Chapter One

History and New Age of Microbiology

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Scope of Microbiology

- Microbiology is the study of all microorganisms (microbes) in the microscopic range. These include **bacteria, algae, fungi, viruses,** and **protozoa**.
- Human life would not exist on this planet without the activities of microbes. They degrade dead plant & animal to provide food necessary to sustain growth of all living organisms

Scope of Microbiology

Where are they?

- Microorganisms present almost everywhere; in air, water (oceans, springs, drinking water), soil, animal & human body (GIT, respiratory tract and skin), in the deep hot interior of earth (temp reaching 110 °C), Antarctic….

Scope of Microbiology

Importance of Microorganisms

- Some capture energy & store it in molecules that other organisms used as food source.
- Some m.o decompose dead organism or waste material
- They make N2 to plants
- Certain m.o live in digestive system of grazing animals & serve in digestive process
- Biochemical rxns carried out by m.o are used by food industry to make pickles, yogurt,

Scope of Microbiology

Importance of Microorganisms

- Fermentation rxns are used to make beer, wine, dough
- One of the most important is synthesis of antibiotics
- Vaccines for disease control
- Considered major tool for genetic engineering (production of interferon, growth hormone, insulin)

The Need To Study Microbiology

- Microorganisms are part of the human environment and are therefore important to human health.
- The study of microorganisms provides insight into life processes in all forms of life; for example:
- **Ecologist**- use principle of microbiology to understand how matter is decomposed and made available for continuous recycling.

- **Biochemists**- use microbes to study metabolic pathways in living organisms
- **Geneticists** - use microbes to study how hereditary information is transferred and how such information controls the structure and functions of organisms.

Researchers - use microorganisms in their research mainly because;

1. Compare to other organisms, microbes have relatively simpler structures.
2. Large number of microorganisms can be used in an experiment.
3. Because microorganisms reproduce very quickly, they are useful in studying the transfer of the genetic information.

Pioneer Microbiologists

Key figures of the late seventeenth century

- **Robert Hooke**: Using a compound microscope described cork cells as “little boxes” that reminded him of the cells used by monks.
- His observations laid the groundwork for development of the cell theory, the concept that all living things are composed of cells.
- He also described fungi but his microscope was unable to resolve bacteria

- **Anton van Leewenhoek**: considered by many to be the “Father of Microbiology”.
- **Leewenhoek** was the first to develop a lens or microscope and was the first to describe” LIVING ”microbes

Development of the Germ Theory of Disease

- This theory states that microorganisms (germs) can invade other organisms and cause disease.
- This was an outgrowth of the work of numerous scientists and medical professionals including:
- **Joseph Lister:** developed antiseptic surgery which included heat-sterilization of instruments and application of phenols to wounds and dressings.

- **Ignaz Semmelweis** : an obstetrician, implemented strict hand-washing procedure to control transmission of streptococcal infection (“Child fever”).He could be considered the “father of infection control”.
- Simple improvements in hygiene reduced transmission of childbirth fever by 2/3.

- **Robert Koch** : German physician, in 1876 provided a critical link between microbes and disease.
- Developed a series of postulates (criteria) to uncover the cause of anthrax.
- Koch Postulates are still in use today to prove the cause of an infectious disease.

Koch's Postulates

- To associate a particular organism with a specific disease; Koch introduced the following postulates:-

1. The specific causative agent must be found in every case of the disease.
2. The disease organism must be isolated in pure culture .
3. Pure culture must produce the same disease or pathological condition when inoculated in a susceptible laboratory animal.
4. The organism must be recovered in pure culture from the inoculated animal.

Koch's Contributions

1. Isolated the bacteria that cause cholera and tuberculosis.
2. Developed tuberculin, now used in a skin test for TB.
3. Developed acid fast staining.
4. Identified bacterial endospores.
5. With colleagues, the first to grow cultures on solid media.
6. Received Nobel prize for medicine 1905.

Contributions of Louis Pasteur

- **Fermentation**: He observed that yeast fermented sugar to ethanol and that bacteria oxidized alcohol to acetic acid to cause spoilage.
- **Pasteurization**: Pasteur developed a heating process used to kill spoilage germs in wine but which preserved flavor.
- **Vaccination and Immunity:** Pasteur found vaccine for chicken cholera, rabies and anthrax

Emergence of Special fields of Microbiology

- **Vaccination and Immunology**;- Immunization was first used against smallpox;
- **Jenner** used fluid from cowpox blisters to immunize against it (1802).
- **Pasteur** developed techniques to weaken organisms so they would produce immunity without producing disease.
- **Virology**; - **Beijerinck** characterized viruses as pathogenic molecules capable of taking over a host cell's mechanisms for their own use.

Chemotherapy

- The application of chemical substance which have a specific and toxic effect upon the disease causing microorganism
- **Ehrlich** in 1910 began a systematic search for chemically defined substances that would kill bacteria. He Introduced term “Magic Bullet” and “chemotherapy”

- **Paul Ehrlich** introduced an arsenic-compound called salvarsan to treat syphilis (1910).
- Initially, substances derived from medicinal plants were virtually the only source of chemotherapeutic agents
- **Fleming** and his colleagues in 1928 developed penicillin.
- **Domagk** and others in 1930 developed sulfa drugs.
- **Waksman** and others in 1952 developed streptomycin and other antibiotics derived from soil organisms

Genetics and Molecular Biology

- **Griffith** in 1928 discovered that previously harmless bacteria could change their nature and become capable of causing disease.
- This genetic change was shown by others to be due to DNA.
- **Tatum** and **Beadle** in 1958 studied transmission of hereditary characteristics specially to show how genetic information controls metabolism.

Classification by cellular type

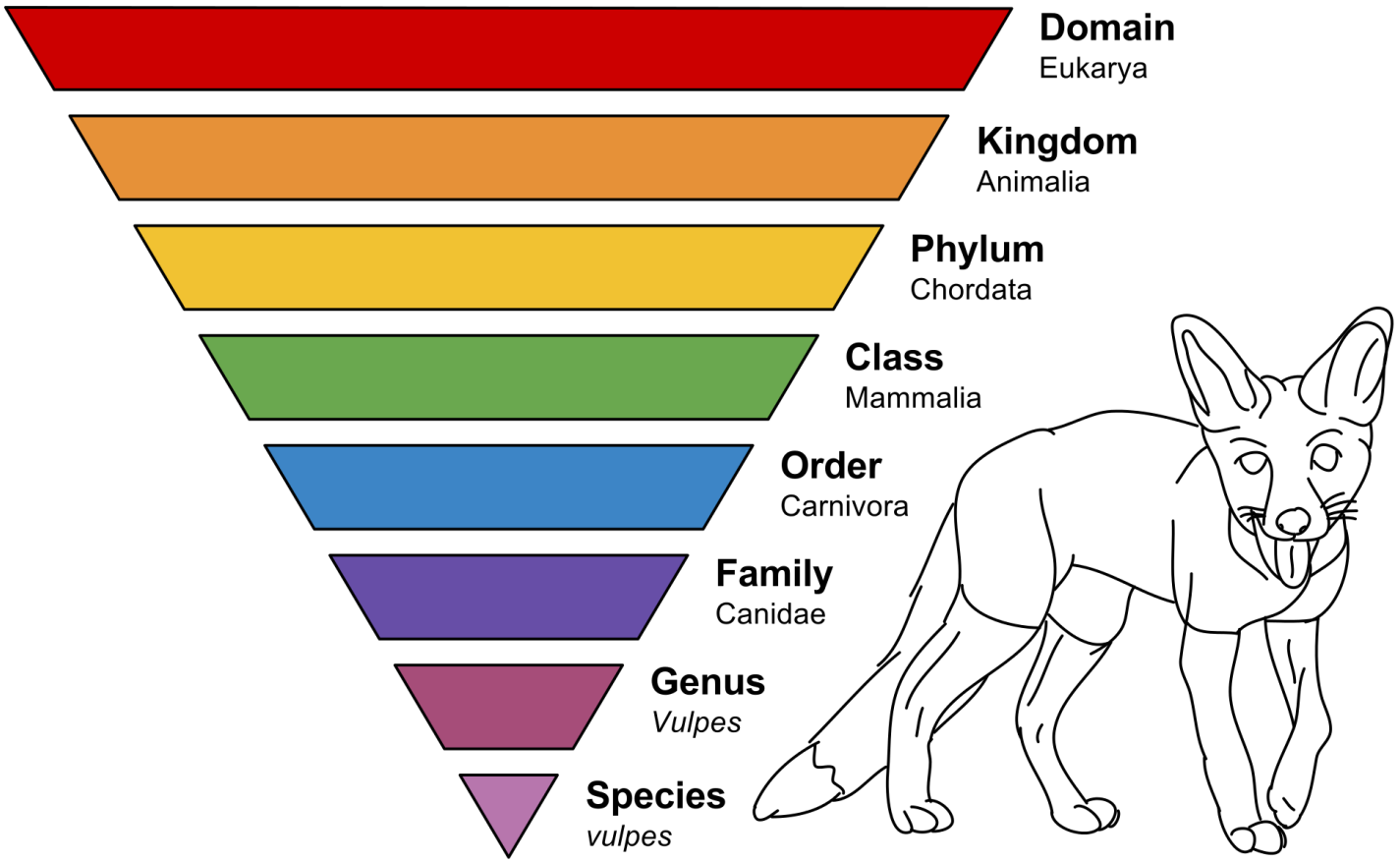
- All the living organisms are classified into the three distinct groups based on type of cell organization and function :

1. **Prokaryotes** - all organisms that lack a cell nucleus mainly referring to bacteria
2. **Eukaryotes** - all organisms that contain a distinct nucleus e.g. fungi, algae, plants, protozoa and animals.
3. **Archaea** - the most recently identified group of organisms that their cell type appear to be somewhat between prokaryotes and eukaryotes. These microorganisms are found under extreme environmental conditions.

Taxonomic Ranks

- The taxonomic ranks (in ascending order) are: species, genus, family, order, class, division (phyla) and kingdom.
- The basic taxonomic group is the species
- Procaryotic species are not defined on the basis of sexual reproductive compatibility (as for higher organisms) but rather based on phenotypic and genotypic differences.

Taxonomic Ranks



Red fox (*Vulpes vulpes*)

Nomenclature

- It provides naming assignments for each organism.
- Standard rules for naming bacteria:
- The family name is capitalized has an *aceae* ending (e.g. Micrococcaceae).
- The genus name is capitalized and followed by the species name, which begins with a lowercase letter.

- Both genus and species should be *italicized* in print but underlined in writing script (e.g., *Staphylococcus aureus* or *Staphylococcus aureus*).
- Often, the genus name is abbreviated by using the first letter of the genus followed by a period and the species name (e.g. *S*. aureus)

Thank You

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