فسيولوجيا الأحياء الدقيقة
Microbial Physiology

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مكتب ٢ ب ٤٥

مقدمة
Introduction

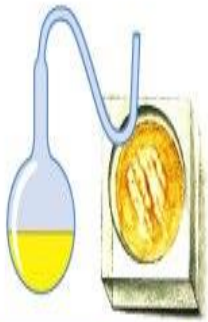
What is "Microbial Physiology"?

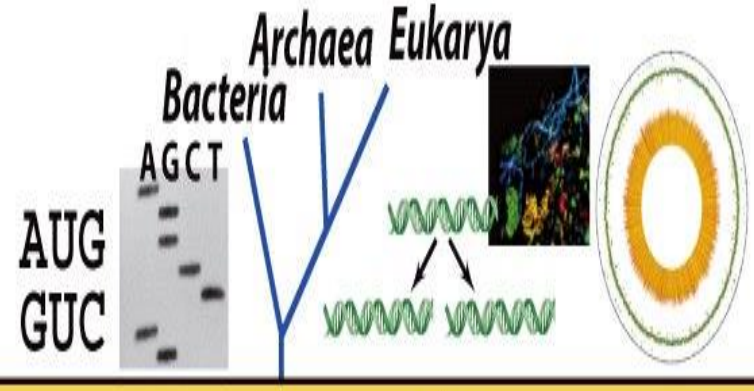
- Physiology: is the understanding of the processes of life as mediated by its structures, operating together to accomplish the common tasks of life.
- Microbial Physiology: is an understanding of cell structure, growth factors, metabolism and genetic composition of microorganisms.

  • introduces the inter-relatedness of Microbiology, Biochemistry, and Genetics while understanding the functioning of the bacterial cell.
  • looks at the simpler single-cell organisms as a model for trying to understand much more complex organisms.

Microbial Physiology

- **We can understand:**
  - how the cell functions in the environment.
  - how it can alter to suit changes in the environment.
  - how it can produce a new cell from very simple substrates available in the environment.





1687 van Leeuwenhoek

1864 Pasteur Winogradsky

1895 Koch,

1941 DNA is genetic material

1944 Streptomycin

1946 Bacterial genetics

1953 Structure of DNA

1966 Genetic code

1977 1. DNA sequencing 2. Discovery of *Archaea*

1985 PCR

1986 Molecular microbial ecology

1995 First genome

2006 Over 500 genomes

Early Days: Discovery, Medical and General Microbiology

Era of Molecular Biology/General Microbiology

Molecular Microbiology, Genomics, and Proteomics

The Importance of Microorganisms

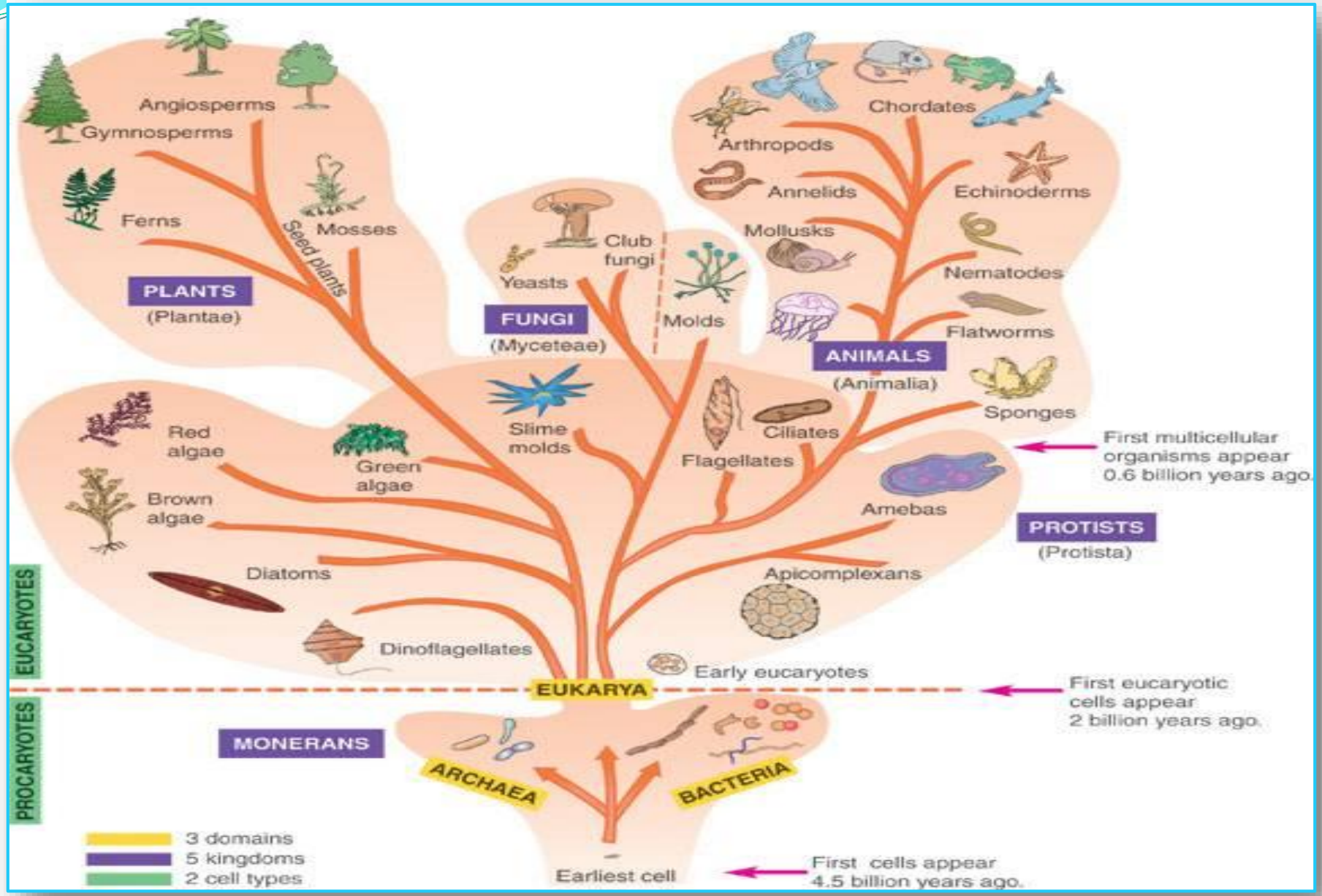
- **Ubiquitous:**
  - Found (present) in almost all environmental niche.
- **Extreme Environments:**
  - Found in environments with extreme temperature, salinity, pressure, etc.
    - Under the ice at the north and south poles at -10ºC.
    - Sea water and Hot Springs.
    - Solid Rocks and Volcanically heated pools (100ºC).
    - Deep seas where barometric pressures can easily squash a human.
- **Important in environmental Processes:**
  - Microbiota (normal flora) in the guts of ruminants animals.
  - Essential to element cycling on Earth, carbon and nitrogen.

The Importance of Microorganisms

- **Important in Industrial Processes:**
  - Antibiotics.
  - Reduce the hazards of wastewaters.
  - Degrade hardy and dangerous compounds (bio-remediation).
  - Ferment substrates to produce important metabolites.

- **Community Structures in Microorganisms:**
  - Individual bacteria may start a process or do a particular step.
  - A complete community is required for completing the process.

Description of Microorganisms



Description of Microorganisms

- **Eukaryotes:**
  - All multi-cellular, and some single-celled organisms.
  - Membrane-bound nucleus within the cell.

- **Prokaryotes: Bacteria & Archaea.**
  - Single-celled organisms.
  - No membrane-bound nucleus.
  - Generally much smaller genome and simpler structure VS. Eukaryotes.

Description of Microorganisms

- **Microorganisms** are described by their phenotype (physical characteristics). Growth optima for temperature, pH, salinity, solute availability, pressure, type of metabolism, and morphological characteristics.

  - ***Caloramator indicus*** is described as a gram-positive rod to filamentous non-motile cell that does not sporulate. It is chemo-organo-trophic and obligately anaerobic. It is an alkalinophilic thermophile that can ferment a wide variety of carbohydrates.

Description of Microorganisms

Some of the more commonly used terms:

- **Temperature**:
  - Psychrophile: -12 to 20^{o}C.
  - Mesophile: 14 to 45^{o}C .
  - Moderate thermophile: 42 to 69^{o}C
  - Extreme thermophile: 66 to 105^{o}C.

- **pH:**
  - Acidophile: Low pH (~ 3.0 and below).
  - Neutrophil: pH ~7.
  - Alkaliphile: High pH (9-11).

Description of Microorganisms

Some of the more commonly used terms:

- **Salinity:**
  - Halophile.
- **Solutes:**
  - Osmophile.
- **Water:**
  - Xerophile.
- **Pressure:**
  - Barophile.

Description of Microorganisms

Some of the more commonly used terms:

- **Metabolism:**
  - Obligate aerobe: require O_2.
  - Facultative anaerobe: O_2 not required, but better growth when present.
  - Aerotolerant: O_2 not required and growth not improved when present.
  - Microaerophile: Low levels of O_2 required.
  - Obligate anaerobe: O_2 inhibits bacterial growth.

- **Morphological Characteristics:** Shape, Size, Gram Stain, Sporulation.

- **Nutrition:** Chemo- (organo-, litho-), photo-, auto-, hetero-troph.
  - **Energy source:** Light vs. Chemical.
  - **Carbon source:** Organic vs. Inorganic.
  - **Terminal electron accepter:** Respiration vs. Fermentation.

Table 27.1 Major Nutritional Modes

Mode of Nutrition	Energy Source	Carbon Source	Types of Organisms
Autotroph			
Photo-autotroph	Light	CO_2	Photosynthetic prokaryotes, including cyanobacteria; plants; certain protists (algae)
Chemo-autotroph	Inorganic chemicals	CO_2	Certain prokaryotes (for example, *Sulfolobus*)
Heterotroph			
Photo-heterotroph	Light	Organic com-pounds	Certain prokaryotes
Chemo-heterotroph	Organic com-pounds	Organic com-pounds	Many prokaryotes and protists; fungi; animals; some parasitic plants

The Importance of Microorganisms in Physiology:

- **Short generation time.**
- **Small Size.**
- **Small genome Size.**
- **Nutritional Diversity.**

QUESTIONS??