

INTRODUCTION OF MICROBIOLOGY FOR DENTISTRY 3RD YEAR

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MICROBIOLOGY FOR DENTISTRY

- ❖ Microbiology (Greek: mīkros small; bios life), so called because it primarily deals with organisms too small for the naked eye to see, encompasses the study of organisms that cause disease, the host response to infection and ways in which such infection may be prevented.
- ❖ Dental students need both a basic understanding of general and medical microbiology, and a detailed knowledge of clinical oral microbiology in order to diagnose oral microbial infections, which are intimately related to the overall treatment plan for their patients.



EMERGING AND RE-EMERGING INFECTIONS

- The new diseases are given the terms emerging infections or re-emerging infections, and they are broadly categorized as:
 1. **New infections**, Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus.
 2. **'Old' infections** – known disease entities where the a etiological agents have been recently identified through advances in technology (e.g. *Helicobacter pylori* causing gastric ulcer disease)
 3. **Re-emergent infections** – diseases that have returned with a vengeance due to genetic and structural transformations and attendant increased virulence of the organism (e.g. drug-resistant *Mycobacterium tuberculosis* with its 'new bag of tricks').



EMERGING AND RE-EMERGING INFECTIONS

❖ The reasons for their emergence are manifold and include:

1. **Societal events** – economic impoverishment (especially in the developing world), war and civil conflicts, as well as mass population migration.
2. **Health care** – new medical devices, organ/tissue transplantation, immunosuppression, antibiotic abuse and contaminated blood and blood products)
3. **Human behaviour** – increasing sexual promiscuity, injectable drug abuse.

EMERGING AND RE-EMERGING INFECTIONS

❖ The reasons for their emergence are manifold and include:

4. **Environmental changes** – deforestation, drought, floods and global warming.
5. **Microbial adaptation** – emergence of new species from the wild (e.g. HIV), changes in virulence and toxin production and development of drug resistance.



IMPORTANT FEATURES OF MICROBIOLOGY

❖ to deal with infectious diseases, the student must understand the important features of microbiology:

1. **Epidemiology:** spread, distribution and prevalence of infection in the community
2. **Pathogenesis:** the means by which microbes cause disease in humans, an understanding of which is critical for the successful diagnosis and management of infections.
3. **Diagnosis:** detection of an infection; this depends on the collection of the correct specimen in the most appropriate manner, and subsequent interpretation of the laboratory results



IMPORTANT FEATURES OF MICROBIOLOGY

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- 4. Treatment:** antibacterial, antifungal or antiviral therapy combined with supportive therapy leads to resolution of most infections.
- 5. Prevention (prophylaxis):** immunization is the most useful mode of preventing diseases such as tetanus and hepatitis B; however, increasing public awareness of diseases and their modes of spread significantly helps to curb the spread of infections in the community (e.g. HIV infection).



CLASSIFICATION OF LIVING BEINGS

- ❖ Traditionally, though they were all classified into two kingdoms, plants and animals, classification was arbitrary and based on morphological and growth characteristics.
- ❖ With the development of novel techniques, the latter classification was expanded to include five kingdoms: monera (Bacteria), protista (protozoa), plantae, fungi and animalia.
- ❖ With the genetic relatedness is that all forms of life fall into three domains: Archaea, Bacteria and Eucarya.
- ❖ The main differences among Archaea, Bacteria and Eucarya are listed in Table 1



CLASSIFICATION OF LIVING BEINGS

- ❖ Note that taken together, **Archaea and Bacteria** are also known as prokaryotes. Fungi, protozoa and humans, for instance, are eukaryotic, whereas viruses are not included in this classification as they are unique, acellular, metabolically inert organisms and therefore replicate only within living cells.



CLASSIFICATION OF LIVING BEINGS

❖ **Differences between viruses and cellular organisms include:**

1. **Structure:** Cells possess a nucleus or, in the case of bacteria, a nucleoid with DNA. This is surrounded by the cytoplasm where energy is generated and proteins are synthesized. In viruses, the inner core of genetic material is either DNA or RNA, but they have no cytoplasm and hence depend on the host for their energy and proteins (i.e. they are metabolically inert).

CLASSIFICATION OF LIVING BEINGS

❖ **Differences between viruses and cellular organisms include:**

- 2. Reproduction:** Bacteria reproduce by binary fission (a parent cell divides into two similar cells), but viruses disassemble, produce copies of their nucleic acid and proteins, and then reassemble to produce another generation of viruses. As viruses are metabolically inert, they must replicate within host cells. Bacteria, however, can replicate extracellularly (except *rickettsiae* and *chlamydiae*, which are bacteria that also require living cells for growth).



MAJOR DIFFERENCES AMONG THE THREE DOMAINS OF LIFE

Bacteria	Archaea	Eucarya
Organization of the genetic material and replication		
DNA free in the cytoplasm	DNA free in the cytoplasm	DNA is contained with a membrane-bound nucleus. A nucleolus is also present
Only one chromosome	Only one chromosome	More than one chromosome. Two copies of each chromosome may be present (diploid)
DNA associated with histone-like proteins	DNA associated with histone-like proteins	DNA complexed with histone proteins
May contain extrachromosomal elements called plasmids	Plasmids may be found	Plasmids only found in yeast
Introns not found in mRNA	Introns not found in most genes	Introns found in all genes
Cell division by binary fission – asexual replication only	Reproduce asexually and spores are not found	Cells divide by mitosis
Transfer of genetic information occurs by conjugation, transduction and transformation (see Chapter 3)	Processes similar to bacterial conjugation enables exchange of genetic material	Exchange of genetic information occurs during sexual reproduction. Meiosis leads to the production of haploid cells (gametes), which can fuse



MAJOR DIFFERENCES AMONG THE THREE DOMAINS OF LIFE

Cellular organization		
Cytoplasmic membrane contains hopanoids	Membranes contain isoprenes	Cytoplasmic membrane contains sterols
Lipopolysaccharides and teichoic acids found	No lipopolysaccharides or teichoic acids found	
Energy metabolism associated with the cytoplasmic membrane		Mitochondria present in most cases
Photosynthesis associated with membrane systems and vesicles in cytoplasm		Chloroplasts present in algal and plant cells
		Internal membranes, endoplasmic reticulum and Golgi apparatus present associated with protein synthesis and targeting
		Membrane vesicles such as lysosomes and peroxisomes present
		Cytoskeleton of microtubules present
Flagella consist of one protein, flagellin	Contains flagella that derive energy from proton pumps	Flagella have a complex structure with 9 + 2 microtubular arrangement
Ribosomes – 70S	Ribosomes behave more like eucarya when exposed to inhibitors	Ribosomes – 80S (mitochondrial and chloroplast ribosomes are 70S)
Peptidoglycan cell walls	Cell walls lack peptidoglycan	Polysaccharide cell walls, where present, are generally either cellulose or chitin