Measuring parameters

- 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 undergoes through its life cycle from seed germination, and through growth, maturation, flowering, and senescence

How Growth occurs?

Plants are able to grow throughout their lifetime due to the presence of *undifferentiated* tissues called meristems.

Apical meristems

Add primary growth and cause the stem and root to increase in length.

- Shoot Apical Meristem (SAM)
- Root Apical Meristem (RAM)

Lateral meristems

Add secondary growth and cause the plant to increase in girth.

Differentiation

- is the process in which generalized cells specialize into the morphologically and physiologically different cells

Dedifferentiation

- This happens when tissues are wounded, as when branches break or leaves are damaged by insects. The plant repairs itself by *dedifferentiating* parenchyma cells in the vicinity of the wound, making cells like those injured or else physiologically similar cells
    - Ex. Callus tissue

Vegetative Phase

- From seed germination through growth of the primary supportive structure
- Includes any type of growth except for flower formation and gamete production
- Three important processes:

- Cell division
- Cell enlargement
- Cell differentiation (initial stages)

Reproductive Growth Phase

- Maturation of tissues produced during vegetative phase
- Development of flower buds, flowers, fruit and seed, or the development of storage organs
- Relatively little cell division occurs
- Most of the carbohydrates, proteins, lipids and others are accumulated in the fruit, seed or storage organs

Sigmoid Growth Curve

Lag period:

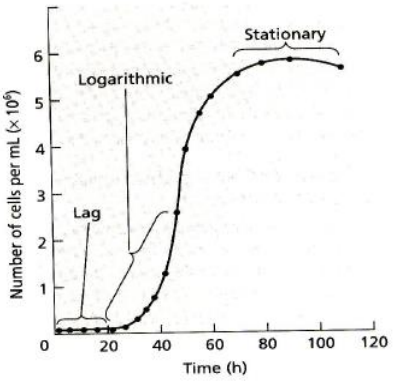
- During this period the growth rate is quite slow because it is the initial stage of growth.

Log period:

- During this period, the growth rate is maximum and reaches the top because at this stage the cell division and physiological processes are quite fast.

stationary period or steady state period:

- During this period the growth is almost complete and become static. Thus, the growth rate becomes zero.



Sigmoid Growth Curve

- A pattern of growth in which, in a new environment, the population density of an organism increases slowly initially, in a positive acceleration phase; then increases rapidly, followed by declines in a negative acceleration phase until at zero growth rate the population stabilizes.

Types of Growth

- Determinate Growth:
    - If, reproductive growth starts only after completion of vegetative growth it is called as determinate growth habit.
    - Ex. Maize, Arabidopsis, all monocarpic plants
- Determinate Organs:
    - Those organs that grow to certain size and then stop growing are called determinate organs. After their growth is completed they eventually senesce and die.
    - Ex. Leaves, flowers and fruits etc.

- Indeterminate Growth:
    - Here, vegetative and reproductive growth overlaps. This is shown in plants that have a capacity for both vegetative growth and flowering over an extended period.
    - Polycarpic plants, perinneal
- Indeterminate Organs:
    - Those organs which grow continuously with the activity of meristems are indeterminate organs.
    - These structures always remain youthful, because of the meristematic activity.
    - Ex. Roots and vegetative stems of perennials.

Measurements of Growth

- Increase in length or width – in case of stem and root.
- Increase in size or volume – in case of leaves and fruits.
- Increase in the number of cells – in algae, yeast and bacteria
- Measuring plant growth is a very simple procedure that can be done
- 1. Measuring Plant Height
- 2. Measuring Leaf length and area
- 3.Calculating Growth Rate with Fresh Plants
- 4. Finding the Growth Rate with Dried Plants
- Number of flowers

plant growth measurements are taken for roots, stems, leaf area, stem cross section, and so on.

Measuring Plant Height

- To measure a plant's growth rate, use a ruler or measuring tape to measure from the base of the plant to its highest point.
- If your plant is in a pot, start your measurement at the base of the pot. Write the measurement down, then repeat 2-3 days later.
- You can then calculate the average growth rate by subtracting the second measurement from the first measurement, then dividing that number by the number of days between the two measurements.
- Set the ruler at the base of the plant.
    - Smaller plants can be measured with a ruler, while taller plants may require a measuring tape, yardstick, or meter stick.
- Record the height of the plant.
    - You will want to measure the plant from its base to its highest point. Write this down in a chart with both the date and the height recorded. Repeat every two to three days.
- Calculate the average using the growth rate formula.
    - You can see the average daily growth rate by taking the change in size and dividing it by the amount of time it has been growing.

- The equation for the growth rate formula is
    - GR= S2-S1/T
    - S1=first measurement, S2=second measurement,

  T = number of days between each.

Measuring Leaf Size

1.Create a chart.

- Your chart should have rows for each date that you measure your leaves.
- The columns should be labeled “number of leaves,” “average length,” and “average width.”
- You should check your leaves every two to three days.

2.Count the leaves on your plant.

Be extremely thoroughly, but make sure you do not count the same leaves twice. Include new leaf tips and sprouts in your count. Record the number of leaves down in your chart.

3.Mark the length and width.

- Choose a random sampling of four or five leaves. Hold the ruler from the bottom to the tip of the leaf. Add up the measurements, and divide by the number of measurements you took.
- Repeat this process to find the width of the leaves.

Measure the leaves at their widest part.

4.Trace your plant's leaves on grid paper.

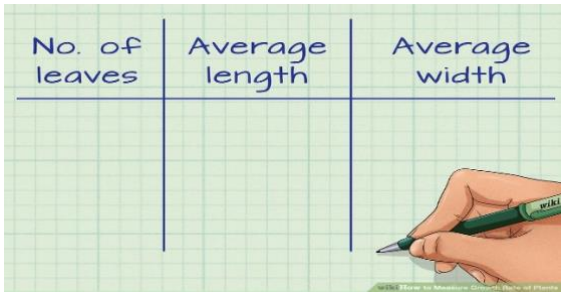
- Keeping the leaf on the plant, draw

around the leaf on grid paper.

- The grid should have squares that are one inch in area.
- Count the number of squares covered to get the surface area of each leaf.

- Repeat the process every couple days. Find the growth rate of leave or find leaf number growth rate to number of leaves growing per day.

- Leaf number growth rate=L2-L1/T
    - L2=Second leaf count, L1= First leaf count, T= time



Measuring fresh weight

- 1.Remove your plant from its pot.
- 2.Rinse soil from the roots. With a gentle stream of water, wash off dirt from the plant.
- 3.Place your plant on the scale. Do not wait for it to lose its moisture.
- 4.Replace the plant in its pot.
- 5. Wait a month before repeating.
- 6. Calculate the growth rate formula. After you have a second measurement, use the growth rate formula to calculate average growth rate.
- Growth rate= W2-W1/T1
- where W1=first weight, W2=second weight, and T=the number of days between each.

  Advantages

    - easier and convenient to measure
    - no need to destroy the specimen
    - the same organism can be used for repeated measurements

Disadvantages

- inaccurate and inconsistent
- because it is affected by the fluctuation of the amount of water in the organism.
- shows greater variation due to the environment

Measuring dry weight

1. Choose a random plant.
    - Dry measurements will kill your plant, so you should only do this type of measurement if you have multiple specimens.
2. Wash off the soil carefully from the roots.
3. Place your plant in the oven.
    - A drying oven is ideal. Set the temperature to 140 Fahrenheit or 60-70 Celsius. Heat the plants for at least 8 to 12 hours and up to two days to dry out the plants.
4. Place your plant in a plastic zip bag
    - this keeps the plant to cool down in dry environment.
5. Weigh the plant parts using sensitive balance.
    - Dry plants are very light since all the water content is removed. Make sure the balance is reading 2 digits (0.00).

Advantages:

- More accurate

Disadvantages:

- Losing specimen (plant)
- Time consuming
- Require skills to prevent losing parts of the plants.
- Comparably expensive (needs tools to dry out the plant)