Microbiology - made of 3 Greek root words which together mean the study of microscopic life.

Mikros - small
Bios - life
logos - science

I. History

First to use the microscope:

Robert Hooke (1665) -first to view cells and first to use a compound microscope

Antony Van Leeuwenhoek (1674-1723) -first to view bacteria and first to use a single lens microscope.
First to describe micro & living cells in our body fluid
Made Primitive microscopes

People believed in Spontaneous Generation

Abiogenesis (Spontaneous Generation) - life from nonliving matter. Living matter is derived spontaneously from non-living matter.

Biogenesis - living from living. Developed with development of the microscope.

Redi (1668) - attempted to disprove Abiogenesis
a. Meat in jar without cover developed maggots
b. meat in jar sealed tight developed no maggots
c. meat in jar with gauze covering developed no maggots
proving maggots arose from flies laying eggs

John Needham (1745) - attempted to prove Abiogenesis. "pro spontaneous generation" . He insisted that air was essential to all life and Abiogenesis of microbes.
- cooked pieces of meat to destroy preexisting organism and placed in open flask which developed microorganisms that he concluded they arose spontaneously from the meat.

Spallanzani (1765) - "anti-spontaneous generation". Attempted to disprove Abiogensis.
- heated beef broth in flask and then sealed developing no growth = argument against abiogenesis

Franz Schulze (1836) - attempting to resolve the "air is essential" controversy
- passed air through strong acid solutions and into boiled meat broth in a sealed flask developing not microbes due to the killing of them from the acid and the heat. Not proving anything because the heat and the acid altered the air

Final Resolution of Spontaneous Generation

Louis Pasteur (1861)
a. confirmed Redi's theory of Biogenesis with a S-shaped flask - the hook in the S allowed any microbes to become trapped not allowing them to pass with the air to the meat.
b. microorganisms in non-living matter
c. aseptic technique without microbes
d. discovered the process of pasteurization with the wine industry
pasteurization = extension of shelf life
e. gave rise to "Golden Age of Microbiology"

II. Golden Age of Microbiology

Germ Theory of Disease

Lister (1860) - discovered the origin of present-day aseptic techniques by soaking bandages & instruments in Carbolic acid (now called phenol)

Robert Koch (1876) -

1. Discovered the Bacillus anthracis bacteria in the blood of infected cattle and found that when air borne could cause pneumonia in people. Did this by using agar (solidifying solution - like Jell-O) and petri dish to isolate anthrax. Thereby being the first to prove that one kind of microbe causes one definite kind of disease

Koch's Postulates: procedure used to identify disease-causing agent (1st application to medicine)

a. obtain pure culture - a specific microorganism can always be found associated with a given disease.
b. The microorganism can be isolated and grown in pure culture in the laboratory.
c. re-inoculate into healthy specimen - The pure culture of the microorganism will produce the disease when injected into a susceptible animal.
d. re-culture culture or re-isolate pure culture - It is possible to recover the injected microorganism from the experimentally infected animal.

Problems with Koch's Postulates:

a. do not always know the appropriate host
b. need for experiment can be life threatening
c. problems obtaining a pure culture

However, we still use this procedure today when trying to find a treatment for a new bacteria.

Vaccination

Edward Jenner (1798) - used immunization against smallpox. Connected that the cowpox protects humans against small pox. First time immunization used for protection against disease

Louis Pasteur

a. coined vaccines thereby discovering vaccinations using Jenner's earlier works with smallpox
b. developed vaccine for rabies
c. terms associated with Louis Pasteur
    1. **Virulent** - ability to cause disease
    2. **Avirulent** - cannot cause disease - used as a vaccine

III. Modern Chemotherapy - treating disease with a chemical substance.

Paul Ehrich (1910) - developed salvarsan, a chemical proven effective against syphilis

Alexander Fleming (1928) -

a. created 1st antibiotic (produced by fungi) - found a mold growing in to middle surrounded by a clear space that had destroyed the bacteria surrounding = penicillin
b. penicillium notatum: penicillin vaccine

problems:

1. resistance - a bacteria called penicillinase found within penicillin. Therefore needing more than one antibiotic to fight different bacteria's because some are resistant to different cillin's.
2. side effects

IV. 20th Century Microbiology

Beginning of Immunology - a process that stimulates body defenses against infection

Vaccines - Jenner developed first vaccination process
Pasteur developed first rabbis vaccination

Interferon - anti-cancer/anti-viral properties

Beginning of Virology - Study of Viruses

Iwanoski & Beijerink (1892) - discovered very small microorganism; A new life form and called it a virus - "Tobacco Mosaic Virus"

Stanley (1935) - discovered structure of Tobacco Mosaic Virus (TMV)

Viruses - species specific

Beginning of Microbial Genetics - Study of Mechanisms by which microbes inherit traits

Beginning of Molecular Biology - How genetic information found in DNA directs synthesis of proteins

Beadle & Tatum - worked with a fungus called "Neurospora" and isolated mutants with different specific deficiencies that were not seen in the parent neurospora. Found that every gene produced an enzyme which coded for protein.
- Nobel prize 1958 for establishing biochemical pathways in Neurospora

DNA/Protein Research - contributions include recombinant DNA technology

Avery, Macleod, McCarty (1944) - established that DNA (not protein) = hereditary material (with their study of pneumococcus)

Watson & Crick (1953) - discovered molecular structure of DNA (double helix) - AGCT (A paired to T and C paired to G)

Jacob & Monod - (1960) - mRNA & regulation of gene function

Recombinant DNA Technology - with the use of enzymes, the DNA molecule can be "cut and spliced" to incorporate a new DNA fragment. This new DNA fragment conveys to the recipient microbe a new biochemical capability.

use restriction enzymes to cut DNA

ligase to seal plasmid & mammalian gene

PCR (polymerase chain reaction) used in lab

Plasmid - a piece of DNA separate from regular strand of DNA that carries additional info not critical for survival (Ex. Antibiotic resistance)

Chapter 1 - The Scope of Microbiology

Current Classification

Linnaeus (1735) - Scientific Binomial system of nomenclature: *Genus/species*

EX. *Staphylococcus aureus* - Staphylo = Grapelike cluster
coccus = circular or round
aureus = golden

Staphylococcus = genus and is always capitalized
aureus = species and is always lower case
Staphylococcus aureus - entire name always either underlined or italicized.

Kingdoms: developed by Whittaker (1969) based on nutritional environments of living things: 1) Photosynthesis 2) Absorption 3) Ingestion.

Monera - (absorption) eubacteria (e.g. pathogens) - true bacteria that cause disease
archaeobacteria (e.g. halophiles) - scientist believe they were archaic bacteria
Prokaryotes - one celled bacteria, no nucleus, no organelles

Protista - unicellular eukaryotics. Microorganisms, which represent all three nutritional types:
Algae = photosynthetic; Protozoa = ingest; Slime Molds = absorption
Eukaryotics - multicellular, true nucleus, membrane bound organelles

Fungi - organisms which have cell walls but lack the photosynthetic pigment chlorophyll found in other plants and thus absorb their food: yeast (unicellular); mold (grows in mats)

Plantae - Photosynthetic green plants and higher algae

Animalia - animals which ingest food

Viruses: DNA & RNA & protein (non living)

Whittaker's scheme showed that the Monera gave rise to the Protista which gave rise to the other three.
A new diagram based on the three Domain's of Bacteria, Archaea, and Eucarya published in 1995

Insert Diagram

rRNA Classification of Species - Ribosomal Ribonucleic Acid

Archaeobacteria
↑
eukaryotes ← common ancestor → eubacteria

plants	Gram negative
animals	Gram positive
fungi	anaerobic bacteria
protozoa	cyanobacteria
slime molds	

symbiosis (to make organelles): have DNA

Groups of species (from smallest to largest)

Viruses

- borderline between living and nonliving things; no cellular by definition
- 20 to 300 nm in diameter (smaller than bacteria) only seen through electron microscope
- parasites - having the ability to insert themselves into the genetic material of cells and do damage
- contain only 1 of either DNA or RNA surrounded by a protein envelope, some contain a lipid envelope
- lack the cellular components for metabolism & reproduction, therefore viruses can reproduce only within a living cell of a host
- has the ability to force the host cells genetic machinery to make many copies of the virus
- exist in several shapes
- can be crystallized like chemicals
- some believe that viruses are genes that escaped from their host

Infections caused by viruses: HIV, common cold, genital herpes, poliomyelitis, hepatitis, etc.

Bacteria

- cell walls contain a carbohydrate called “peptidoglycan”
- single celled procaryotes lacking a nucleus and organelles
- nutrition = decomposers or absorbers
- reproduction = binary fission
- divided into two groups:

Eubacteria

- variety of shapes - spheres=coccus; rods=bacillus; and corkscrew=spiral
- width ranges from 0.5 to 5.0 μm
- unicellular often appearing in pairs=diplo; chains=strepto; tetrads; & clusters=staphylo.
- some with flagella swim
- essential in recycling wastes and the production of antibiotics

Infections caused by Eubacteria: streptococcal sore throat, tetanus, plague, cholera, and tuberculosis

Archaeobacteria

- ability to survive harsh surroundings: high levels of salt, acid and temperature
- capable of production of methane gas from carbon dioxide and hydrogen when living in environments without oxygen

Fungi

- eucaryotic with rigid cell walls containing a true nucleus and organelles
- contain carbohydrate called “chitin” in their cells
- reproduction = asexual and sexual
- microscopic to much larger
- do not contain chlorophyll thus no photosynthesis
- nutrition = absorption and decomposers
- resist high osmotic pressure = can grow in presence of high sugar or salt
- unicellular = yeasts; multicellular = molds

molds

- cylindrical in shape, forming threadlike filaments called “hyphae”
- individual hyphae are microscopic; but when connected can be seen with naked eye and are called “mycelium”
- used for producing antibiotic penicillin, soy sauce, cheeses, etc.
- deteriorate textiles and wood and grow in showers and baths
- cause athletes foot and moldy spoilage of peanuts

yeasts

- shapes = spherical to ovoid; ellipsoidal to filamentous
- beneficial in baking industry because they produce gas used in bread rising
- essential in making alcoholic beverages
- cause food spoilage and diseases such as vaginitis and thrush

Algae

- plantlike eucaryotes with rigid cell walls containing cellulose and the green pigment chlorophyll
- nutrition = photosynthesis
- unicellular = microscopic; mullticellular = several meters in length
- wide range of shapes and sizes
- most live in aquatic environments
- cause clogging of water pipes, releasing toxic chemicals
- used to produce extracts for cooking
- used for anti-inflammatory drugs and a source of agar

Protozoans

- single celled eucaryotic
- reproduction = asexual and sexual
- nutrition = absorption and parasites
- cause coccidiosis in chickens and malaria in humans
- beneficial in stomachs of cattle, sheep, and termites that help to digest food
- classified by locomotion:
  - pseudopod = amoebas which creep
  - cilia and flagella = swimmers
  - parasites = no movement

Multicellular animal parasites -

flatworms = helminths
roundworms = pin worms
each has a microscopic stage in their life cycle