

# Microbiology

By

Dr. Konrad T. Juskiewicz, MD, MPH

# Microbiology

- From Greek μῖκρος, *mīkros*, "small"
- βίος, *bios*, "life"
- -λογία, --logia , study
- **Microbiology** is the study of microscopic is the study of microscopic organisms, either
  - unicellular (single cell),
  - multicellular (cell colony), or
  - acellular (lacking cells)
- Microbiology encompasses numerous sub-disciplines including : virology Microbiology encompasses numerous sub-disciplines including : virology, mycology Microbiology encompasses numerous sub-disciplines including :

# Taxonomic arrangement

- [Bacteriology](#): The study of bacteria.
- [Mycology](#): The study of fungi.
- [Protozoology](#): The study of protozoa.
- [Phycology](#) (or algology): The study of algae.

# Taxonomic arrangement

- [Parasitology](#): The study of parasites.
- [Immunology](#): The study of the immune system.
- [Virology](#): The study of viruses.
- [Nematology](#): The study of the nematodes
- Microbiology: The study of microbes.

# Integrative arrangement

- [Microbial cytology](#): The study of microscopic and submicroscopic details of microorganisms.
- [Microbial physiology](#) Microbial physiology: The study of how the microbial cell functions biochemically. Includes the study of microbial growth, microbial [metabolism](#) Microbial physiology: The study of how the microbial cell functions biochemically. Includes the study of microbial growth, microbial metabolism and [microbial cell structure](#).
- [Microbial ecology](#): The relationship between microorganisms and their environment.
- [Microbial genetics](#) Microbial genetics: The study of how [genes](#) Microbial genetics: The study of how genes are organized and regulated in microbes in relation to their

# Integrative arrangement

- [Cellular microbiology](#) Cellular microbiology: A discipline bridging microbiology and [cell biology](#).
- [Evolutionary microbiology](#): The study of the evolution of microbes. This field can be subdivided into:
  - [Microbial taxonomy](#): The naming and classification of microorganisms.
  - [Microbial systematics](#): The study of the diversity and genetic relationship of microorganisms.

# Integrative arrangement

- Generation microbiology: The study of those microorganisms that have the same characters as their parents.
- Systems microbiology Systems microbiology: A discipline bridging systems biology and microbiology.
- Molecular microbiology: The study of the molecular principles of the physiological processes in microorganisms.

# Other

- [Nano microbiology](#): The study of those organisms on nano level.
- [Exo microbiology](#) Exo microbiology (or [Astro microbiology](#)): The study of microorganisms in outer space
- [Biological agent](#): The study of those microorganisms which are being used in weapon industries.



# Applied microbiology

- Medical microbiology Medical microbiology: The study of the pathogenic microbes and the role of microbes in human illness. Includes the study of :
  - microbial pathogenesis
  - Epidemiology
- Related to the study of disease pathology Related to the study of disease pathology and immunology.
- Pharmaceutical microbiology: The study of microorganisms that are related to the production of antibiotics, enzymes, vitamins, vaccines, and other pharmaceutical products and that cause pharmaceutical contamination and spoil.
- Industrial microbiology: The exploitation of microbes for use in industrial processes.
  - industrial fermentation
  - wastewater treatment.
- Closely linked to the biotechnology Closely linked to the biotechnology industry. This field also includes brewing or

# Applied microbiology

- [Microbial biotechnology](#): The manipulation of microorganisms at the genetic and molecular level to generate useful products.
- [Food microbiology](#): The study of microorganisms causing food spoilage and foodborne illness. Using microorganisms to produce foods, for example by fermentation.
- [Agricultural microbiology](#): The study of agriculturally relevant microorganisms. This field can be further classified into the following:
  - [Plant microbiology](#) and [Plant pathology](#): The study of the interactions between microorganisms and plants and plant pathogens.
  - [Soil microbiology](#): The study of those microorganisms that are found in soil.

# Applied microbiology

- Veterinary microbiology Veterinary microbiology: The study of the role of microbes in veterinary medicine Veterinary microbiology: The study of the role of microbes in veterinary medicine or animal taxonomy.
- Water microbiology (or Aquatic microbiology): The study of those microorganisms that are found in water.
- Aeromicrobiology (or Air microbiology): The study of airborne microorganisms.

# Applied microbiology

- [Environmental microbiology](#): The study of the function and diversity of microbes in their natural environments.
- This involves the characterization of key bacterial habitats such as the [rhizosphere](#) This involves the characterization of key bacterial habitats such as the rhizosphere and [phyllosphere](#) This involves the characterization of key bacterial habitats such as the rhizosphere and phyllosphere, [soil](#) This involves the characterization of key bacterial habitats such as the rhizosphere and phyllosphere, soil and [groundwater](#) This involves the characterization of key bacterial habitats such as the rhizosphere and phyllosphere, soil and groundwater [ecosy s-tems](#) This involves the characterization of key bacterial habitats such as the rhizosphere and phyllosphere, soil and groundwater ecosy s-tems. open [oceans](#) This involves the characterization of key

# Benefits

- [We fear microbes](#) due to the association of some microbes with various human illnesses,
- Microbes responsible for numerous beneficial processes such as
  - [industrial fermentation](#) industrial fermentation (e.g. the production of [alcohol](#) industrial fermentation (e.g. the production of alcohol, [vinegar](#) industrial fermentation (e.g. the production of alcohol, vinegar and [dairy products](#)),
  - [Antibiotic](#) production
  - As vehicles for [cloning](#) in more complex organisms such as plants.
- Knowledge of microbes to produce biotechnologically important [enzymes](#) Knowledge of microbes to produce biotechnologically important enzymes such as [Taq polymerase](#) Knowledge of microbes to produce biotechnologically important enzymes such as Taq polymerase, [reporter genes](#) Knowledge of microbes to produce biotechnologically important enzymes such as Taq polymerase, reporter genes for use in other genetic systems and novel molecular biology techniques

# Benefits

## The industrial production of [amino acids](#)

- *Corynebacterium glutamicum*: bacterial species with an annual production of more than two million tons of amino acids, mainly L-glutamate and L-lysine
- A variety of [biopolymers](#) A variety of biopolymers, such as [polysaccharides](#) A variety of biopolymers, such as polysaccharides, [polyesters](#) A variety of biopolymers, such as polysaccharides, polyesters, and [polyamides](#), are produced by microorganisms
- Biotechnological production of biopolymers with tailored properties suitable for high-value medical application such as [tissue engineering](#) and drug delivery.
- The biosynthesis of [xanthan](#) The biosynthesis of xanthan, [alginate](#) The biosynthesis of xanthan, alginate, [cellulose](#) The biosynthesis of xanthan, alginate, cellulose, [cyanophycin](#) The biosynthesis of xanthan, alginate, cellulose, cyanophycin, poly( $\gamma$ -glutamic

# Benefits

- Microorganisms beneficial for [microbial biodegradation](#) Microorganisms beneficial for microbial biodegradation or [bioremediation](#) Microorganisms beneficial for microbial biodegradation or bioremediation of domestic, agricultural and industrial wastes and subsurface [pollution](#) in soils, sediments and marine environments.
- The ability of each microorganism to degrade [toxic waste](#) The ability of each microorganism to degrade toxic waste depends on the nature of each [contaminant](#).
- Since sites typically have multiple pollutant types, the most effective approach to [microbial biodegradation](#) Since sites typically have multiple pollutant types, the most effective approach to microbial biodegradation is to use a mixture of

# Benefits

- Symbiotic microbial communities are known to confer various benefits to their human and animal hosts health including
  - aiding digestion,
  - production of beneficial vitamins and amino acids, and
  - suppression of pathogenic microbes.
- Some benefit may be conferred by consuming fermented foods, [probiotics](#) Some benefit may be conferred by consuming fermented foods, probiotics (bacteria potentially beneficial to the digestive system) and/or [prebiotics](#) (substances consumed to promote the growth of probiotic microorganisms).
- The ways the microbiome influences human and animal health, as well as methods to influence the microbiome are active areas of research.



# Benefits

- Microorganisms could be useful in the treatment of [cancer](#).
- Various strains of non-pathogenic [clostridia](#) can infiltrate and replicate within solid tumors.
- Clostridial vectors can be safely administered and their potential to deliver therapeutic proteins has been demonstrated in a variety of preclinical models.