Learn STEM

Innovative Model of learning STEM in secondary schools

ERASMUS+ KA220
Cooperation Partnerships in School Education

Reference Number:
2022-1-TR01-KA220-SCH-000087583

Duration:
31.12.2022 to 30.12.2024 (24 months)

LearnSTEM

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Learning Unit:
Multiplication of Yeast as bioorganisms

Topic III:Nature

Yusuf Demir Science and Art Center

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1. Definition of a Yeast
2. General Knowledge of yeasts
3. Diagram of a Yeast
4. Structure of yeasts
5. Type of yeasts
6. The use of yeast
7. Proliferation of yeast
8. Task for learners

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1. Definition of a Yeast

“a type of fungus that is used in making alcoholic drinks (such as beer and wine) and in baking to help make dough rise.” (Britannica - https://www.britannica.com/dictionary/yeast)
“a yellowish surface froth or sediment that occurs especially in saccharine liquids (such as fruit juices) in which it promotes alcoholic fermentation, consists largely of cells of a fungus (such as the saccharomyces, *Saccharomyces cerevisiae*), and is used especially in the making of alcoholic liquors and as a leaven in baking “. (Merriam-Webster Dictionary - https://www.merriam-webster.com/dictionary/yeast)
“**a type of fungus that is used in making alcoholic drinks such as beer and wine, and for making bread swell and become light**.” (Cambridge Dictionary- https://dictionary.cambridge.org/dictionary/english/yeast)

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2. General Knowledge of yeasts

https://unsplash.com/de/s/fotos/yeasts

Yeast; oval in shape, colorless and smooth, converts carbohydrates to alcohol during fermentation, reproduces through budding, used in baking industry and in the production of ethanol, e.g. *Saccharomyces cerevisiae* (Baker's yeast).

https://www.slideshare.net/shiningpearl18/fungiyeastmolds

Yeast is a single-celled organism from the fungi kingdom. There are more than 500 species and thousands of variants of yeast. Yeast can be found in the soil, in sugary liquids (fruit and flowers), and on the surface of plants and animals. Yeast has several applications in biotechnology and plays a significant part in producing bread and alcoholic beverages. https://byjus.com/neet/yeast-diagram/

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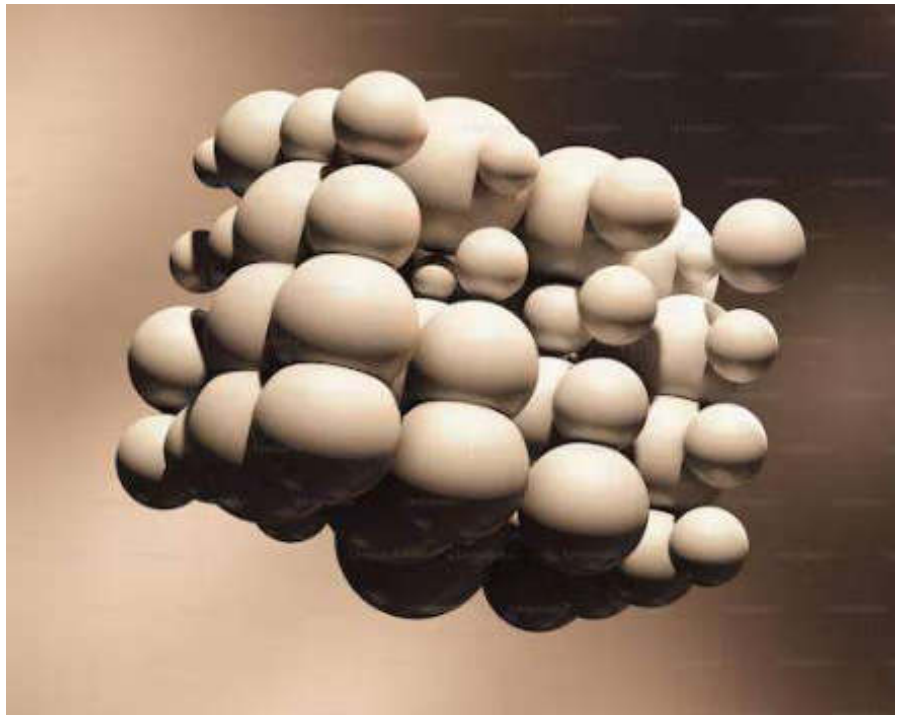
4. Structure of yeasts



https://unsplash.com/s/photos/structure-of-yeasts

Yeast cell can ferment approximately its own weight of glucose per hour.
https://www.britannica.com/science/yeast-fungus

Yeast is a eukaryotic organism with a complex and spherical cell structure and a cell size of approximately 5-8 µm. Cell size directly depends on the culture components and environmental conditions in which the yeast grows(Pamir, 1985).

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5. Type of yeasts

In food manufacture, yeast is used to cause fermentation and leavening. The fungi feed on sugars, producing alcohol (ethanol) and carbon dioxide; in beer and wine manufacture the former is the desired product, in baking it is the latter.

https://www.britannica.com/science/yeast-fungus

https://www.pexels.com/search/Yeast/

There are four main types of yeast you can use for bread baking: active dry yeast, instant dry yeast, fast-acting instant yeast, and bread machine yeast.

https://www.seriouseats.com/all-about-dry-yeast-instant-active-dry-fast-acting-and-more

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6.The use of yeast

https://unsplash.com/s/photos/yeasts

Yeasts are used in production of important foods such as bread, cheese, wine, and beer.

https://www.biologyonline.com/dictionary/fungi-yeast-mold

CO_2 bubbles produced during fermentation. Yeast replicate quickly and are easy to manipulate genetically. The doubling time for yeast (the time required for a cell to duplicate and divide itself) is about 90 minutes.

https://wiki.yeastgenome.org/index.php/What_are_yeast%3F

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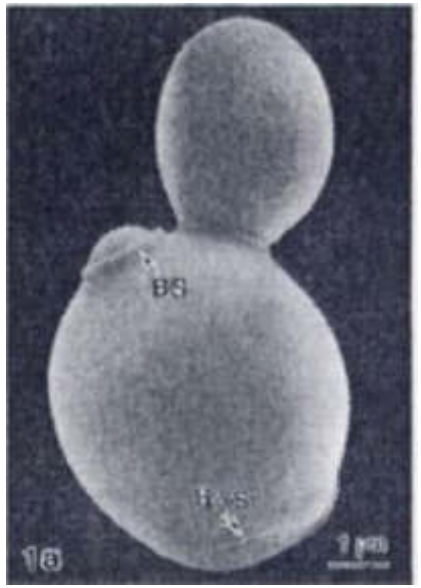
7. Proliferation of yeast



Scanning electron micrographs of yeast bud (Walker, 1998).

https://unsplash.com/s/photos/yeast

In yeast, budding usually occurs during the abundant supply of nutrition. In this process of reproduction, a small bud arises as an outgrowth of the parent body. Later the nucleus of the parent yeast is separated into two parts and one of the nuclei shifts into the bud. The newly created bud divides and grows into a new cell.

https://byjus.com/biology/budding/

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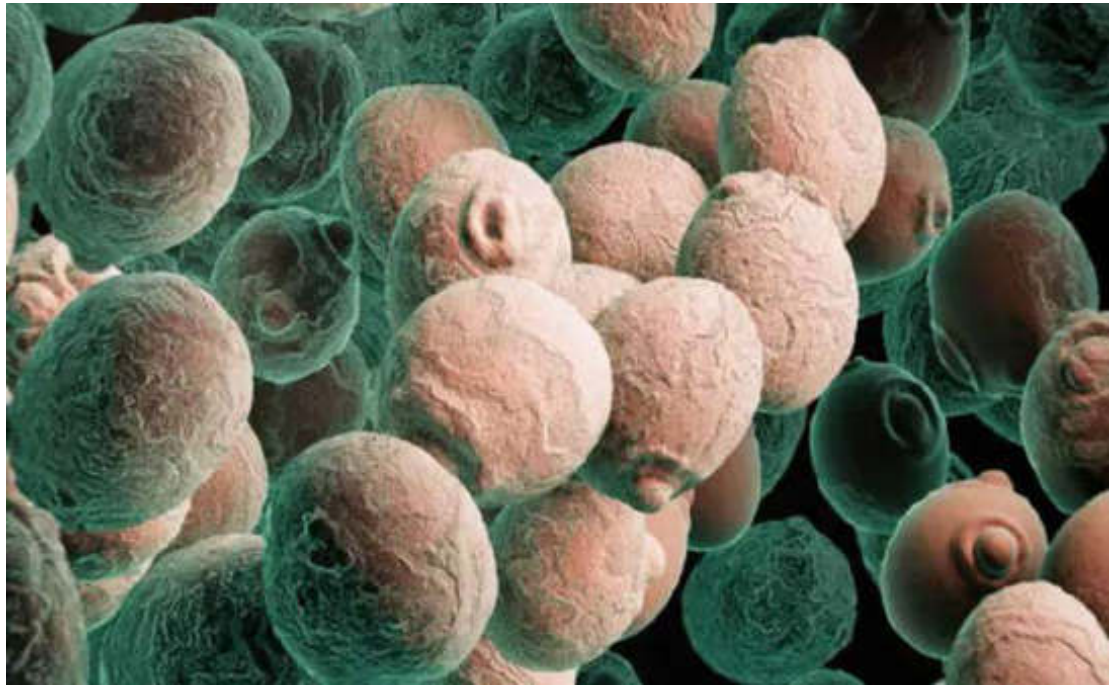
7. Proliferation of yeast



https://unsplash.com/s/photos/proliferation-yeasts

Factors affecting yeast proliferation:

- Temperature
- pH
- O2 Exchange
- Carbon source and concentration
- Nutrient media combination
- Mixing speed etc….

(Koçak, 2019)

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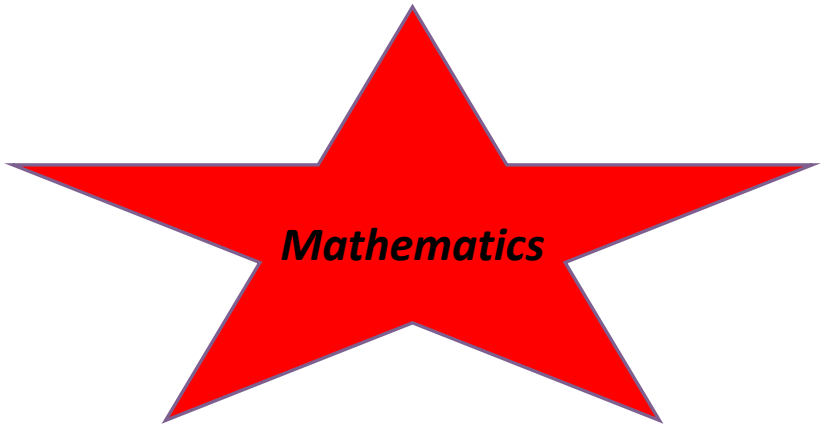
7. Proliferation of yeast



The behavior of the dough during fermentation can be presented as sigmoidal curves using different mathematical models.

Bread making is fundamentally a temperature dependent two step progression, consisting of fermentation, in which CO_2 production linked with yeast activity is manifested in porous dough structure with the development of dough volume during baking where yeast activity is ended and the bread structure is finalized. (Ali et al., 2012)

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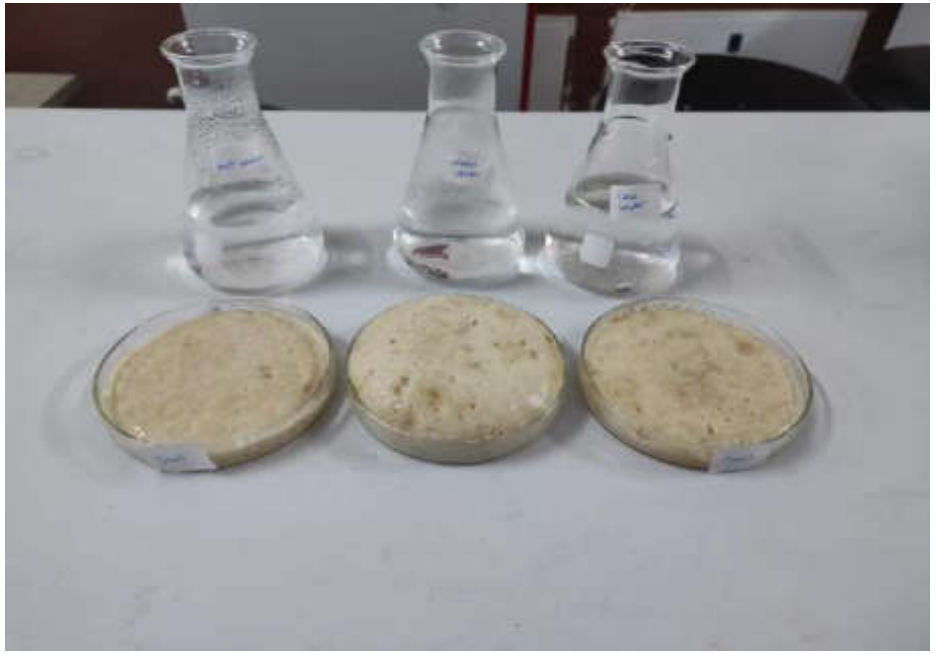
What can we do about yeast proliferation?

You can test it yourself



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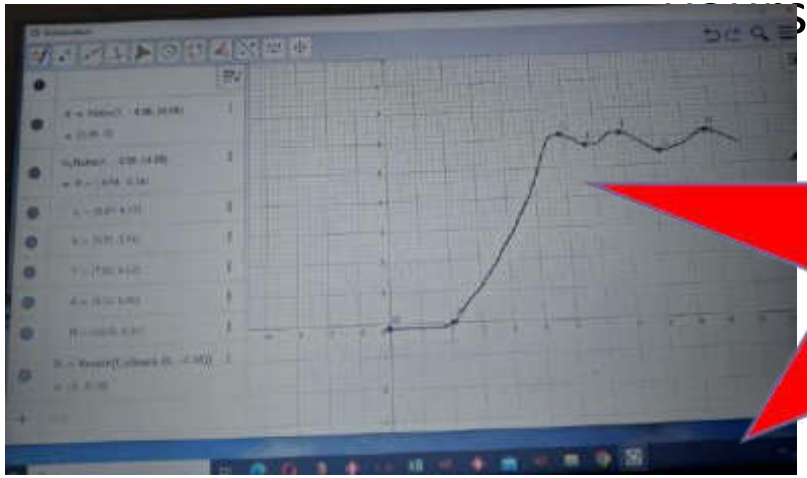
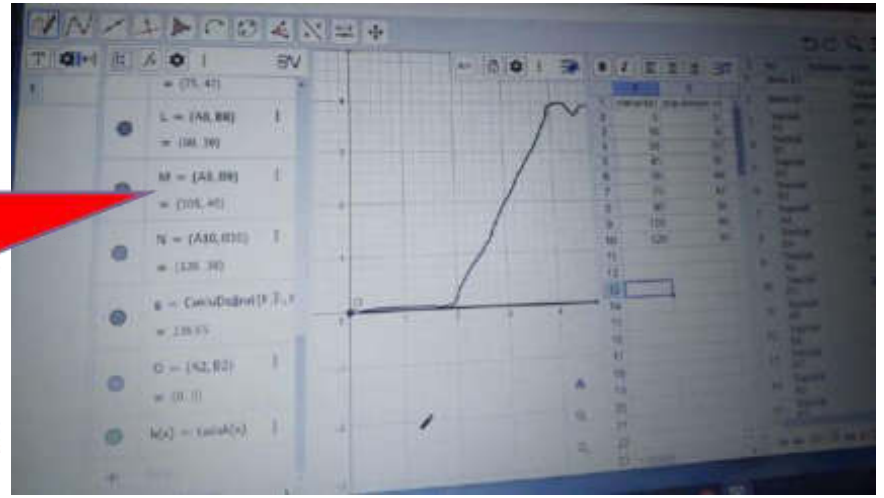


Figures. Sigmoidal graphs of yeast proliferation

Mathematics



Figures. Sigmoidal graphs of yeast proliferation

Sigmoidal graphs can be created by uploading data about yeast proliferation to the **GeoGebra** program.

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8. Task for learners

What kind of designs can we make to use yeast proliferation more efficiently?

I am waiting for you to think about this and make a design.

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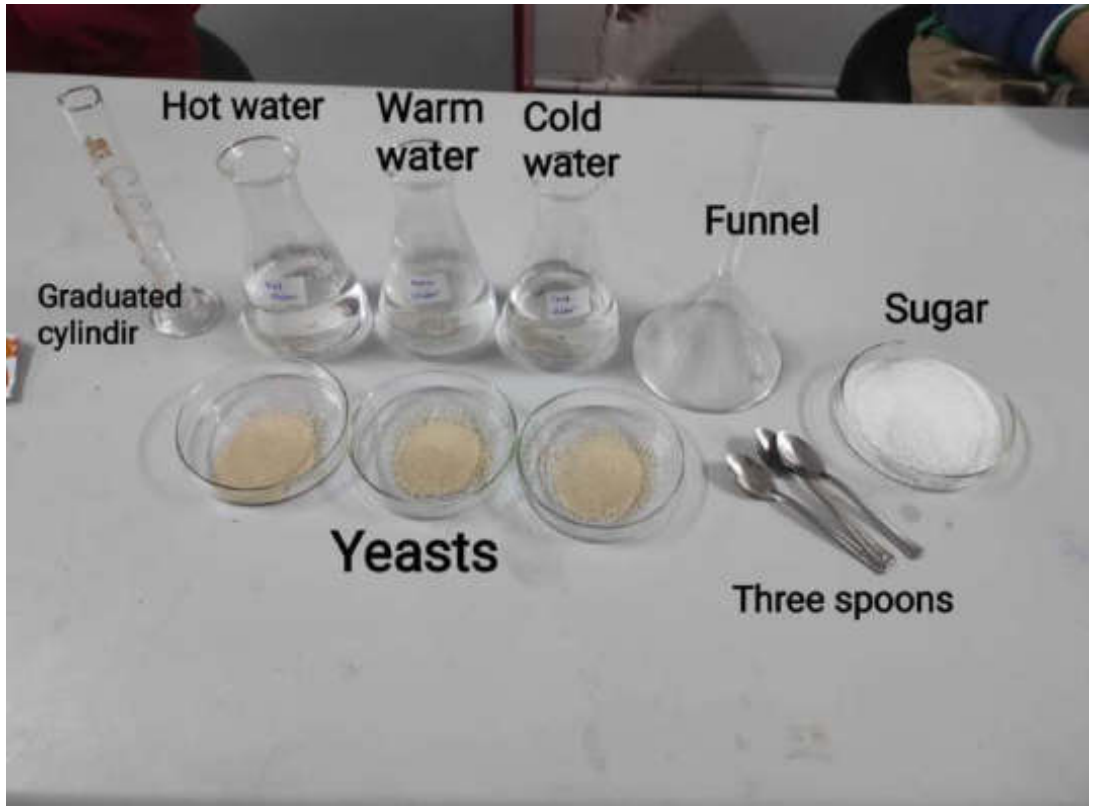
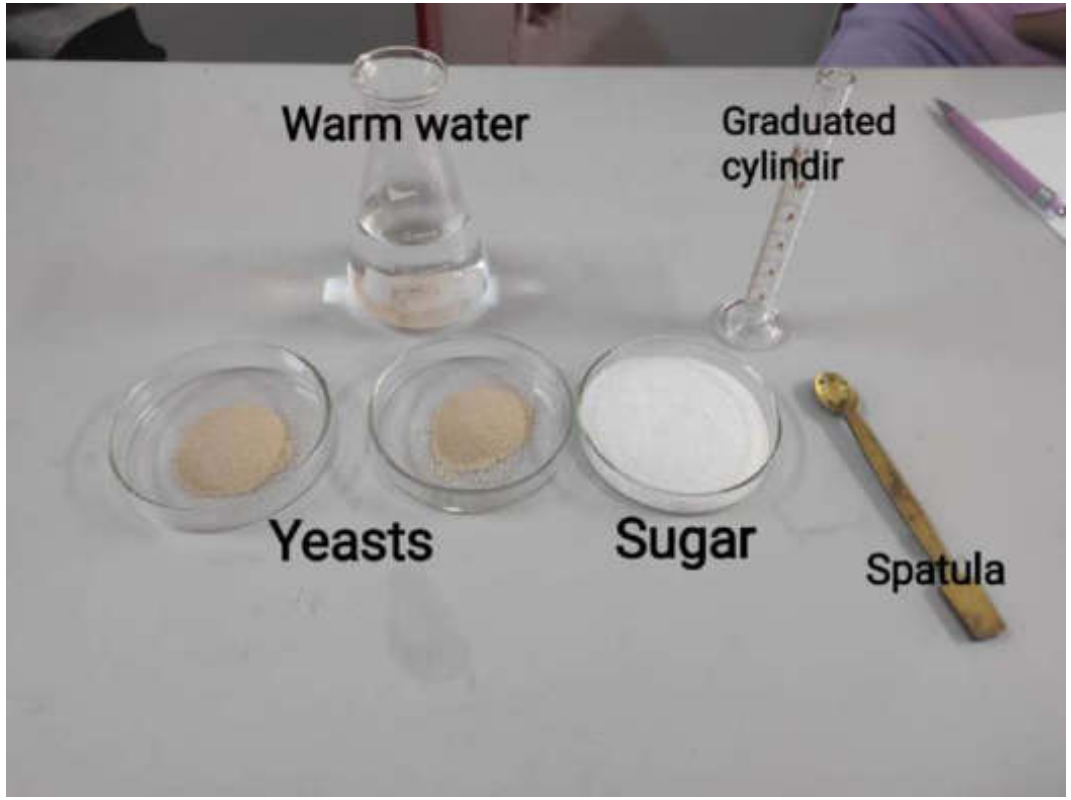
8. Task for learners

Some tools you can use:

For design



For design



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https://www.pexels.com/search/Yeast
https://wiki.yeastgenome.org/index.php/What_are_yeast%3F
https://byjus.com/biology/budding/
https://unsplash.com/s/photos/structure-of-yeasts
https://unsplash.com/s/photos/proliferation-yeasts
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Learning Unit:
Growth of plants and salinity

Topic III: Nature

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Content

1. Definition of a plant
2. Growth of plants
3. Effect of salinity on plant growth
4. Irrigation and fertilization increases the salt concentration
5. Task for learners

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1. Definition of a plant?

"a living thing that grows in the ground, usually has leaves or flowers, and needs sun and water to survive" (Britannica - https://www.britannica.com/dictionary/plant)
"A **plant** is a living thing that grows in the earth and has a stem, leaves, and roots." (Collins Dictionary- https://www.collinsdictionary.com/dictionary/english/plant)
"any of a kingdom of mostly photosynthetic living things usually lacking the ability to move from place to place under their own power, having no obvious nervous or sensory organs, possessing cellulose cell walls, and often having a body that is able to keep growing without taking on a fixed size and shape". (Merriam-Webster Dictionary - https://www.merriam-webster.com/dictionary/plant)
"a living thing that grows in earth, in water, or on other plants, usually has a stem, leaves, roots, and flowers, and produces seeds" (Cambridge Dictionary- https://dictionary.cambridge.org/dictionary/english/plant)

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2. Growth of plants

https://pixabay.com/images/search/plant/

https://pixabay.com/images/search/growth%20of%20plant/

Factors Affecting Plant Growth; light, water, carbon dioxide, air, temperature, the availability of essential nutrients, the pH of the soil, and the space to grow.

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2. Growth of plants

https://www.pexels.com/search/growth%20of%20plant/

Water is one of the primary elements required by plants. When you think of gardening, you generally think of water, soil and sunlight. Plants can suffer when any of these are compromised.

The importance of water to your plants goes beyond merely keeping them alive. Water is also a necessary element to help plants thrive. Water is what allows for the uptake of vital nutrients from the soil. It is also water that helps to carry sugar and other elements that may be required by flowers or fruit.

https://swanhose.com/blogs/general-watering/how-does-water-its-amount-its-quality-affect-plant-growth

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2. Growth of plants (Aritmetic growth in plants)

https://unsplash.com/s/photos/Aritmetic-growth-in-plants

How to Measure Plant Growth
Plant growth can be measured in four different ways:

Measuring the plant height
Measuring the leaf size
Calculating the growth rate with fresh plants
Calculating the growth rate with dried plants

https://swanhose.com/blogs/general-watering/how-does-water-its-amount-its-quality-affect-plant-growth

Mathematics

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3. Effect of salinity on plant growth

https://pixabay.com/images/search/growth%20of%20plant/

Soluble salts can be easily taken up by plants. Depending on the type and amount of salt compounds entering the plant, they become harmful to the plant when they exceed a certain concentration. They have a poisonous effect on the plant by disrupting nutrition and metabolism. In addition, as the salt concentration in the soil increases, it becomes difficult for the plant to absorb water from the soil, the structure of the soil deteriorates and plant development slows down or even stops. (Ekmekci et al.,2005)

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3. Effect of salinity on plant growth

Various undesirable effects appear because of high salt concentration. Ion imbalance is one of the major consequences. A high concentration of Na and Cl ions, as an example, can lead to biochemical processes which can prove to be fatal for the plants. Sodium and chloride toxicity not only induce nutritional disorders but also cause physiological drought by lowering the osmotic potential of the soil solutions. (Shahid et al., 2020)

https://pixabay.com/images/search/growth%20of%20plant/

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3. Effect of salinity on plant growth

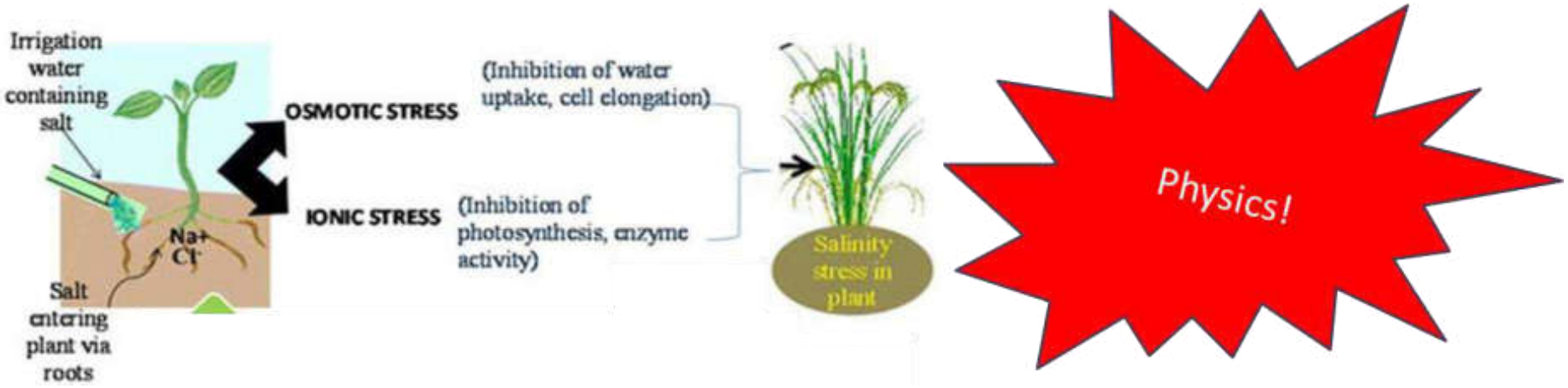

Figure. Schematic diagram showing routes of salt stress toxicity and various tolerance strategies in plants. (Shahid et al., 2020)

It has been observed that plants begin to wilt under some conditions even though there is sufficient water in the soil. This situation is generally called "physiological drought" which is caused by high soil salinity. In case of physiological drought, plant roots cannot take up the available water in the soil due to high osmotic pressure.(Ekmekçi et al., 2005)

3. Effect of salinity on plant growth

Figure. Petretto et al., 2019)

Figure. Petretto et al., 2019)

Salinity caused by NaCl is one of the most common abiotic stress affecting plant physiology. Salt stress causes several plants disorders (nutrient ion imbalance, decrease in stomatal conductance, low photosynthetic activity, etc.) morphological alteration (reduction in leaves number, plant size, roots length and fruit production), and secondary metabolites changes (signal molecules, hormones and oxidative compounds). Therefore, the use of saline water for plant cultivation requires the identification specie-specific thresholds at which crops show sensitivity to salinity(Petretto et al., 2019).

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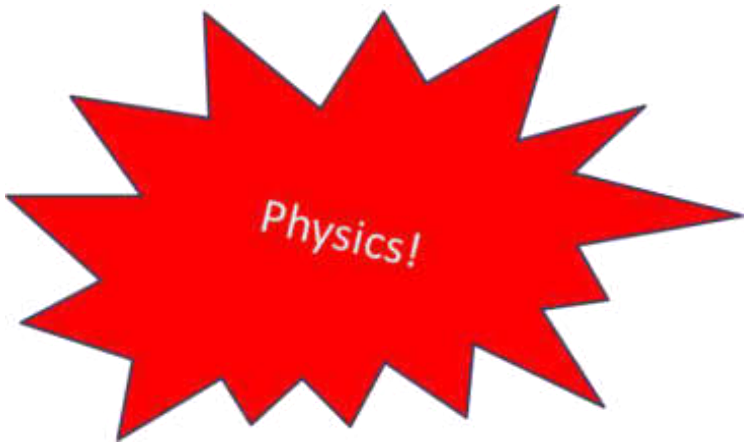
While some plants are more sensitive to salinity, some plants are more resistant. Resistant plants are plants that can develop greater strength against the osmotic effect in order to meet water requirements in saline soils. Examining the salt resistance of plants is important in order to select and grow plants that can produce crops at an economic level, especially in areas where soil salinity cannot be reduced below a certain level(Kotuby et al., 1997).

https://www.pexels.com/search/salinity%20of%20plant/

4. Irrigation and fertilization increases the salt concentration

https://www.pexels.com/search/salinity%20of%20plant/



High electrical conductivity values are often indicative of saline soils, where the salt concentration is above the threshold level for optimal plant growth. Saline soils can hinder water uptake by plants, leading to water stress and reduced nutrient absorption.

https://atlas-scientific.com/blog/how-does-electrical-conductivity-affect-plant-growth/

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4. Plant growth and salinity

Biology

You can test it yourself.

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4. Plant growth and salinity

Biology

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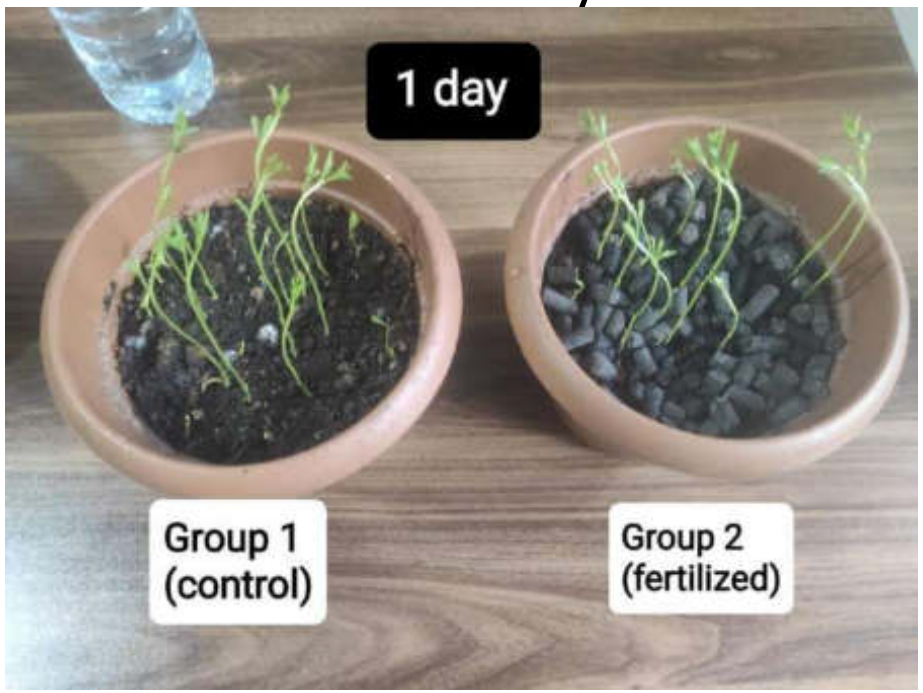

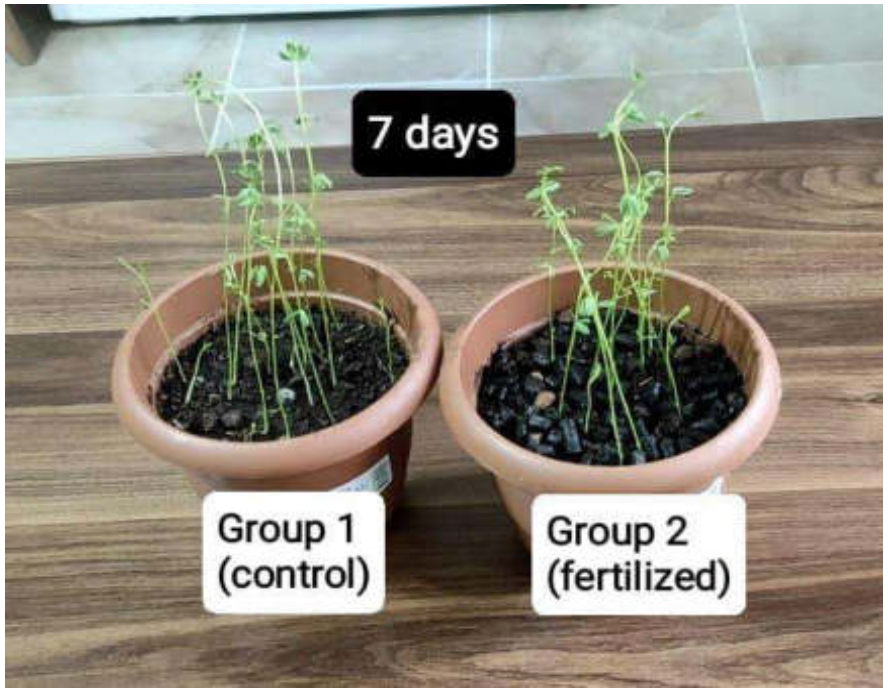

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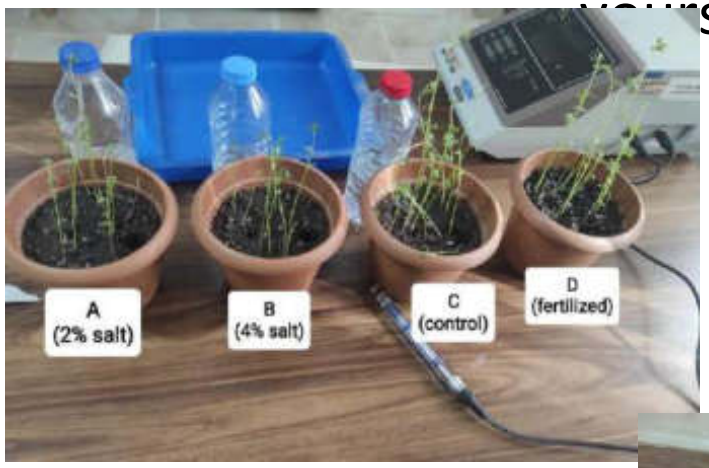

Physics!

Table. Electrical conductivity values (EC)

Experimental group	EC value (mS/ cm)
A (%2 salt)	15,3
B (%4 salt)	51,2
C (control)	6,8
D (fertilized)	7,7

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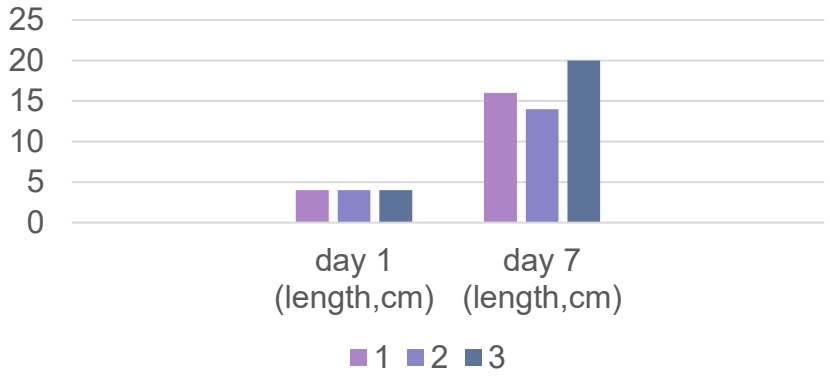
4. Plant growth and salinity

You can test it yourself.

Table. The amount of plant growth in the salination experimental groups

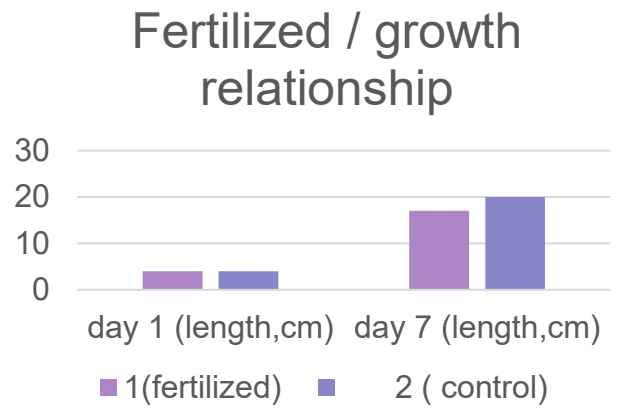
Experimental group	1 (2% salt)	2 (4% salt)	3 (control)
day 1 (length,cm)	4	4	4
day 7 (length,cm)	16	14	20



Mathematics

Table. The amount of plant growth in the fertilizaiton experimental groups

Experimental group	1 (fertilized)	2 (control)
day 1 (length,cm)	4	4
day 7 (length,cm)	17	20



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5. Task for learners

What kind of designs can we make to use the relationship between plant growth and salinity more efficiently in daily life?

I am waiting for you to think about this and make a design.

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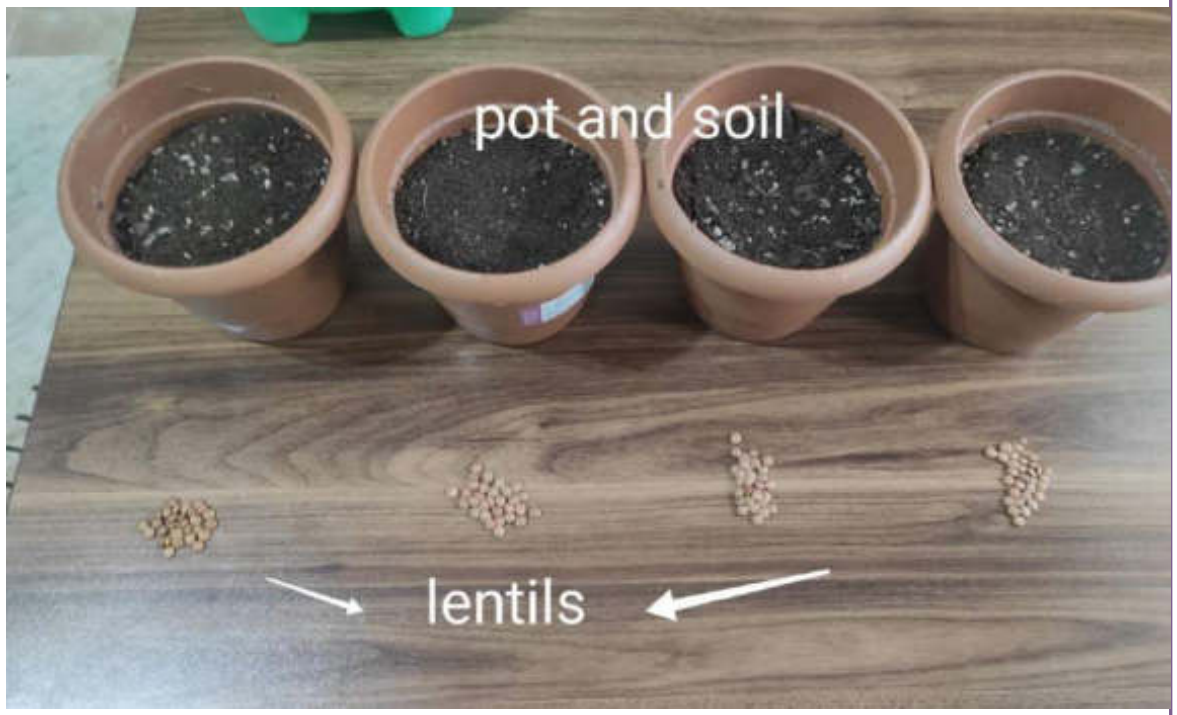
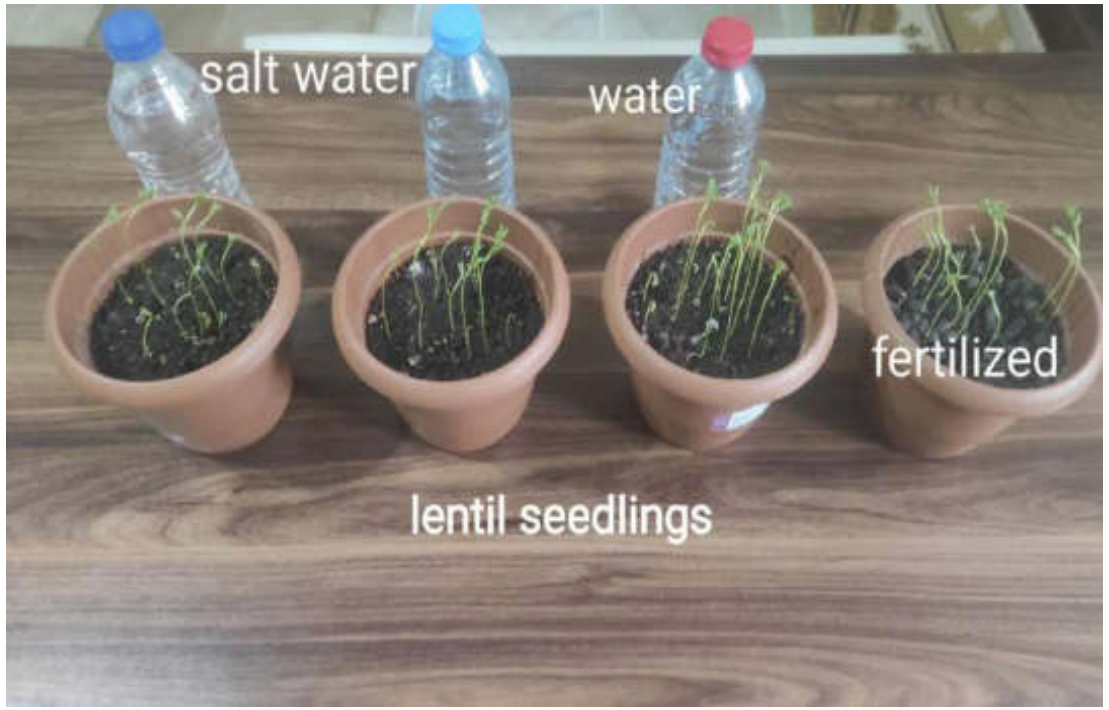
5. Task for learners

Some tools you can use:

For design



For design



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Innovative Model of learning STEM in secondary schools

ERASMUS+ KA220
Cooperation Partnerships in School Education

Reference Number:
2022-1-TR01-KA220-SCH-000087583

Duration:
31.12.2022 to 30.12.2024 (24 months)

LearnSTEM

Innovative Model of learning STEM in secondary schools

Learning Unit:
Leaves transport and evaporate water

Topic III:Nature

Yusuf Demir Science and Art Center

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Content

1. Structure of leaves
2. Leaves absorb water
3. Water transport in leaves
4. Water evaporation in leaves
5. Task for learners

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1. Structure of leaves

"The leaf is one of the most important parts of a plant. Leaves produce food for the plant through a process called photosynthesis. The leaves of different plants vary widely in size, shape, and color."

(Britannica - https://kids.britannica.com/kids/article/leaf/433080)

"The leaves of a tree or plant are the parts that are flat, thin, and usually green. Many trees and plants lose their leaves in the winter and grow new leaves in the spring."

(Collins Dictionary- https://www.collinsdictionary.com/dictionary/english/leaf)

"The leaf is a lateral outgrowth from a plant stem that is typically a flattened expanded variably shaped greenish organ, constitutes a unit of the foliage, and functions primarily in food manufacture by photosynthesis ".

(Merriam-Webster Dictionary - https://www.merriam-webster.com/dictionary/leaf)

"The leaf is one of the flat, usually green parts of a plant that are joined at one end to the stem or branch."

(Cambridge Dictionary- https://dictionary.cambridge.org/dictionary/english/leaf)

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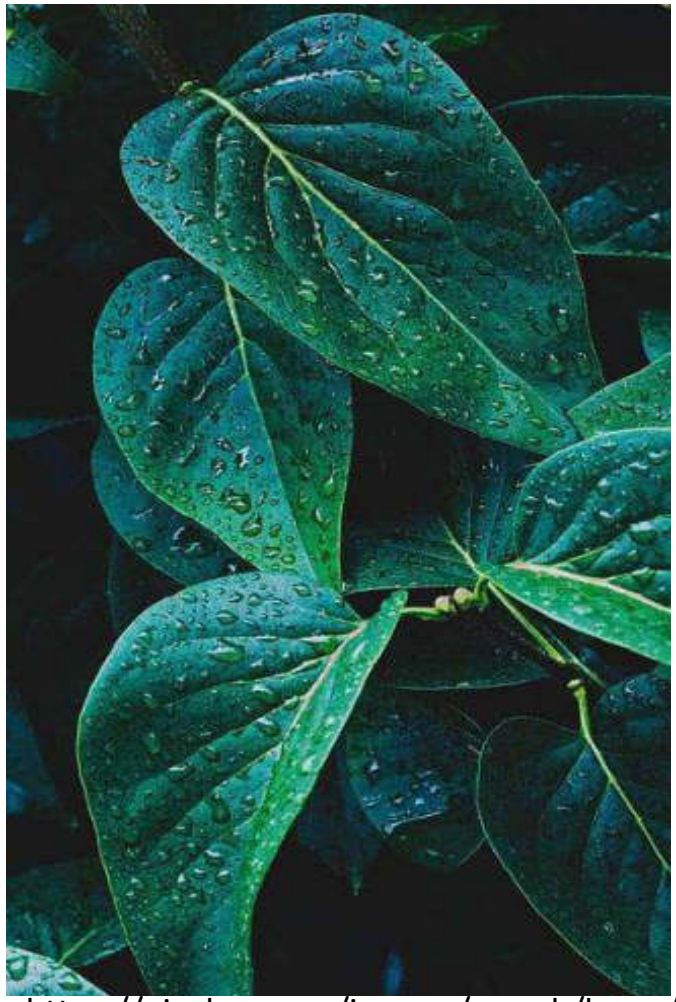
1. Structure of leaves

The leaf is the energy factory of the plant, and clearly it is indispensable for its survival. Photosynthesis converts light energy to sugar, which in turn is transported to the photosynthetically inactive parts of the plant, such as the roots (Katifori, 2018).
Leaves are generally the major plant interface for gas exchange, and they are distally located to the main source of water, that is, the soil. As a result, they are the most dehydrated plant organ and ultimately control transpiration rates (Guzman-Delgado et al., 2018).



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1. Structure of leaves

https://pixabay.com/images/search/structure%20of%20leaves/

Veins: The network of veins in the leaf carries water from the stems to the leaves. Glucose produced is also sent to the other parts of the plant from the leaves through the veins.
Stomata (holes): The stomata (tiny holes underneath the leaf) allow air in and out of the leaf. Stomata are usually at the bottom surface of the leaf.
The stomata close in the night to retain gases and moisture in the leaf cells and opens during the day for gaseous exchange to continue.

https://eschooltoday.com/learn/leaf-structure/

1. Structure of leaves

https://unsplash.com/s/photos/Structure-of-leaves

An overview of a leaf and how its structure affects a plant's internal functions.

Encyclopædia Britannica, Inc.

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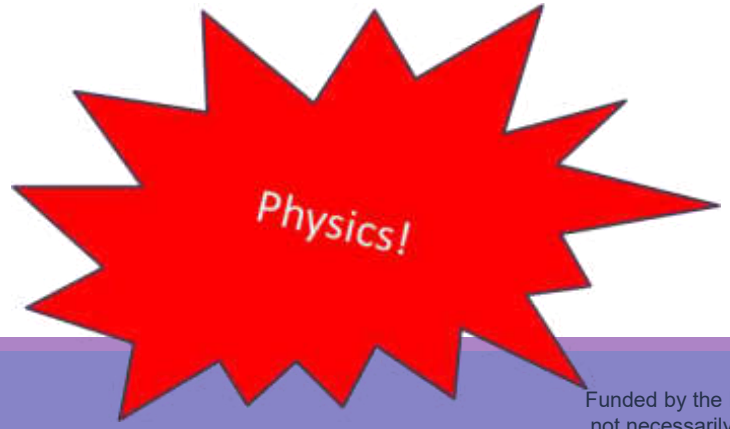
2. Leaves absorb water

The osmotic push of water molecules from the soil into the roots causes an upwards pressure, which is known as root pressure. Because of this pressure, the water absorbed from the soil is pushed upwards through the xylem tissue of the stem. The xylem is the vascular tissue responsible for transporting water and dissolved minerals from the roots up to the stem and leaves of the plant. The water is transported the rest of the way by transpiration, which provides most of the force needed for water transport in plants.

https://www.nagwa.com/en/presentations/638126046213/

Leaf water uptake may play a particularly important role in periods of soil water deficit if leaf-wetting events, such as fog, occur (Boaneres et al., 2018).

https://www.pexels.com/search/leaves%20absorb%20water/



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2. Leaves absorb water

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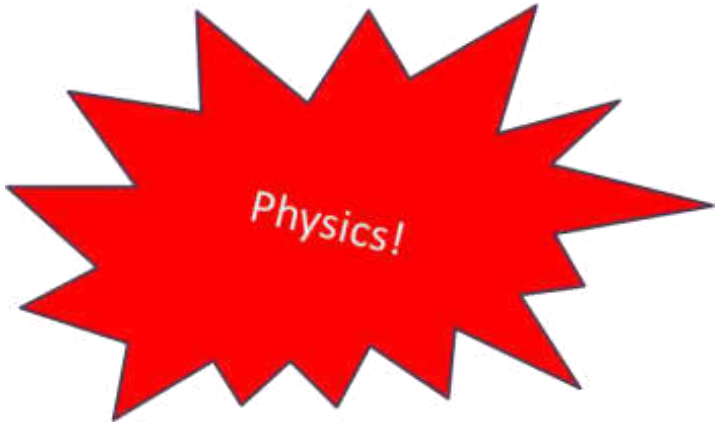

The main method of movement is for free water molecules to pass from the soil into the cell through the root hair membrane. This process is known as osmosis

(Britannica- https://www.britannica.com/video/73123/Plants-osmosis-roots-water-transpiration-leaves-moisture)

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3. Water transport in leaves

Transpiration is the movement of water up the stem of a plant from root to leaf when water is lost from the plant due to evaporation of water from a plant's surface. Firstly, water is absorbed by the root and moves through root hair cells via the process of osmosis. When water evaporates from the surface of the leaves, the pressure change pulls the column of water upwards to replace the water lost. There's a constant transpiration stream of water through the plant.

https://www.science-sparks.com/changing-colour-flowers-with-transpiration/

https://unsplash.com/s/photos/leaf

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4. Water evaporation in leaves

Transpiration is the discharge of water vapor from the leaves of plants into the atmosphere. It is known that a large oak tree can transpire 40,000 gallons (151,000 liters) per year.
https://eschooltoday.com/learn/transpiration/

Like all living organism, plants also require an excretory system to discharge excess water from their body. This process of elimination of excess water from the plant body is known as transpiration. It is generally the evaporation of water from the surface of the leaves.
https://byjus.com/biology/transpiration/

Stomatal openings are necessary to admit carbon dioxide to the leaf interior and to allow oxygen to escape during photosynthesis.
https://www.britannica.com/science/transpiration

https://pixabay.com/images/search/leave/

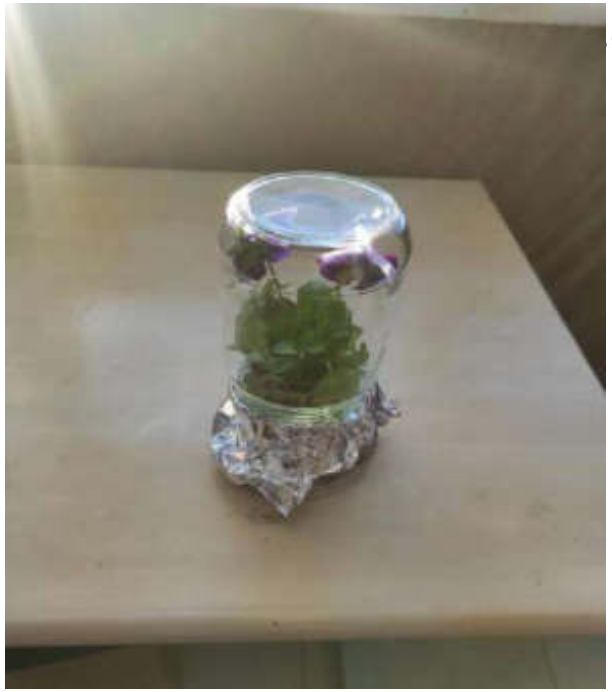
4. Water transport in leaves

You can test it yourself.

4. Water evaporation in leaves

You can test it

elf.



5. Task for learners

What kind of designs can we make to use leaves transport and evaporate water more efficiently in daily life?

I am waiting for you to think about this and make a design.

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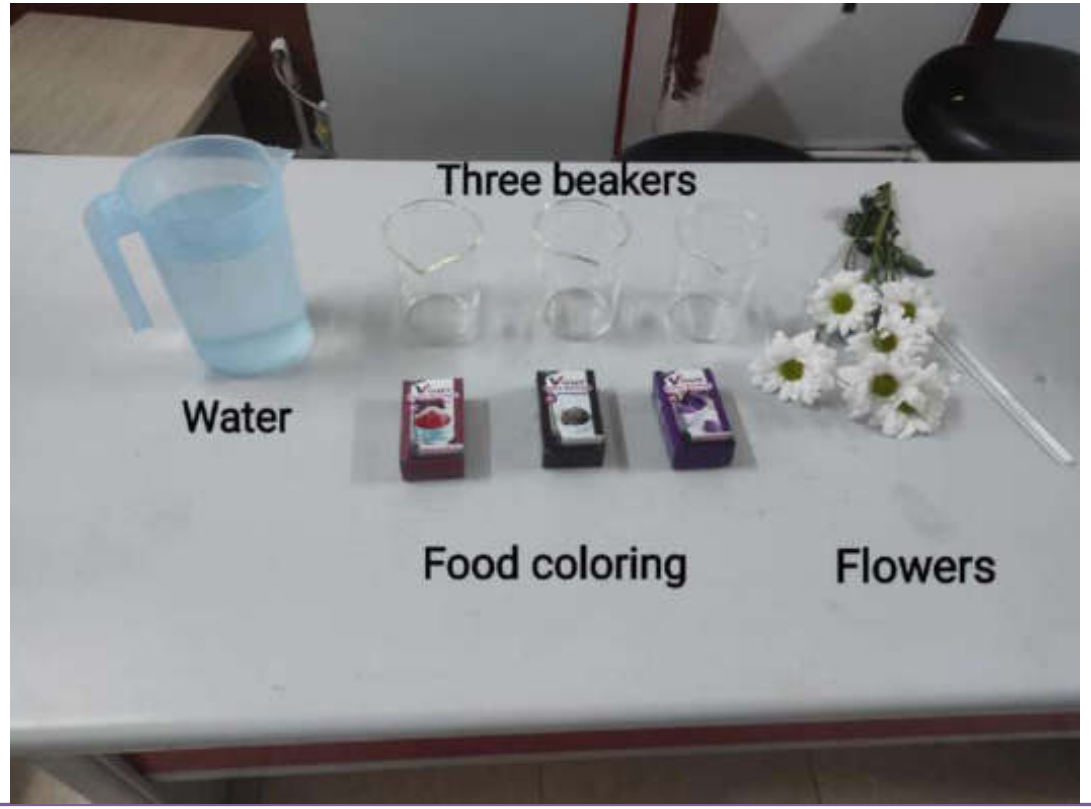
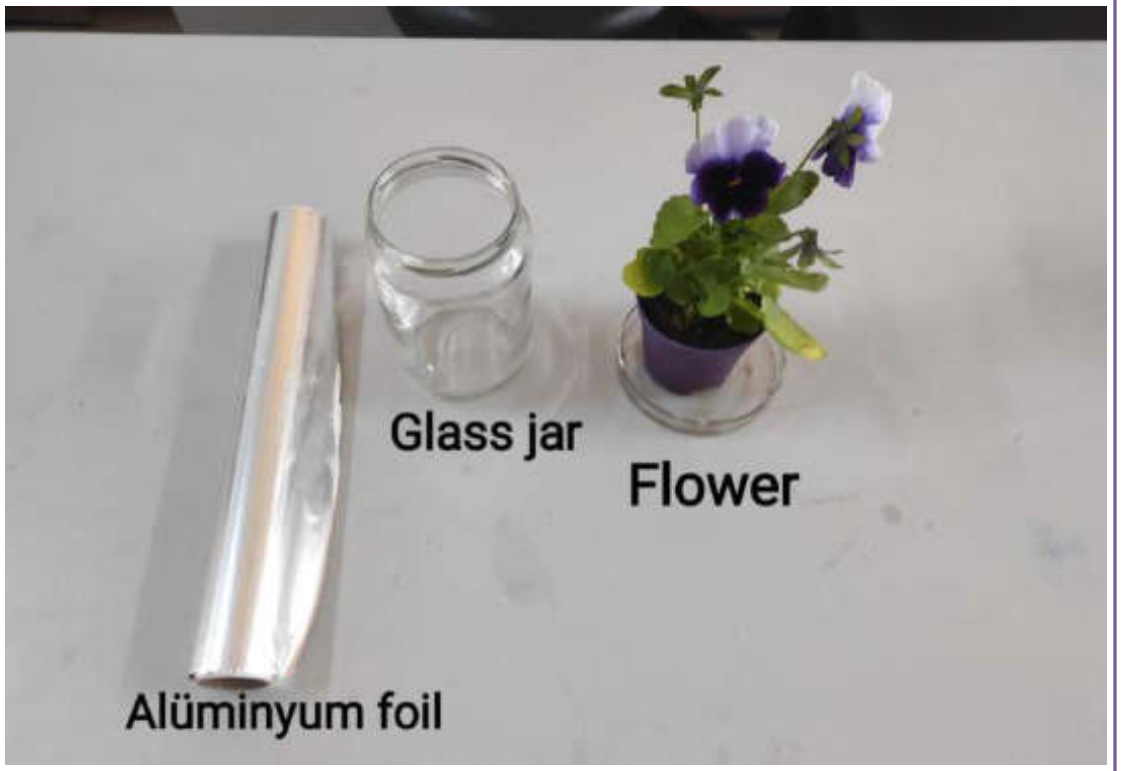
5. Task for learners

Some tools you can use:

For design



For design



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https://www.science-sparks.com/changing-colour-flowers-with-transpiration/

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https://www.britannica.com/science/transpiration

https://pixabay.com/images/search/leave/

https://unsplash.com/s/photos/Structure-of-leaves

https://unsplash.com/s/photos/Leaves-absorb-water

https://unsplash.com/s/photos/leaf

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LearnSTEM

Innovative Model of learning STEM in secondary schools

Learning Unit:
Design a Solar Panel

Topic III:Nature

Yusuf Demir Science and Art Center

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Content

1. What is solar energy?
2. How do solar panels work?
3. How is solar energy used?
4. Can solar panels be designed differently?
5. Task for learners.

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1. What is Solar Energy?

“Solar energy is the radiation from the Sun capable of producing heat, causing chemical reactions, or generating electricity”. (Britannica - https://www.britannica.com/science/solar-energy)
“Solar energy is any type of energy generated by the sun. Solar energy is created by nuclear fusion that takes place in the sun”. (National Geographic - https://education.nationalgeographic.org/resource/solar-energy/)
“Energy that uses the power of the sun to produce electricity“. (Cambridge Dictionary - https://dictionary.cambridge.org/dictionary/english/solar-energy)

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2. How do solar panels work?

The amount of sunlight that hits the Earth's surface in 1.5 hours can cover the entire Earth's energy consumption for one year. Solar radiation is the light emitted by the sun and is known as electromagnetic radiation. The amount of solar radiation reaching any given point on the Earth's surface varies. Solar technologies capture this radiation and convert it into useful energy (Office of Energy Efficiency and Renewable Energy - https://www.energy.gov/eere/solar/how-does-solar-work).

2. How do solar panels work?

Solar technologies can convert sunlight into electricity through two methods.
(Office of Energy Efficiency and Renewable Energy -https://www.energy.gov/eere/solar/how-does-solar-work)

Photovoltaics Basics

It is the most commonly used method in solar panels (PV). When the sun shines on the panel, the energy from the sunlight is absorbed by the PV cells in the panel. This energy creates electric charges that move in response to the electric field in the cell and cause electricity to flow.

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2. How do solar panels work?

Solar technologies can convert sunlight into electricity through two methods.
(Office of Energy Efficiency and Renewable Energy -https://www.energy.gov/eere/solar/how-does-solar-work)

Concentrating Solar-Thermal Power Basics (CSP)

These systems use mirrors to reflect and concentrate sunlight onto receivers that collect and convert it into heat. This can then be used to generate electricity or stored for later use. They are mainly used in very large power plants.

3. How is solar energy used?

MBSS used for powering fuel station (Budapest, Hungary)

Almadhhachi, M., Seres, I., & Farkas, I. (2022). Significance of solar trees: Configuration, operation, types and technology commercialization. *Energy Reports*, *8*, 6729-6743.

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3. How is solar energy used?

Super tree (Singapore)

Almadhhachi, M., Seres, I., & Farkas, I. (2022). Significance of solar trees: Configuration, operation, types and technology commercialization. *Energy Reports*, *8*, 6729-6743.

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4. Can solar panels be designed differently?

The sun is widely used as a renewable energy source all over the world. Thanks to solar panels with different characteristics, solar energy is converted into electrical energy and a significant amount of energy needs are met.

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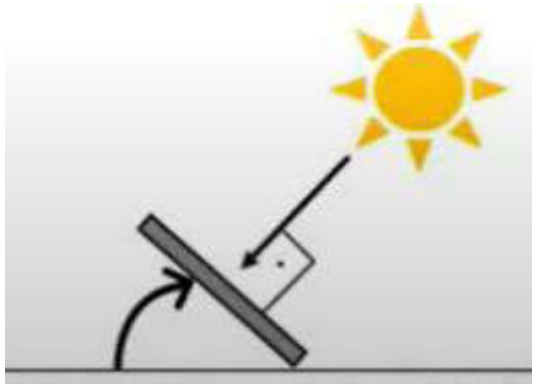
4. Can solar panels be designed differently?

The position and angle of the solar panels affect the amount of electrical energy to be obtained from the sun's rays. The tilt angle of solar panels for different times of the year in different regions can affect energy efficiency (Tang & Wu, 2004; Bakirci, 2012; Roux, 2016; Melhem & Shaker, 2023). The falling of the sun rays on the solar panel at a right angle increases the electricity production (Dal, 2021).



Situation of the sun's rays perpendicular to the panel (Dal, 2021)

4. Can solar panels be designed differently?

You can test it yourself.

4. Can solar panels be designed differently?

The angle of incidence of the sun's rays on the solar panels differs at different time intervals in different parts of the world. At the same time, the sun rays falling on the solar panels change according to different settings of the year and different times. This situation affects the efficiency of electrical energy obtained from solar panels. It is possible to obtain maximum efficiency by changing the angle of the solar panels according to the position of the sun.

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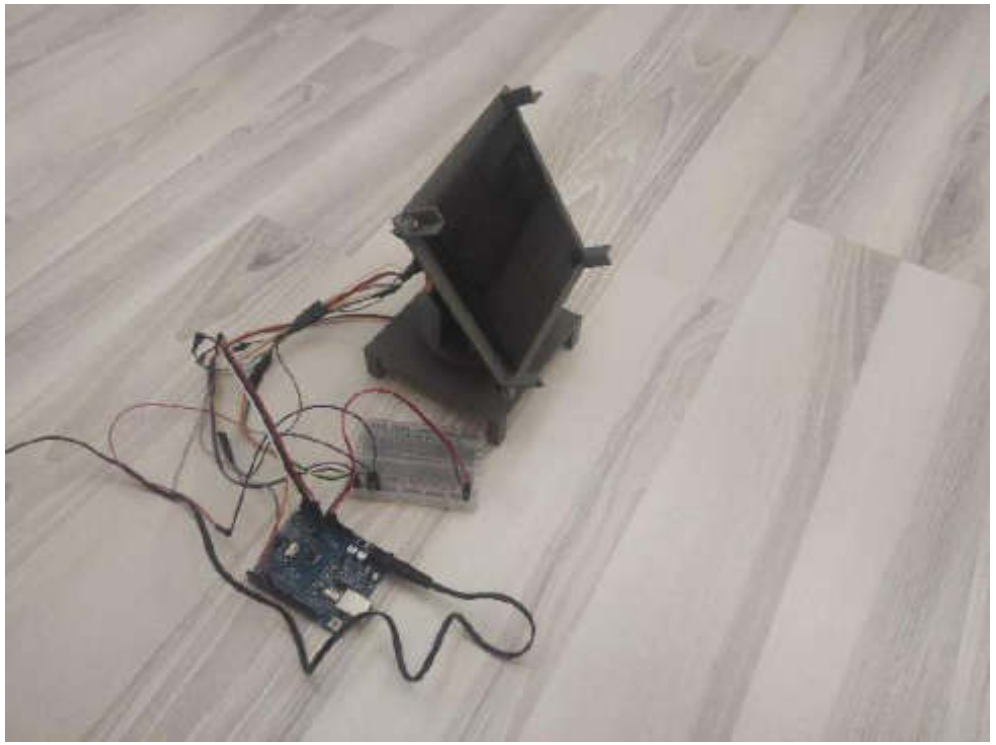
4. Can solar panels be designed differently?

Different designs are being made today in order to make maximum use of solar energy.



5. Task for learners

What kind of designs can we make to use solar panels more efficiently in daily life?

I am waiting for you to think about this and make a design.

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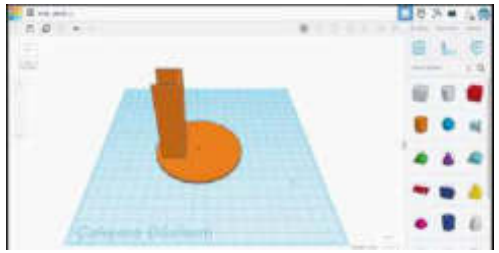
5. Task for learners

Some tools you can use:

For design



3D design program

3D printer

or

plywood

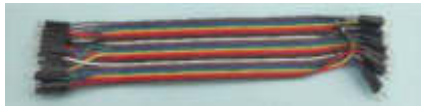
cardboard

silicon gun

For electronics

Servo motor

Light sensor



Jumper cable

Resistor

Voltmeter

Arduino Uno

Soldering iron

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https://www.energy.gov/eere/solar/how-does-solar-work