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Microbiology 265

Introduction and History

- We live in a microbial world
  - → Bacteria were the first life forms (fundation of biology)
  - → For the first 2 billion years, only anaerobic metabolism occurred
  - → Microbes created the extant atmosphere (oxygen)
  - → Microbes occupy almost every environmental niche and represent reservoirs of essential nutrients (C, P, N)
- Microbial communities
  - → Microbes always exist in mixed populations (never in isolation)
  - → Community depends on:
    - Resources (nutrients)
    - Conditions (temp., pH, oxygen, etc.)
  - ★ Communities are shaped by diverse interactions between species
  - → Communities are found everywhere (study of microbial ecology)
    - There are more bacterial cells in the human body than human cells
- Microbes and Human Health
  - → most microorganisms are harmless or beneficial
  - → There are millions of microorganisms at the surface and inside of our bodies
    - this is the <u>normal microbiome</u>
    - <u>microbiome</u> = ecological community of commensal, symbiotic, and pathogenic microorganisms
  - → Roles of the normal microbiome
    - protection against diseases by preventing proliferation of harmful microorganisms
    - contribution to metabolism
    - interactions with drugs (some drugs must be metabolized by bacteria to become active)
- Importance of microbial exposure
  - → more exposure = improved immunity
  - → Antibiotics, improvement in hygiene = less exposure
    - changes in microbiome
    - increase in allergic reactions and autoimmune diseases
      - immune system has fewer things to attack → attacks itself

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- Human microbiome project
  - → Individuals have very different microbiomes
  - → affected by:
    - changes in natural environment
    - infections
    - chronic use of drugs
    - diet
    - host genetics
- History of Microbiology
  - → 1665: Robert Hooke and Cell Theory
    - First description of microbes (mold)
  - → 1673-1723: First observations of Bacteria by Antonie van Leeuwenhoek
    - called them "animalcules"
    - looked at dental plaque
  - → Spontaneous generation

384-55 BC
- Lucretius - disease is caused by invisible living creatures
- Aristotle - came up with the idea of "spontaneous generation"
  - prevailed for 2000 years

- Francesco Redi - cheesecloth over meat = no maggots
  - contradicted
- John Needham - Boiled broth then sealed jars = became turbid
  - Supported
- Lazzaro Spallazani - sealed flasks, then boiled broth = did not become turbid
  - contradicted (but perhaps air was needed for growth)
- Louis Pasteur - First to connect cause and effect (microorganisms are responsible for disease, growth, metabolic products)
  - Discovered fermentation and developed pasteurization
  - determined nature of disease
  - disproved spontaneous generation ☆

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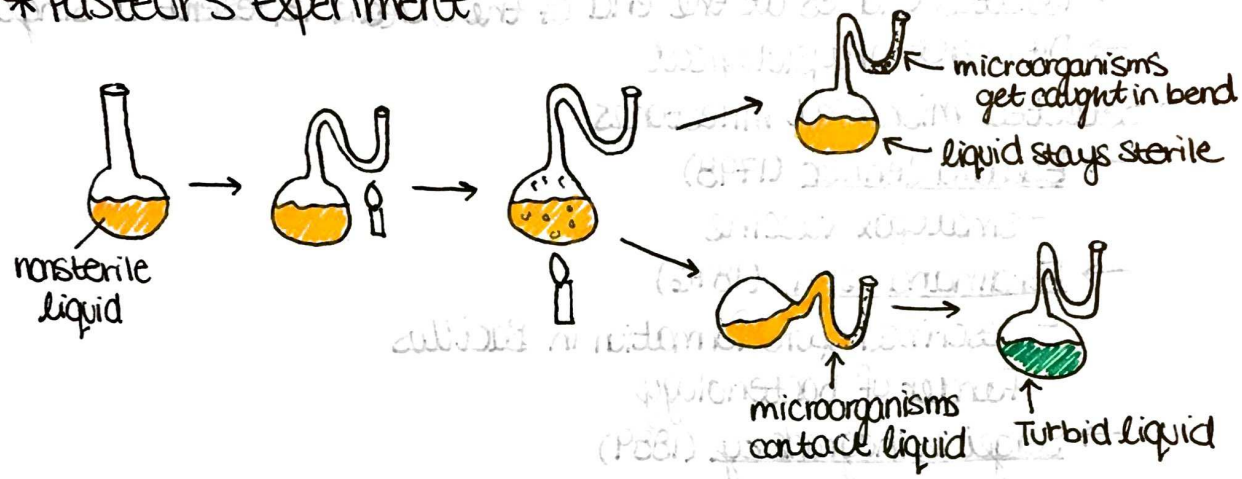
* Pasteur's experiment



→ Robert Koch
- methods and principles led to isolation of pure bacterial cultures
- Proved cause of disease
- discovered cause of tuberculosis

☆ - Koch's postulates:
1. The suspected pathogen must be present in all cases of the disease and absent in healthy animals
2. The suspected pathogen must be grown in pure culture
3. Cells from a pure culture of the suspected pathogen must cause disease in a healthy animal
4. The suspected pathogen must be reisolated and shown to be the same as the original

- Limitations of koch's postulates
  * "The pathogen must grow in a pure culture"
    ↳ pathogens requiring complex nutrients from the host will not grow
    ↳ Slow-growing organisms will fail
    ↳ organisms that do not grow on selected media will fail
  ☆ Environment is important (temp., pH, etc.)

• Pure culture isolation
→ Initially developed by:
- Fannie and Walter Hesse (agar)
Richard Petri (do I need to elaborate?)

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→ Isolated colonies at the end of the streak represent a single cell
→ Different physiological

- Selected microbial milestones
  → Edward Jenner (1798)
    - Smallpox vaccine
  → Ferdinand Cohn (1876)
    - Described spore formation in Bacillus
    - Fander of bacteriology
  → Sergei Winogradsky (1889)
    - concept of chemolithotrophy and autotrophy
    - alternative metabolisms - more diverse than complex organisms
  → Martinus Beijerinck (1901)
    - Enrichment culturing method (select for specific species)
    - Concept of a virus
  → Alexander Fleming (1929)
    - discovery of penicillin
  → Howard Foley (1945)
    - large-scale production of penicillin

☆ since introduction of antibiotics/vaccines: life expectancy has increased from 47 to 78 years

  → Selman Waksman and Albert Schatz (1944)
    - discovery of streptomycin in soil bacteria (produce antibiotics)
    - fondation of modern pharmaceutical industry
  → Thomas Brock (1967)
    - Discovery of Thermus aquaticus
    - source of Taq polymerase
  → Carl Woese and George Fox (1977)
    - Discovery of archaea
  → Craig Venter and Hamilton Smith (1995)
    - first complete sequence of the bacterial genome

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