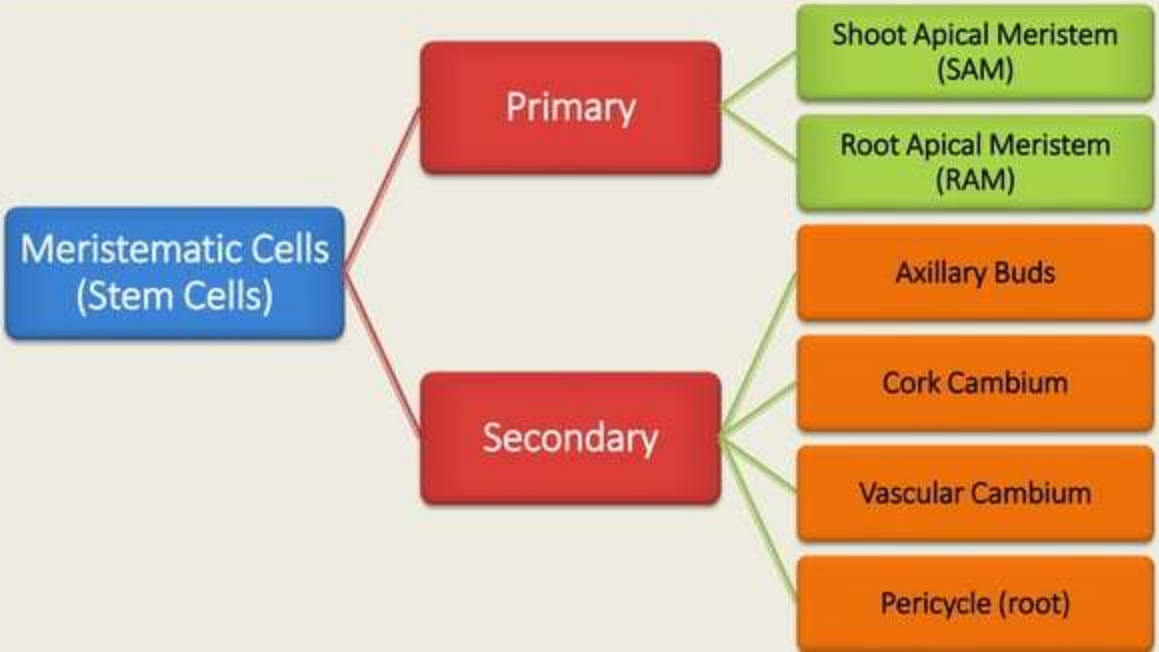
Phases of growth

1.
- Cell division/ meristematic

2.
- Elongation

3.
- Differentiation/ Maturation

Meristematic: both at the root apex and the shoot apex represent the meristematic phase of growth.



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Elongation: The size of individual cell increases after cell division due to increase in the volume of its protoplasm.

Location

- Adjacent to Meristems
- Internode growth - Shoot
- Zone of Elongation – Root

Factors for elongation

- Turgor Pressure
- H_2O Uptake
- Cell Wall Loosening
- new cell walls

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Maturation

- Maturation (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.

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Growth Rates

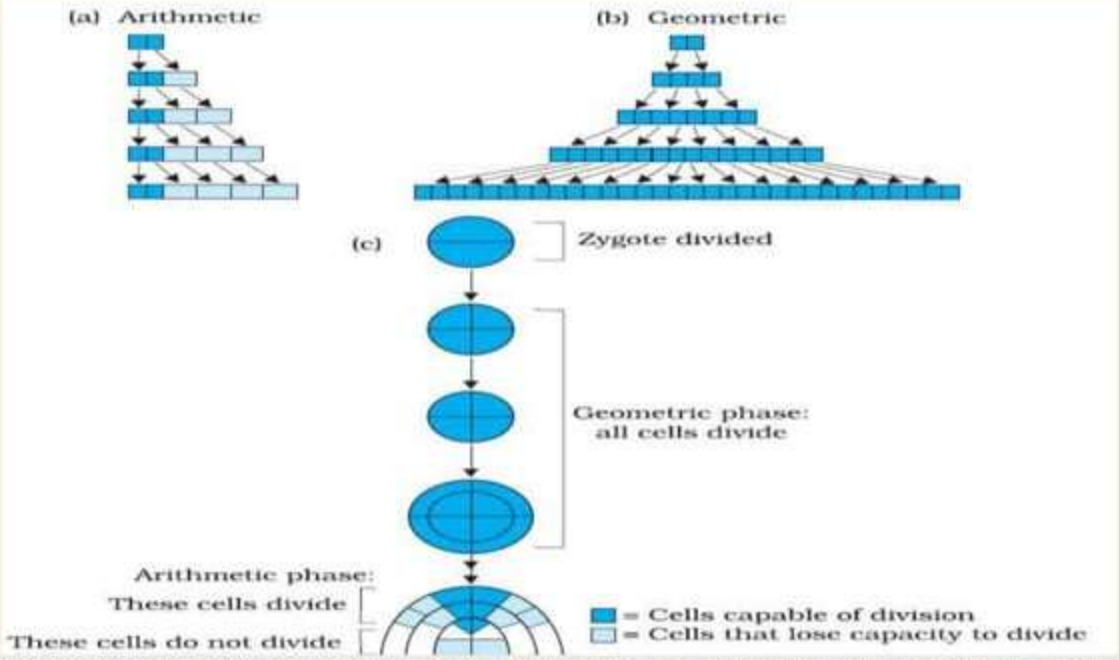
- **The increased growth per unit time is termed as growth rate.**
- Thus, rate of growth can be expressed mathematically. An organism, or a part of the organism can produce more cells in a variety of ways.

Types of growth rates

In arithmetic growth, following mitotic cell division, only one daughter cell continues to divide while the other differentiates and matures. The simplest expression of arithmetic growth is exemplified by a root elongating at a constant rate.

In geometrical growth ,both the progeny cells following mitotic cell divide and continue to do so .

During the the development of an embryo ,both types of growth rates are involved .this transforms a single cell zygote into a multicellular organisms .



Diagrammatic representation of : (a) Arithmetic (b) Geometric growth and (c) Stages during embryo development showing geometric and arithematic phases

Growth Curve

- The rate of growth of a plant or plant part is not always the same during its life span. Sometimes it is slow and at other times rapid. If we plot the increase in cell number (growth rate) against time, a typical **S shape** curve is obtained. This is called growth curve or **sigmoid curve.**

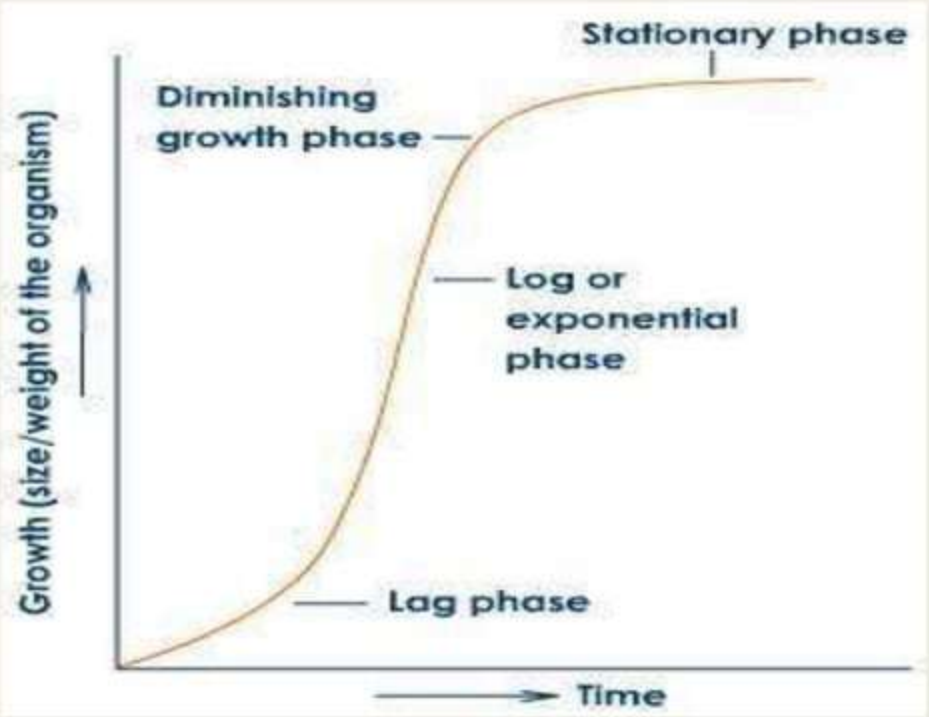
- This curve has three phases of growth.

(i) Lag Phase – This is the initial phase of growth when the rate of growth is very slow.

(ii) Log Phase – It shows rapid growth and is maximum for the entire life span.

(iii) Stationary Phase – Here the rate of growth starts decreasing and finally it stops.

Sigmoid curve of growth



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Growth Requirements

- Nutrients
- Water
- Temperature (Heat)
- Light
- Growth Substances (Hormones)

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Types of Growth

Growth is of two types:

Indefinite or unlimited growth	• exhibited by root, stem and their branches
Definite or limited growth	• exhibited by leaves, flowers, fruits, etc.

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Development

- To begin with, it is essential and sufficient to know that the development of a mature plant from a zygote (fertilized egg) follow a precise and highly ordered succession of events.
- During this process a complex body organization is formed that produces roots, leaves, branches, flowers, fruits, and seeds, and eventually they die.
- Development is associated with **morphogenesis and differentiation.**

- **Morphogenesis :is the process of** development of shape and structure of an organism.
- When a cell loses the capacity to divide, it leads to differentiation. Differentiation results in development of structures that is commensurate with the function the cells finally has to perform.
- **General principles for differentiation for cell, tissues and organs are similar.**
- A differentiated cell may **dedifferentiate** and then **redifferentiate**.
- Since differentiation in plants is open, the development could also be flexible, i.e., the development is the sum of growth and differentiation.

Differentiation

- **Cellular differentiation is the process by which a less specialized cell becomes a more specialized cell type.**
- Cells derived from meristems and cambium differentiate and mature to perform specific functions which is termed as differentiation. Cells undergo structural changes during differentiation.
- Changes take place both in their cell walls and protoplasm.
- Example :- Cells lose their protoplasm during the formation of tracheary elements.
- Plants develop a strong, elastic, lignocellulosic secondary cell walls, to carry water to long distances even under extreme tension.

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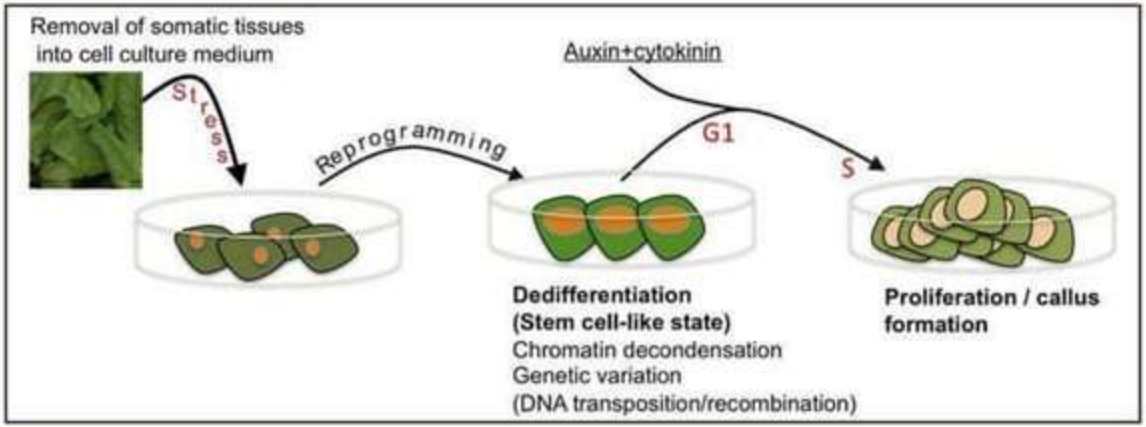
Dedifferentiation



Dedifferentiation is an important biological phenomenon whereby cells regress from a specialized function to a simpler state reminiscent of stem cells.

- An undividable differentiated cell sometimes regains the power of division. This process is called dedifferentiation.
- Dedifferentiation is a common process in plants during secondary growth and in wound healing mechanisms.

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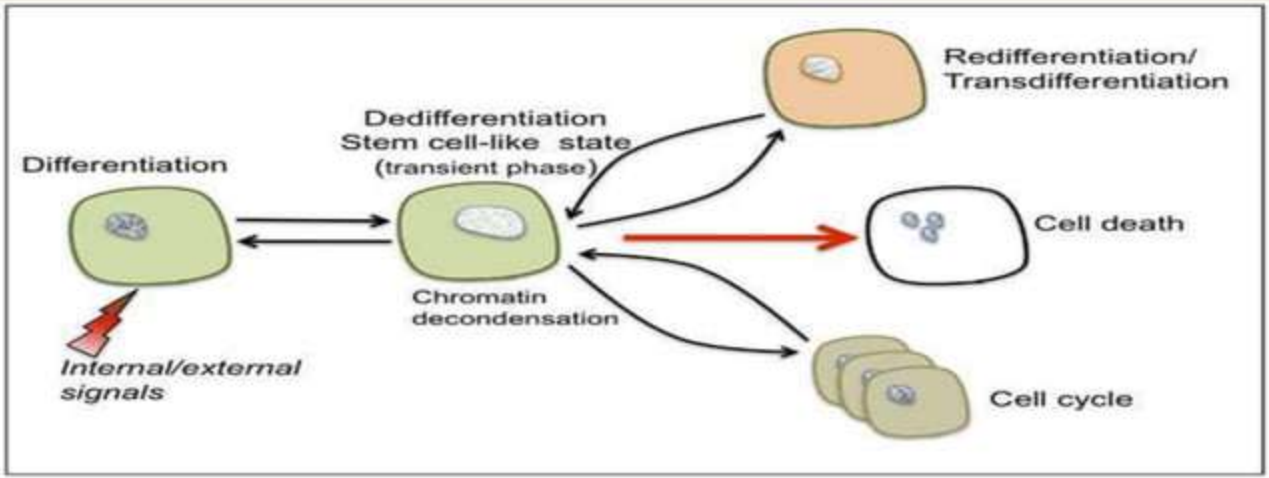
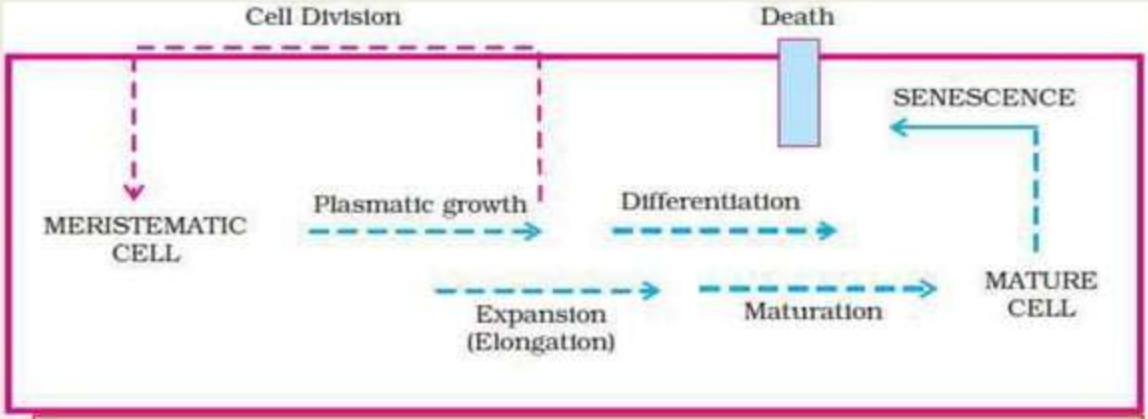
Redifferentiation

- A dedifferentiated cell can divide and produce new cells. New cells produced again loose the power of division and become a part of permanent tissue which is called **"redifferentiation'**.
- Example:- Formation of tumour cells.



Development

- Development is a term that includes all changes that an organism goes through during its life cycle from germination of the seed to senescence.



Sequence of the developmental process in a plant cell

Plasticity in development

- Plant exhibit plasticity in development.
- Plants follow different pathways in response to environment or phases of life to form different kinds of structures.
- This ability is called **plasticity.**

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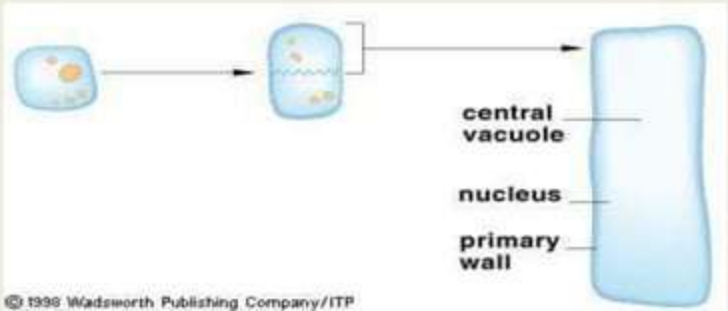
Growth vs Development

Growth

- Quantitative
- Number, size, and volume increase

Development

- Qualitative
- Emergence of specialized body parts



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You tube links for these topics

- https://youtu.be/gmKNwkQANi0 growth & development part-1
- https://youtu.be/ISvujMb-zOA growth & development part-2

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