

Monera (Day 3)

Friday, June 21, 2024 1:57 PM

here's a detailed explanation of the general characteristics of Kingdom Monera, focusing on the features of bacteria, their morphology, and cell structure:

Kingdom Monera

Kingdom Monera encompasses all unicellular organisms with a prokaryotic cell structure. Prokaryotes are the simplest and most ancient form of life on Earth. They lack a true nucleus and membrane-bound organelles, unlike the more complex eukaryotic cells. Despite their simplicity, bacteria exhibit a remarkable diversity in terms of shape, size, metabolism, and ecological niches.

Features of Bacteria

- **Unicellular:** Bacteria are single-celled organisms. They exist as individual cells or can form multicellular colonies, but each cell functions independently.
- **Prokaryotic Cell Structure:** As mentioned earlier, bacteria lack a true nucleus and membrane-bound organelles. Their genetic material is a single, circular chromosome located in the cytoplasm.
- **Cell Wall:** Most bacteria possess a rigid cell wall made of peptidoglycan, a complex sugar linked to amino acids. The cell wall provides shape, support, and protection against osmotic pressure.
- **Cell Membrane:** The cell membrane is a phospholipid bilayer that separates the cytoplasm from the external environment. It controls the passage of nutrients and waste products into and out of the cell.
- **Cytoplasm:** The cytoplasm is a gel-like fluid that fills the bacterial cell. It contains ribosomes, enzymes, nutrients, and other cellular components.
- **Genetic Material:** The bacterial chromosome is a single, circular DNA molecule located in the cytoplasm. It carries all the genetic information needed for the cell to function and reproduce.
- **Ribosomes:** Ribosomes are the sites of protein synthesis in bacteria. They are smaller and simpler than eukaryotic ribosomes.
- **Inclusion Bodies:** Inclusion bodies are non-membranous storage structures within the cytoplasm. They store various materials such as nutrients, pigments, or gases.
- **Flagella:** Some bacteria have flagella, whip-like structures that aid in locomotion. Flagella rotate due to a rotary motor at the base, propelling the bacterium forward.
- **Pili:** Pili are hair-like structures shorter than flagella. They can be used for attachment to surfaces, conjugation (transfer of genetic material between bacteria), or twitching motility.
- **Capsule:** Some bacteria have a capsule, a gelatinous layer external to the cell wall. It provides additional protection against desiccation (drying out) and phagocytosis (being eaten by other cells).

Morphology of Bacteria

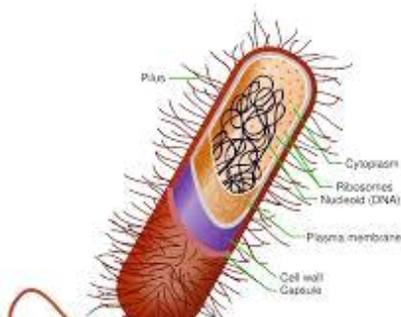
Bacteria come in various shapes and sizes. The most common bacterial shapes are:

- **Coccus:** Spherical shaped bacteria (e.g., Staphylococcus)
- **Bacillus:** Rod-shaped bacteria (e.g., Escherichia coli)
- **Spirillum:** Spiral-shaped bacteria (e.g., Treponema pallidum)
- **Vibrio:** Comma-shaped bacteria (e.g., Vibrio cholerae)

Cell Structure of Bacteria

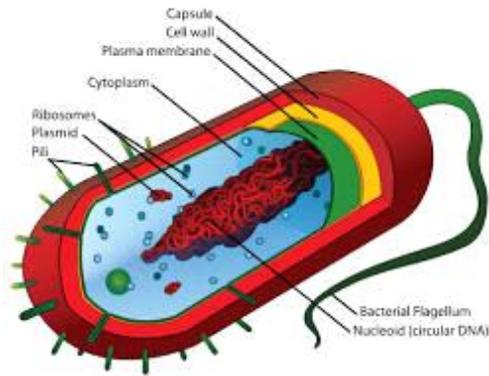
Here's a breakdown of the key components of a bacterial cell:

1. **Capsule:** Not all bacteria have a capsule, but it can be visualized as a fuzzy layer external to the cell wall.



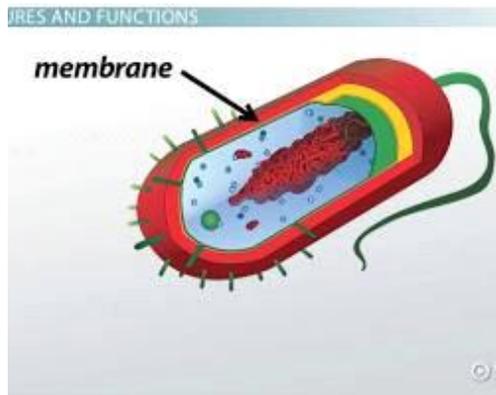
Capsule of Bacteria Cell

- 2. Cell Wall:** The cell wall is a rigid structure surrounding the cell membrane. It provides shape, support, and protection.



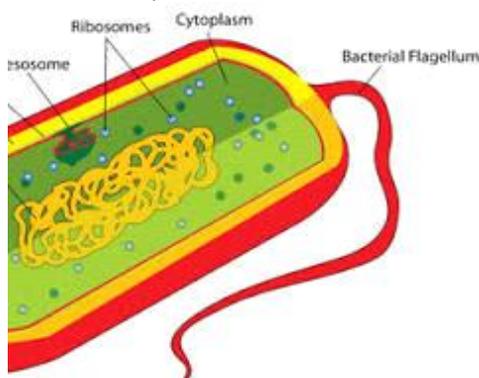
Cell Wall of Bacteria Cell

- 3. Cell Membrane:** The cell membrane is a phospholipid bilayer that controls the passage of materials into and out of the cell.



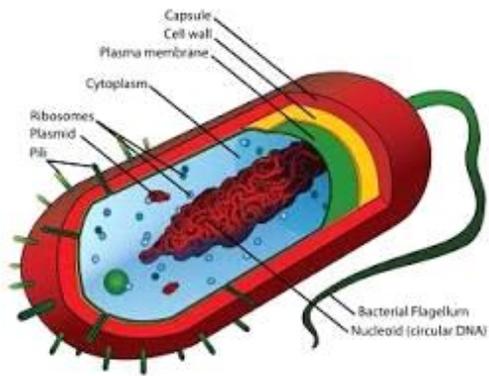
Cell Membrane of Bacteria Cell

- 4. Cytoplasm:** The cytoplasm is a gel-like fluid that fills the cell. It contains ribosomes, enzymes, nutrients, and other cellular components.



Cytoplasm of Bacteria Cell

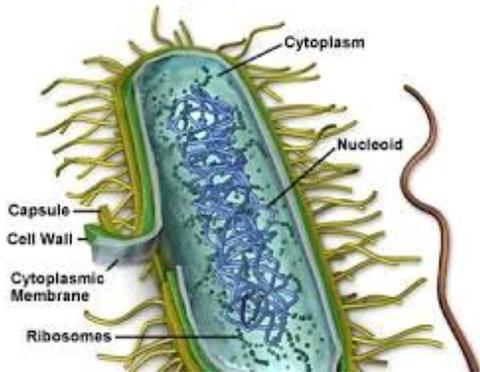
- 5. Nucleoid:** The nucleoid is the region in the cytoplasm where the bacterial chromosome is located. It's not enclosed by a nuclear membrane.



Nucleoid of Bacteria Cell

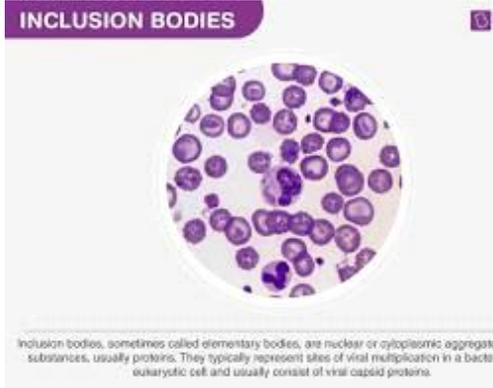
6. **Ribosomes:** Ribosomes are the sites of protein synthesis in bacteria.

Prokaryotic Cell Structure



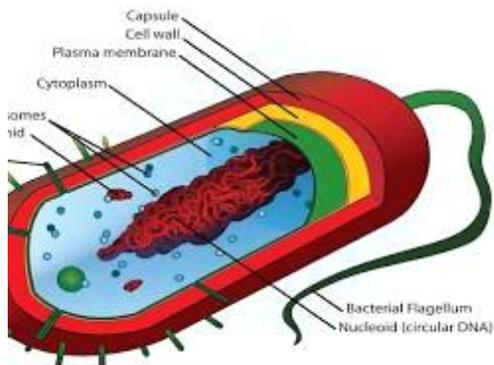
Ribosomes of Bacteria Cell

7. **Inclusion Bodies:** Inclusion bodies are non-membranous storage structures within the cytoplasm.



Inclusion Bodies of Bacteria Cell

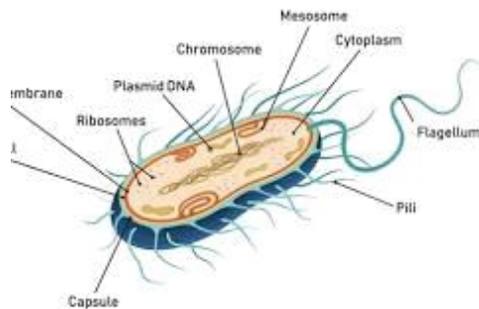
8. **Flagella:** Flagella are hair-like structures that some bacteria use for locomotion.



Flagella of Bacteria Cell

9. **Pili:** Pili are shorter hair-like structures used for attachment, conjugation, or twitching motility.

STRUCTURE OF A BACTERIAL CELL



Pili of Bacteria Cell

By understanding these features and structures, you gain a deeper appreciation for the remarkable world of bacteria and their immense contribution to life on Earth.

Classification of monera up to class (Whittaker 1969)

Question

The Whittaker five-kingdom classification (1969) did not classify organisms within Kingdom Monera down to the class level.

This classification system focused on broader categories based on cell structure, nutrition, and reproduction. Monera was simply defined as the kingdom containing all unicellular prokaryotes.

Later advancements in our understanding of life, particularly the discovery of significant differences between bacteria and archaea, led to the division of Monera into two separate domains:

- **Bacteria**
- **Archaea**

Monera [Ar
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These domains are further classified into lower taxonomic ranks like phyla, classes, orders, families, genera, and species. So, while Whittaker's system didn't classify Monera further, modern classification systems categorize bacteria and archaea into more detailed taxonomic levels.

You're right, a more detailed explanation is needed. Here's a breakdown of the classification issue with Kingdom Monera in the Whittaker system:

Whittaker's Five-Kingdom Classification (1969):

- This system aimed to categorize all living organisms into five kingdoms based on:
 - Cell structure (prokaryotic vs. eukaryotic)
 - Nutritional mode (autotrophic vs. heterotrophic)
 - Reproductive complexity (sexual vs. asexual)
- Kingdom Monera was established for all unicellular prokaryotic organisms.
- The classification didn't delve deeper into classes or lower ranks within Monera.

Limitations of Monera in Whittaker's System:

- As science progressed, researchers discovered significant differences between bacteria and archaea, both housed in Monera.
 - Bacteria and archaea have distinct cell wall structures, metabolic pathways, and sensitivities to antibiotics.
- Grouping them together under Monera didn't reflect these fundamental differences.

Modern Classification System:

- The discovery of archaea led to the abandonment of Monera as a single kingdom.

- Modern systems classify organisms into three domains:
 - Bacteria
 - Archaea
 - Eukarya (all organisms with eukaryotic cells)
- Each domain is further classified into lower taxonomic ranks like phyla, classes, orders, families, genera, and species.
- Bacteria and archaea are now categorized within their respective domains with detailed classifications.

Here's an analogy: Imagine a library with just two sections: Fiction and Non-Fiction. While helpful initially, as the collection grows, you might need sub-sections like Romance, Sci-Fi, History, Science, etc., for better organization. Similarly, the classification system needed more specific ranks to accommodate the diversity of life.

This highlights the dynamic nature of scientific classification. As our understanding of life evolves, so do the systems we use to categorize organisms.

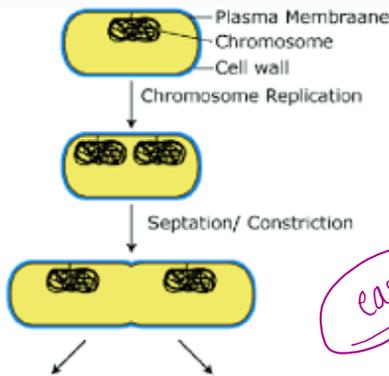
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Reproduction (Binary fission; Spore formation; Transformation; Conjugation and Transduction) in monera

Monera, though classified differently now, displayed various reproductive strategies, ensuring their survival and propagation. Here's a breakdown of the common reproductive methods in these organisms:

Asexual Reproduction:

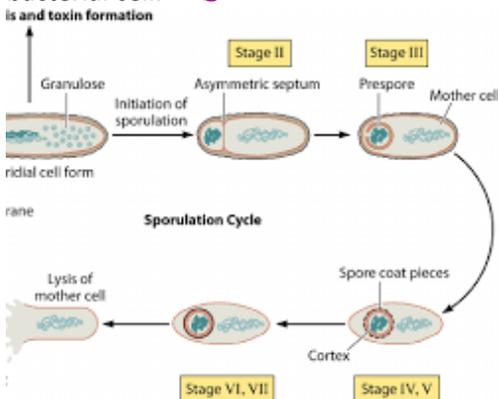
- **Binary Fission:** This is the most prevalent mode of reproduction in Monera. The single bacterial cell replicates its DNA, creates a new cell wall, and then divides into two identical daughter cells. This process is rapid and efficient, allowing for quick population growth under favorable conditions.



Asexual - Binary Fission
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spore = extreme Nutr

Binary Fission in Bacteria

- **Spore Formation:** In harsh environments, some bacteria can develop spores. Spores are dormant stages where the bacterium goes into a protective shell. They can withstand extreme temperatures, desiccation (drying out), and nutrient deprivation. When conditions improve, the spore can germinate and develop back into a vegetative bacterial cell.





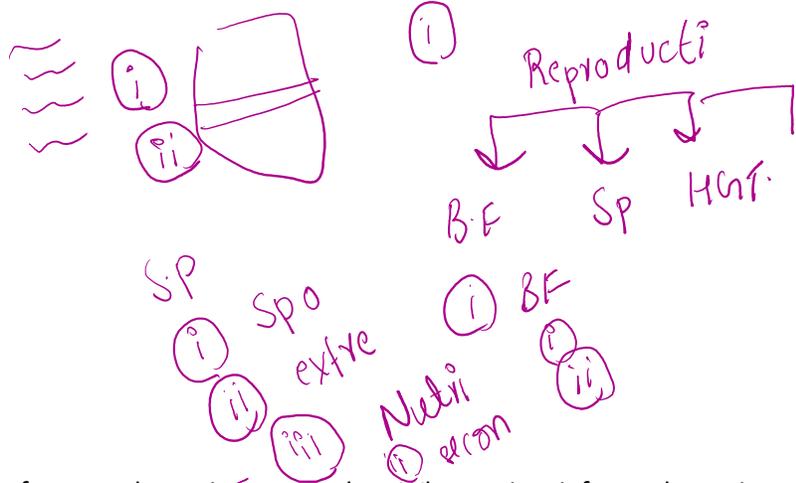
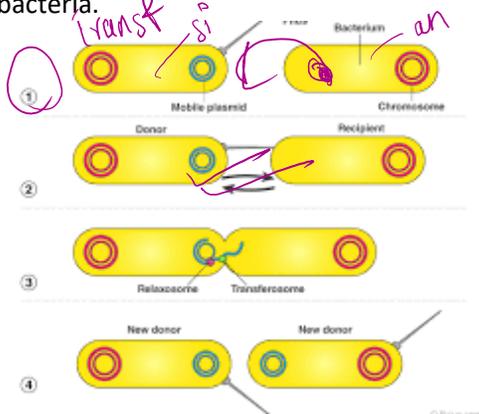
Spore Formation in Bacteria

Horizontal Gene Transfer (HGT):

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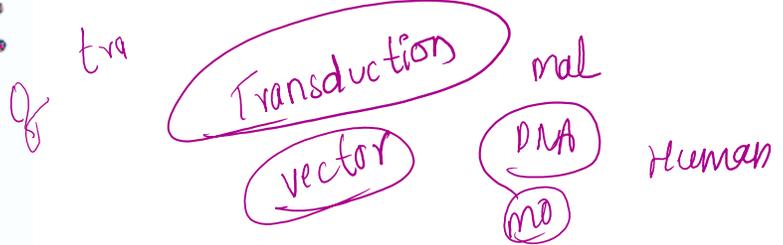
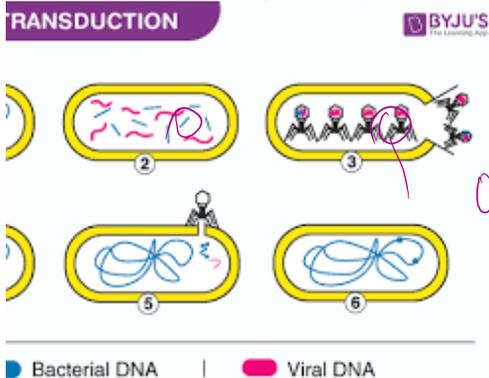
While not technically reproduction, HGT allows bacteria to share genetic material with other individuals, promoting genetic diversity and adaptation. Here are three mechanisms of HGT in Monera:

- **Transformation:** Bacteria can take up naked DNA from the surrounding environment, incorporating it into their own genome. This allows them to acquire new traits, such as antibiotic resistance.
- **Conjugation:** Two bacteria physically connect through a pilus, and one bacterium transfers a plasmid (a small circular DNA molecule) containing genes to the other. This facilitates the spread of beneficial genes between bacteria.



Conjugation in Bacteria

- **Transduction:** Viruses can carry bacterial genes from one bacterium to another. When a virus infects a bacterium, it packages some bacterial DNA along with its own viral DNA. This viral particle can then infect another bacterium, potentially introducing the acquired bacterial genes.



Transduction in Bacteria

It's important to note that these methods are not mutually exclusive. Bacteria can employ different reproductive strategies depending on the environmental conditions. Understanding these mechanisms helps us appreciate the adaptability and resilience of these microscopic organisms.

Benefits

Harmful

Economic Importance of Bacteria: Friend and Foe

Bacteria, though often associated with illness, play a crucial role in our economy and daily lives. Let's explore their beneficial and harmful activities:

Beneficial Activities:

- **Genetic Engineering:** Bacteria serve as workhorses in genetic engineering. Scientists insert desired genes into

beneficial and harmful activities:

Beneficial Activities:

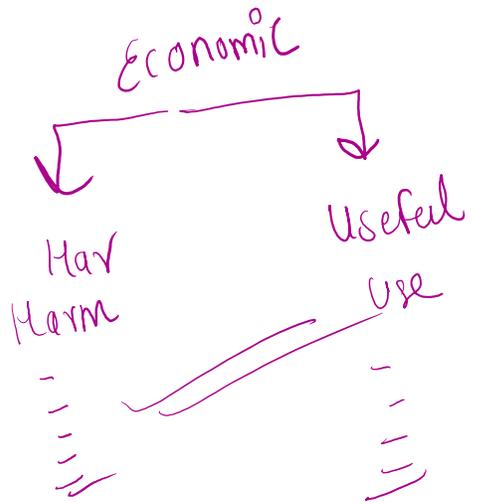
- **Genetic Engineering:** Bacteria serve as workhorses in genetic engineering. Scientists insert desired genes into bacteria, allowing them to produce valuable products like insulin, human growth hormone, and antibiotics.
- **Bacteria and Soil Fertility:** Certain bacteria, like Rhizobia, have a symbiotic relationship with legumes (plants like peas and beans). These bacteria fix atmospheric nitrogen (convert it into a usable form) which enriches the soil, promoting plant growth. This reduces reliance on artificial fertilizers.
- **Bacterial Metabolism - Commercial Importance:** Bacteria play a vital role in various industries:
 - **Food Production:** Bacteria are used in the production of yogurt, cheese, bread, and fermented vegetables like kimchi and sauerkraut. They contribute to flavor, texture, and preservation.
 - **Waste Treatment:** Bacteria decompose organic waste in sewage treatment plants, cleaning wastewater before it's released back into the environment. They also help in composting, converting organic waste into nutrient-rich fertilizer.
 - **Biofuels:** Some bacteria can convert organic matter into biofuels like ethanol, a potential alternative to fossil fuels.
- **Bacteria as Human Symbionts:** While some bacteria cause disease, others live in a symbiotic relationship with humans. These gut bacteria aid digestion, produce essential vitamins, and compete with harmful pathogens.

Harmful Effects:

- **Spoilage of Foodstuffs:** Certain bacteria can cause food spoilage, making food unfit for consumption. This leads to economic loss and food waste.
- **Causes of Animal Diseases:** Bacterial infections can devastate livestock populations. Diseases like anthrax and brucellosis are caused by bacteria and have significant economic impacts.
- **Causes of Human Diseases:** Many human diseases, from food poisoning to pneumonia and tuberculosis, are caused by bacteria. These illnesses cause immense human suffering and healthcare costs.
- **Causes of Plant Diseases:** Bacteria can infect plants, causing significant crop losses. Examples include fire blight in apples and citrus canker in oranges.

Note: Although "Monera" is no longer a valid classification in modern systems, the bacteria we discussed fall under the domain Bacteria.

By understanding both the benefits and drawbacks of bacteria, we can leverage their positive aspects for economic gain and develop strategies to mitigate their harmful effects.



cyanobacteria

Saturday, June 22, 2024 7:42 PM

Oscillatoria (Cyanobacteria)

General characteristics:

- **Microscopic:** They are single-celled organisms, but these cells aggregate into long, thin filaments visible only under a microscope.
- **Photosynthetic:** Oscillatoria uses photosynthesis to produce its own food using sunlight, carbon dioxide, and water.
- **Filamentous:** These filaments are unbranched and can form tangled mats or lie flat on surfaces.
- **Color:** They appear blue-green due to the presence of pigments like chlorophyll and phycocyanin.
- **Motility:** Oscillatoria exhibits a slow, swaying motion, which is how it got its name. This movement is thought to be caused by the secretion of slime that helps them move towards sunlight.



Oscillatoria cyanobacteria

Systematic position:

- **Division:** Cyanobacteria
- **Class:** Not applicable (Cyanobacteria is not formally classified into classes)
- **Order:** Oscillatoriales
- **Family:** Oscillatoriaceae
- **Genus:** Oscillatoria

Occurrence:

Oscillatoria is commonly found in freshwater environments like ponds, lakes, and slow-moving streams. They can also be found in brackish water and even some hot springs. They prefer areas with high nutrient levels and tend to grow well in stagnant or slow-moving water. While some species of Oscillatoria can fix nitrogen from the atmosphere, others rely on nitrogen runoff from land.

Ecological Impact:

While Oscillatoria plays a role in aquatic ecosystems as a primary producer, under certain conditions, they can form large blooms. These blooms can be harmful as they can deplete oxygen levels in the water, leading to fish kills. Some species of Oscillatoria also produce toxins that can be harmful to humans and animals.

Oscillatoria (Cyanobacteria) ; Structure of the thallus.

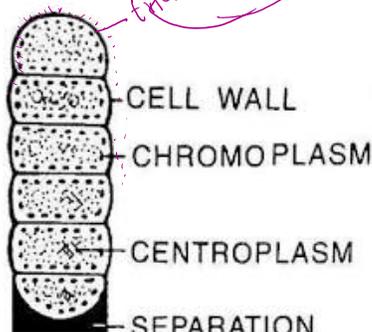
Oscillatoria (Cyanobacteria)

Structure of the thallus:

The body of Oscillatoria, known as the thallus, is a unique structure unlike that of plants or fungi.

- **Unbranched filament:** The thallus is a single, unbranched thread-like structure made up of a single row of cylindrical cells. These filaments, called trichomes, can be quite long and are visible under a microscope.
- **Trichomes:** Each trichome is surrounded by a gelatinous sheath, which helps the organism stay hydrated and glide on surfaces. This sheath can also help to trap nutrients and detritus from the surrounding water.
- **Cells:** The cells within the trichome are prokaryotic, meaning they lack a membrane-bound nucleus and other membrane-bound organelles found in eukaryotic cells.
- **Special cells:** Within the trichome, there are two special types of cells:
 - **Nesoidia:** these are dead, colorless cells with thickened walls that separate sections of the filament. They

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- **Special cells:** Within the trichome, there are two special types of cells:
 - **Necridia:** These are dead, colorless cells with thickened walls that separate sections of the filament. They are sometimes called "false septa" because they don't completely divide the cell.
 - **Hormogonia:** These are short motile fragments of the trichome that can break off and develop into new filaments. This is a form of asexual reproduction for Oscillatoria. *Hormogonia*
- **Pigments:** The cells contain photosynthetic pigments like chlorophyll a, which gives them their characteristic blue-green color. Other pigments like phycocyanin also contribute to their coloration.



Oscillatoria thallus structure

The combination of the trichomes and the gelatinous sheath allows Oscillatoria to form large mats or scums on the surface of the water or on submerged objects.

Oscillatoria (Cyanobacteria): Reproduction

Oscillatoria lacks sexual reproduction and relies solely on vegetative and asexual methods for propagation. Here's a breakdown of the methods it employs:

Vegetative Reproduction (Fragmentation):

- This is the primary mode of reproduction for Oscillatoria.
- The long trichomes can break apart due to various factors like physical stress, grazing by animals, or through the action of special dead cells called **necridia**.
- Necridia have thickened cell walls and lose their cellular contents, becoming weak points in the filament.
- Fragmentation at these points creates short motile pieces called **hormogonia** (discussed further below).
- Each hormogonium, containing a few to several cells, can then grow into a new, independent Oscillatoria filament.

Asexual Reproduction:

- Oscillatoria utilizes two main asexual reproductive strategies:
 1. **Hormogonia formation:** As mentioned earlier, fragmentation creates hormogonia. These short motile pieces are capable of gliding through the water column.
 - They achieve motility by secreting mucilage, a slimy substance, that allows them to move and position themselves in favorable conditions, often towards light.
 - Once in a suitable environment, the hormogonia lose their motility and the individual cells within them divide by binary fission, giving rise to a new filament.
 2. **Akinete formation (not common):** In some less frequent cases, Oscillatoria can produce specialized resting cells called **akinetes**.
 - Akinetes are thick-walled, dormant cells with stored food reserves.
 - They form under unfavorable conditions like nutrient depletion or extreme temperatures.
 - When conditions improve, akinetes can germinate and resume growth into a new filament.

Overall Significance:

These efficient reproductive methods allow Oscillatoria to rapidly colonize new environments and maintain populations when conditions are favorable. Fragmentation and hormogonia formation are particularly advantageous as they don't require specific partners or specialized structures, allowing for quick and widespread reproduction. However, the lack of sexual reproduction limits genetic diversity in Oscillatoria populations.

Oscillatoria (Cyanobacteria)

Oscillatoria (Cyanobacteria)

Dix bloom - water -

Economic Importance:

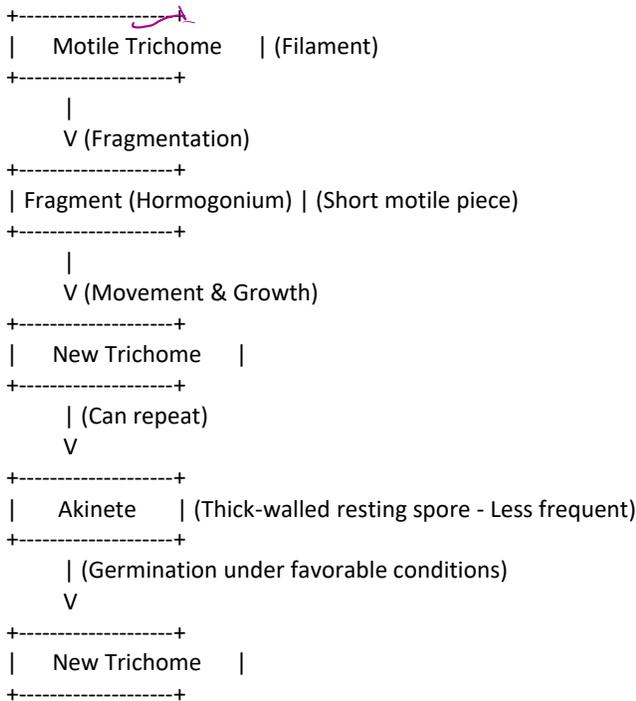
While Oscillatoria can sometimes form harmful blooms, it also offers some economic benefits:

- **Potential food source:** Some Oscillatoria species, particularly those found in Asia, are cultivated and consumed as a food source. They are a good source of protein and can be consumed fresh, dried, or even ground into flour.
- **Biofertilizer:** Due to their nitrogen-fixing abilities (in some species), Oscillatoria can be used as a biofertilizer to enrich soil with nitrogen. This can improve plant growth and reduce reliance on synthetic fertilizers.
- **Biofuel production:** Research is ongoing into the potential of Oscillatoria and other cyanobacteria for biofuel production. Their ability to photosynthesize makes them a promising source of renewable energy.

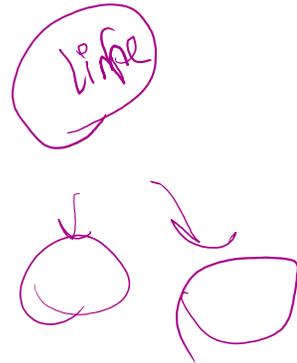
However, it's important to note that some Oscillatoria species can produce toxins that are harmful to humans and animals. Additionally, excessive blooms can deplete oxygen levels in water bodies, harming aquatic life.

Life Cycle (Diagrammatic Representation):

Oscillatoria has a relatively simple life cycle that relies solely on vegetative and asexual reproduction. Here's a diagrammatic representation:



Motile trichome.
 ↓ *fragme*
Hormo (short)
 ↓ *move*
 ↓ *New*
 ↓ *repeat*
 AK



Explanation:

1. The starting point is a mature, motile trichome (filament) of Oscillatoria.
2. Fragmentation occurs, either due to physical stress, grazing, or through necridia (dead cells). This creates short, motile pieces called hormogonia.
3. Hormogonia move through the water using mucilage secretion.
4. When conditions are favorable, hormogonia lose motility and the individual cells within them divide by binary fission.
5. This division results in the formation of a new, independent trichome of Oscillatoria.
6. In some less frequent cases, akinetes may form under harsh conditions. These thick-walled resting spores germinate into new trichomes when conditions improve.

Key Points:

- Fragmentation and hormogonia formation are the primary modes of reproduction.
- Akinetes offer a survival strategy during unfavorable conditions.
- The entire life cycle revolves around the trichome structure and its ability to divide and form new individuals.

Spirulina (Cyanobacteria)

Spirulina is a type of organism that's often referred to as blue-green algae. However, despite the name, spirulina is not actually an algae. It belongs to a group of bacteria called cyanobacteria.

General characteristics

- Microscopic and filamentous (spiral-shaped)
- Photosynthetic (uses sunlight to produce energy)
- Grows in freshwater lakes and ponds



Spirulina cyanobacteria

green

Money

25

Systematic position

- **Division:** Cyanobacteria
 - **Class:** Oxyphotobacteria
 - **Order:** Spirulinales
 - **Family:** Oscillatoriaceae
 - ◆ **Genus:** Arthrospira (formerly Spirulina)

Note: While the common name "spirulina" is still widely used, the scientific community now classifies the edible species under the genus Arthrospira.

Occurrence

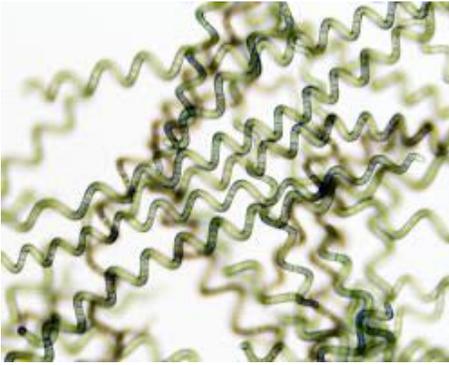
Spirulina is found in naturally occurring bodies of freshwater, particularly in warm, alkaline (high pH) lakes in subtropical and tropical regions. It can also be grown commercially in large ponds or tanks.

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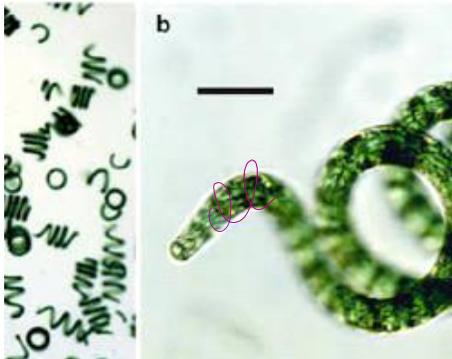
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Structure

Thallus Structure

Spirulina has a multicellular, filamentous structure called a **trichome**. This trichome is made up of cylindrical cells arranged in a tight coil, giving it the characteristic spiral shape we recognize. Unlike some other cyanobacteria, *Spirulina*'s trichomes are unbranched and lack specialized cells called heterocysts.



Spirulina trichome

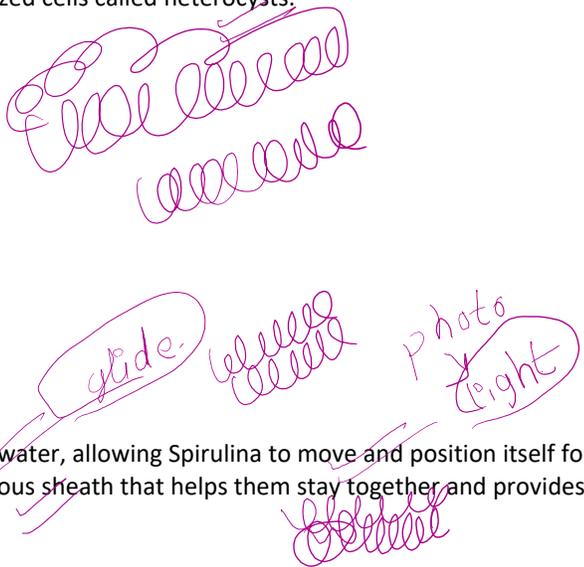
The trichomes are not rigid and can glide through the water, allowing *Spirulina* to move and position itself for optimal sunlight exposure. They are also surrounded by a mucous sheath that helps them stay together and provides some protection from the environment.

Cell Structure

Being a prokaryote, *Spirulina* has a simpler cell structure compared to eukaryotic organisms. It lacks membrane-bound organelles like a nucleus or mitochondria. However, it does contain some key features for survival and function:

- **Cell wall:** Provides protection and shape.
- **Plasma membrane:** Controls the flow of materials in and out of the cell.
- **Cytoplasm:** Contains the cell's machinery and carries out essential processes.
- **Thylakoids:** Membranous structures within the cytoplasm that house chlorophyll and carry out photosynthesis.
- **Gas vacuoles:** Small pockets of gas that help *Spirulina* float in water.
- **Inclusions:** Storage reserves like glycogen and protein granules.

While *Spirulina* doesn't have a true nucleus, it does contain a region of DNA called the nucleoid which holds its genetic information.



Spirulina (Cyanobacteria): Reproduction

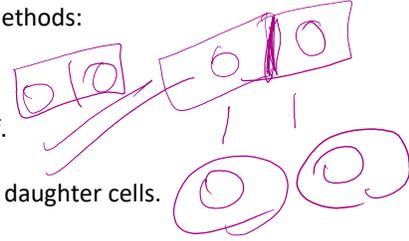
Spirulina, like many cyanobacteria, reproduces asexually. Here's a breakdown of its two main methods:

Vegetative Reproduction: Binary Fission

This is the primary mode of reproduction for Spirulina. It's a simple and efficient process:

1. **DNA Replication:** The single circular chromosome within the Spirulina cell replicates itself.
2. **Cell Elongation:** The cell elongates to create space for the two daughter cells.
3. **Septation:** A new cell wall forms, dividing the elongated cell into two genetically identical daughter cells.
4. **Separation:** The daughter cells separate and become independent individuals.

This process allows Spirulina populations to grow rapidly under favorable conditions.



Asexual Reproduction: Hormogonia Formation

Hormogonia formation is another asexual method, but less common than binary fission.

1. **Filament Breakage:** Environmental stress or other factors can cause the Spirulina filament (trichome) to break into smaller fragments called hormogonia. These fragments consist of a few to several cells.
2. **Motility and Growth:** Hormogonia are motile, meaning they can move slightly in the water. They can then grow and develop into new, mature filaments through repeated binary fission.

Hormogonia formation serves two purposes:

- **Dispersal:** Broken fragments can help Spirulina spread to new locations.
- **Survival:** Under harsh conditions, hormogonia formation allows some cells to survive until conditions improve for growth.

Note: While some cyanobacteria can reproduce sexually, this process is not observed in Spirulina.



Spirulina (Cyanobacteria)

Economic Importance:

Spirulina boasts a remarkable range of economic applications due to its unique nutritional profile and other properties.

Here's a breakdown of its key economic uses:

- **Food Supplement:** Spirulina is a rich source of protein, vitamins, minerals, and antioxidants. It's often consumed as a powder or tablet as a dietary supplement, particularly for its potential health benefits.
- **Animal Feed:** The high protein content of Spirulina makes it a valuable supplement for animal feed, especially for aquaculture (fish farming).
- **Natural Colorant:** Spirulina's pigments, particularly phycocyanin, contribute to its blue-green color. This natural colorant can be used in food and cosmetics.
- **Bioremediation:** Spirulina's ability to absorb pollutants and nutrients makes it useful for treating wastewater and cleaning polluted water bodies.
- **Biofuel Production:** Research is ongoing on using Spirulina as a source for biofuel production.

Life Cycle: Diagrammatic Representation

Here's a simplified representation of Spirulina's life cycle:

1. **Growth:** Spirulina filaments grow through repeated binary fission. The single-celled organism elongates, replicates its DNA, and divides into two genetically identical daughter cells.
2. **Motility:** Spirulina filaments can exhibit some gliding motility, allowing them to move and position themselves for optimal sunlight exposure.
3. **Fragmentation:** Under certain conditions, like stress, filaments can break into smaller fragments called hormogonia.
4. **Hormogonia Growth:** Hormogonia, if conditions are favorable, can grow and develop into new, mature filaments through further binary fission.

Note: This is a simplified depiction, and the life cycle may vary depending on environmental factors.

Here's a basic diagram you can imagine:

