Lecture 1

MICROBIOLOGY

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Microbiology in the biological world
Microbiology is the study of microbes which can be observed only with the use of various types of microscopes with only rare exceptions.

33% of diseases are originated from infectious diseases.
Microorganisms share their small sizes; although they are simple they can be extraordinarily complex.

Superficially, bacteria appear to be relatively simple forms of life; in fact, they are sophisticated and highly adaptable.

indigenous are in or on the body

there is three relationships between microbes and host: mutualism, parasitism, neutralism
Why Study Microbiology?

- Indigenous microbiota.
- Opportunistic pathogens
- Microbes produce oxygen (algae and cyanobacteria a group of photosynthetic bacteria that produce oxygen)
- Microbes are involved in the decomposition of dead organisms and the waste products of living organisms

fungus is the main decomposer of death organisms
• Microbes are capable of decomposing industrial wastes (oil spills).

• Many microbes are involved in elemental cycles, e.g: nitrogencycle

• Algae and bacteria serve as food for tiny animals.

• Microbes produce substances that are of value to the host e.g: E. coli produce vitamins K and B1

  
  vit B1 also called thiamine  
  lactobacillus is found in activia(dairy product)
Many microbes are essential in various food and beverage industries.

Some bacteria and fungi produce antibiotics that are used to treat patients with infectious diseases.

Microbes are essential in the field of genetic engineering.

Microbes have been used as “cell models. *E. coli* is one of the most studied of all microbes.
These organisms are studied for many reasons; one important reason is that they cause deadly diseases.

Pathogens cause two major types of diseases: infectious diseases and microbial intoxications.

التلوث الناتج عن سموم البكتيريا مثل في بقايا الطعام:
3% of known microbes are capable of causing disease and said to be pathogenic
Earliest Known Infectious Diseases

Human pathogens have existed for thousands of years because damage caused by them has been observed in the bones and internal organs of mummies and early human fossils.
Van Leeuwenhoek: the first using magnification glass to identify bacteria and to describe their shapes.

He wasn't a scientist but he described microbes.
Lens

Object being viewed

Adjusting screws

1 inch
Spontaneous generation

- life can arise spontaneously from nonliving material is called the theory of spontaneous generation or abiogenesis.

- life can only arise from preexisting life. This is called the theory of biogenesis.
Francesco Redi debunked the spontaneous generation theory by simple experiment. He covered pieces of meat with strong mesh to prevent microbes from reaching them, and the meat didn't decay. The mesh could prevent microbes, but if they contained eggs before the mesh was used, the eggs would pass through the fine mesh.

Experimental design showed this reveals a flaw in the theory.

Pasteur designed an experiment to debunk spontaneous generation theory (Swann neck experiment).

Francesco Redi's experiment was disapproved by another scientist.
1. Broth sterilized
2. Broth allowed to cool slowly
3. Broth stays sterile indefinitely
4. Flask tilted so that the sterile broth interacts with bacteria and dust from air
5. Bacteria grow and multiply in broth

Trapped air escapes from open end of flask
Bacteria and dust from air settle in bend
Hours/days
starting with sterilization of nutrient media (broth media), no microbes in this broth in the flask, and by keeping the flask vertical to microbes or air could enter the broth, because of the injection of the neck "no bacterial growth in the broth"
when the flask is tipped down the air starts to enter the flask and reaching in face to face or exposed to the organism, the organism now will start to grow in the broth.

Pasteur defined disease specificity (every single organism can cause specific disease in specific organ)

like Ecoli infects urethra as its receptors are there so it didn't cause symptoms if affect the lungs
• Pasteur introduced the terms “aerobes” and “anaerobes”

before 120 yr

• Pasteur developed Pasteurization  
pasteurization: using middle to high temp for a short time to kill pathogens only not all microbes

• Pasteur made significant contributions to the germ theory of disease

• Anthrax  →  (Bacillus anthracis)

• Pasteur lead changes in hospital practices to minimize the spread of disease by pathogens.

• Pasteur developed vaccines to prevent chicken cholera, anthrax, and swine erysipelas (a skin disease).

• Pasteur developed a vaccine to prevent rabies in dogs

dاء السعار

rabies: داء السعار
made an actual experiment designed by an experimental animal. "every single disease should have a single organism and a single pathogen"

one pathogen causes a disease in susceptible host. if we isolate the causative agent of this disease and inject it in another organism he will be infected by the same host.
• Koch discovered that B. anthracis produces spores

• Koch developed methods of cultivating bacteria on solid media

• Koch discovered the bacterium (M. tuberculosis) that causes tuberculosis and the bacterium (Vibrio cholerae) that causes cholera.

• Koch’s work on tuberculin

  tuberculosis is a re-emerging disease

  1/3 of world population contains TB but in its inactive form (latent form)

  active TB symptoms: coughing, fever, weight loss, night sweat 😢
1. The microorganism must always be found in similarly diseased animals but not in healthy ones.

2. The microorganism must be isolated from a diseased animal and grown in pure culture.

3. The isolated microorganism must cause the original disease when inoculated into a susceptible animal.

4. The microorganism can be reisolated from the experimentally infected animal.
# MODERN ERA:

## Nobel Laureates

<table>
<thead>
<tr>
<th>Years</th>
<th>Nobel laureates</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1901</td>
<td>Von behring</td>
<td>Dipth antitox</td>
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<tr>
<td>1902</td>
<td>Ronald Ross</td>
<td>Malaria</td>
</tr>
<tr>
<td>1905</td>
<td>Robert koch</td>
<td>Tb</td>
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<tr>
<td>1908</td>
<td>Metchnikoff</td>
<td>Phagocytosis</td>
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<tr>
<td>1945</td>
<td>Flemming</td>
<td>Penicillin</td>
</tr>
<tr>
<td>1962</td>
<td>Watson, Crick</td>
<td>Structur DNA</td>
</tr>
<tr>
<td>1968</td>
<td>Holley, Khorana</td>
<td>Genetic code</td>
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<tr>
<td>1997</td>
<td>Pruisner</td>
<td>Prions</td>
</tr>
<tr>
<td>2002</td>
<td>Brenner, Hervitz</td>
<td>Genetic regulation of organ development &amp; cell death</td>
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Medical microbiology - past triumphs

- Golden Age of microbiology 1875-1918, most pathogenic bacteria were identified

- 10 million died of smallpox, as a result of vaccination no cases have been reported since 1977
  
  smallpox is from top ten lethal diseases

- 1346-1350, 1/3 of the entire population of Europe died from bubonic plague

- The discovery of antibiotic provided an important weapon against bacterial diseases
In 1964, the surgeon general of the United States delivered a speech to Congress: “It is time to close the book on infectious diseases,” he said. “The war against pestilence is over.”

In 1998, Surgeon General David Satcher had a different message. The *Miami Herald* reported his speech with this headline: “Infectious Diseases a Rising Peril; Death Rates in U.S. Up 58% Since 1980.”

collistin resistant bacteria : bacteria that have resistant to antimicrobials
Medical microbiology- future challenges

- The importance of medical microbiology as an active field of research

- 750 million cases of infectious diseases occur in the USA leading to 200,000 deaths annually and results in tens of billions of dollars in health care costs alone

- Respiratory infections and diarrheal diseases are the leading causes of illness and deaths

- Diseases that were attributed to other causes have now been shown to be caused by microorganisms i.e peptic ulcer

  90% of the causes of peptic ulcer are from H.pylori
Medical microbiology - future challenges

- New diseases continue to arise i.e. legionnaires disease, AIDS, toxic shock syndrome

TSS: a condition caused by bacterial toxins

- Many infectious diseases started to increase again i.e. international traveler incubating a disease in his body could theoretically circle the globe, such diseases as malaria, cholera, plague still exist, these diseases have been eliminated through sanitation, vaccination and quarantine

globalization:
القرية العالمية‌ای سه‌وله الاتصال این الشعوب:
Medical microbiology - future challenges

- Control by vaccination of childhood diseases (measles, mumps, whooping cough) results in lax about having their children vaccinated and a dramatic increase in the number of those infected has resulted.

- Treatment of infectious diseases result in prolonged life of people that lower the diseases resistance of patients weaken the ability of the immune system to fight diseases.

- TB has increased worldwide and thousands of cases are reported annually, these new cases of TB is resistant to the drugs that once effective in curing the disease.
## Top Causes of Death—All Diseases

<table>
<thead>
<tr>
<th>United States</th>
<th>No. of Deaths</th>
<th>Worldwide</th>
<th>No. of Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Heart disease</td>
<td>652,000</td>
<td>1. Heart disease</td>
<td>12.2 million</td>
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<tr>
<td>2. Cancer</td>
<td>559,000</td>
<td>2. Stroke</td>
<td>5.7 million</td>
</tr>
<tr>
<td>3. Stroke</td>
<td>144,000</td>
<td>3. Cancer</td>
<td>5.7 million</td>
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<tr>
<td>4. Chronic respiratory disease</td>
<td>131,000</td>
<td>4. Respiratory infections*</td>
<td>3.9 million</td>
</tr>
<tr>
<td>5. Unintentional injury (accidents)</td>
<td>118,000</td>
<td>5. Chronic respiratory disease</td>
<td>3.6 million</td>
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<tr>
<td>6. Diabètes</td>
<td>75,000</td>
<td>6. Accidents</td>
<td>3.5 million</td>
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<tr>
<td>7. Alzheimer’s disease</td>
<td>72,000</td>
<td>7. HIV/AIDS</td>
<td>2.9 million</td>
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<tr>
<td>8. Influenza and pneumonia</td>
<td>63,000</td>
<td>8. Perinatal conditions</td>
<td>2.5 million</td>
</tr>
<tr>
<td>10. Septicemia</td>
<td>34,000</td>
<td>10. Tuberculosis</td>
<td>1.6 million</td>
</tr>
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influenza and pneumonia and septicemia

* Diseases in red are those most clearly caused by microorganisms.

*Source: Data from the World Health Organization, 2008.*
Beneficial applications of microbiology

- Human life would not exist on this planet without the activities of bacteria
Medical Microbiology

This branch deals with microbes that cause diseases in humans and animals. Researchers examine factors that make the microbes virulent and mechanisms for inhibiting them.
Public Health Microbiology and Epidemiology

These branches monitor and control the spread of diseases in communities.
Immunology

This branch studies the complex web of protective substances and cells produced in response to infection. It includes such diverse areas as vaccination, blood testing, and allergy.
Agricultural Microbiology

This branch is concerned with the relationships between microbes and domesticated plants and animals.

Plant specialists focus on plant diseases, soil fertility, and nutritional interactions.

Animal specialists work with infectious diseases and other associations animals have with microorganisms.
Industrial Microbiology

This branch safeguards our food and water, and also includes biotechnology, the use of microbial metabolism to arrive at a desired product, ranging from bread making to gene therapy.

Microbes can be used to create large quantities of substances such as amino acids, beer, drugs, enzymes, and vitamins.
Environmental Microbiology

These microbiologists study the effect of microbes on the earth’s diverse habitats. Whether the microbes are in freshwater or saltwater, topsoil or the earth’s crust, they have profound effects on our planet.
Careers in Microbiology

A microbiologist is a scientist who studies microbes. He or she might have a bachelor’s, master’s, or doctoral degree in microbiology.
Medical Microbiology

An excellent career field for individuals having interests in medicine and microbiology
Clinical microbiology or diagnostic microbiology

An excellent career field for individuals with interests in laboratory sciences and microbiology.