History and Importance of Microbiology

1. Describe how the experiments both Redi and Pasteur conducted helped disprove the idea of spontaneous generation.

How is it that these experiments allowed people to understand that life comes from other living organisms, not just when environmental conditions are right? (1 point)

Answer:

The theory of Spontaneous Generation supported the fact that life could be spontaneously generated from the non living matter.

In the 17th century, an Italian scientist Franceso Redi conducted an experiment to controvert the theory of Spontaneous Generation. He showed that fly larvae do not spontaneously arise from decaying meat.

1. He placed meat in two identical jars and left one jar uncovered and allowed flies to come into contact with the meat. He covered the other jar with a cheese cloth that allowed air to pass through. Contact with the air allowed the meat to decay.
2. After a short period of time, he observed fly larvae on the decaying meat of the open jar. There were no fly larvae on the meat in the covered jar.

3. Redi concluded that the flies laid eggs on the meat in the open jar. As the flies had not laid eggs on the meat in the covered jar, no fly larvae were produced. Thus, Redi therefore proved that decaying meat did not produce fly larvae.

In the late 1800s by Louis Pasteur concluded same theory with a classic experiment. His hypothesis states that if cells could arise from nonliving substances, then they should appear spontaneously in sterile broth.

To test his hypothesis, he created two treatment groups:

a) One broth that was exposed to a source of microbial cells.

b) One broth that was not exposed to a source of microbial cells.

For control treatment, he used a straight-necked flask that allowed particles in the air to fall into the broth stored in the flask. For his experimental treatment, Pasteur used a swan-necked flask. The neck shaped and length assured that no cells could enter the broth from the air.

Pasteur then performed the same procedure on these two flasks. He boiled the broth to kill any existing organisms. He then let the broth cool and allowed it to sit for several days, after which he removed the necks of the flasks and checked the broth for the growth of any organisms. Pasteur found living organisms only in the control flask. Because the experimental flask remained sterile, the hypothesis of spontaneous generation was rejected.

2. Why is cell theory an important part of microbiology and how does it contribute to the field still today? (1 point)

Answer:

The Cell Theory supports the idea that cells are the basic unit of structure in every living thing. It was proposed by german scientists Theodor Schwann, Matthias Schleiden and Rudolph Virchow. The cell theory is one of the basic foundations of life science.

The Cell Theory states that:

- All living organisms are composed of cells. They may be unicellular or multicellular.
- The cell is the basic unit of structure and function in all living organisms. Existing cells arise from pre-existing cells.
- Energy flow (metabolism and biochemistry)occurs within cells.
- Heredity information (DNA and RNA) is passed on from cell to cell.
- All cells are basically the same in chemical composition in organisms of similar species.

3. Describe how Koch's postulates relate to the germ theory of disease and how it is his series of experiments/steps help us link certain microbes to certain illnesses. (1 point)

Answer:

Robert Koch was the first scientist to devise a series of tests used to assess the germ theory of disease. Koch's work published in 1890 and demonstrated that anthrax was caused by the bacterium Bacillus anthracis. These postulates are still

used today to help determine whether a newly discovered disease is caused by a microorganism.

4. Discuss the three main categories of microbial control we went over during lecture. Provide at least one example for each broad category and tell me how that practice influenced human health/disease. (1point)
Answer:

1. Protozoa are single-celled eukaryotic organisms, exist in both water and soil. Most protozoa feed on bacteria and decaying organic matter, although a wide range of protozoan species are insect parasites. The protozan Nosema locustae is a natural bio control agent of many grasshopper species. Nosema infects at least 90 species of grasshoppers. It is non-toxic to humans and other mammals.

2. *Trichoderma* species. are the most common fungi in nature, act as bio control agents. These microbial bio fungicides out-compete pathogenic fungi for food and space, and in the process can stimulate plant host defenses and affect root growth. They also have the ability to attack and parasitize plant pathogens under certain environmental conditions

5. Go to one of the links I provided in the “Extra Resources” section of the PowerPoint. Look it over, play a game, etc. and tell me what your experience with it was and why it could be useful in your life either personally or professionally. Make sure to provide me with the link you used and a brief description of what you did while on that site. (1 point)

<u>Structure and Function of Prokaryotic Cells</u>

1. Starting from the outside and working in (or vice versa) describe the generalized prokaryotic cell. List the major structures in the cell and provide a brief piece about their functions as well. Why is it that knowing about the structure and function of these types of organisms is so important? (2 points)
Answer:
Prokaryotic Cell Structure

Prokaryotic cells do not have true nucleus as the DNA is coiled up in a region of the cytoplasm known as nucleoid. The major structures of prokaryotic cells are:

a) Capsule: It is found in some bacterial cells. It provides an additional outer covering protects the cell when it is engulfed by other organisms, helps in retaining moisture. capsule also assists the cell adhere to surfaces and nutrients.

b) Cell Wall: It is the outer covering(in most of the cells), that protects the bacterial cell and provides a shape to it.

c) Cytoplasm: It is a gel like substance composed mainly of water. It also contains enzymes, salts, cell components and other organic molecules.

d) Cell Membrane: It surrounds the cell's cytoplasm and regulates the in and out flow of substances in the cell.

e) Pili: It is a hair-like structures on the surface of the cell. It helps cell to attach to other bacterial cells. Shorter pili is known as fimbriae.

f) Flagella: Flagella is a long, whip-like protrusion that helps in cellular locomotion.

g) Ribosomes: Ribosomes are responsible for protein production.

h) Plasmids: Plasmids are the circular DNA structures carrying genes on them. They are not involved in reproduction.

i) Nucleiod: Nucleid is the area of the cytoplasm that contains the single bacterial DNA molecule.

2. Describe the main differences between Gram positive and Gram negative bacterial cells. What are the basic steps in the staining process and how do they work to allow us to differentiate between a Gram positive and Gram negative cell. If you want to draw the structures to help you illustrate your points, feel free. (2 points)

Answer:

Gram positive bacteria retain a crystal violet dye during the Gram staining process. They appear blue or violet under a microscope, whereas Gram-negative bacteria appear red or pink. This difference in classification is due to

difference in the cell wall of the bacteria.

Major characteristics of Gram-positive bacteria are:

1. They have a thick cell wall made of peptidoglycan.
2. If a flagellum is present in them, it contains two rings for support.
3. Teichoic acids are present in gram positive bacteria. It act as chelating agents and assist bacteria for adherence.

Gram negative bacteria are those that do not retain crystal violet dye. They are mostly pathogenic. Major characteristics of Gram-negative bacteria are:

1. Cell walls contain a few layers of peptidoglycan and surrounded by an outer membrane of lipopolysaccharide
2. outside the peptidoglycan layer.
3. Porins exist in the outer membrane.There is a space between the layers of peptidoglycan and the secondary cell membrane. This space is known as the periplasmic space.
4. If flagella is present, it has four supporting rings instead of two.
5. No teichoic acids are present
6. Lipoproteins are attached to the polysaccharide backbone whereas in Gram-positive bacteria no lipoproteins are present.

Gram Staining technique:

Prepare a light suspension of cells from very young cultures grown on appropriate agar medium. If the suspension prepared is too turbid, dilute with distilled water.

1. Add one drop to a clean glass slide and spread the drop with a loop over the surface of the slide. Allow to air-dry.
2. Fixate the cells by moving the slide into a flame .
3. Flood the slide for 1 minute with Hucker's reagent. and then wash it by dipping the slide into slow running tap water.
4. Flood the slide with iodine solution for 1 minute and then place it diagonally in glass box and rinse of iodine solution with safranin.
5. Add excess amount of fresh safranin and wait for 35 seconds, then rinse slide with water and allow the slide to air-dry.
6. Examine the slides in the microscope. A drop of oil can be placed on the slide directly.
7. Gram-positive cells appear purple and Gram-negative cells pink.

3. Pick at least one of the special structures we discussed (fimbriae, flagella or endospores) and discuss why this structure can be useful for the bacterium. Tell me why knowing about this structure is important for us as well. (1 point)
Answer:

Certain bacteria form endospores in dry environments. This process of endospore is known as sporulation. They are also known as endospores, because the spores are formed within the cell. Endospores are very advantageous to bacterial cells. They are extremely resistant to a number of harsh environments, such as heat, desiccation, radiation, chemicals, acids, and drying.

Bacillus subtilis spores proved to be useful for the expression of recombinant proteins. Particularly for the surface display of peptides and proteins , which act as a tool for fundamental research in the fields of biotechnology and vaccination.

Structure and Function of Eukaryotic Cells

1. Again, starting from the outside in (or vice versa) describe the generalized eukaryotic cell (make sure to mention both the cell-walled and non-cell-walled varieties). List the major structures in the cell and provide a brief piece about their functions as well. Why is it that knowing about the structure and function of these types of organisms is so important? (2 points)

Answer:
Eukaryotic cells have an organized nucleus with a well developed nuclear envelope. The nucleus is known as the brain for the cell. This is the discrete area to keep DNA. Such well developed nucleus is known as true nucleus. Eukaryotic cells are mainly classified in two categories:
a) Plant cells
b) Animal Cells

In animal cells , cell wall is absent whereas in plant cells cell wall is present. The major structures of plant and animal cells are listed with their functions. The major structures of plant and animal cells are listed with their functions:

Cell Organelles	Functions	Animal Cell	Plant Cell
Nucleus	Genetic information is stored	Present	Present
Cilia	Responsible for movement	Present	rare
Chloroplast	Photosynthesis	Animal cells don't have chloroplasts	Plant cells have chloroplasts because they make their own food
Endoplasmic Reticulum , Golgi Apparatus and Ribosomes	Protein synthesis	Present	Present
Mitochondria	ATP production known as powerhouse of cell	Present	Present
Cell wall	Provides protection and rigidity	Absent	Present
Flagella	Locomotion	May be found in some cells	May be found in some cells

2. Discuss endosymbiotic theory. Tell me how it works, what the evidence for it is, and why it is important to understand. (1 point)

Answer:

According to this theory, certain organelles originated as free-living bacteria that were taken inside another cell as endosymbionts.The theory supported that:

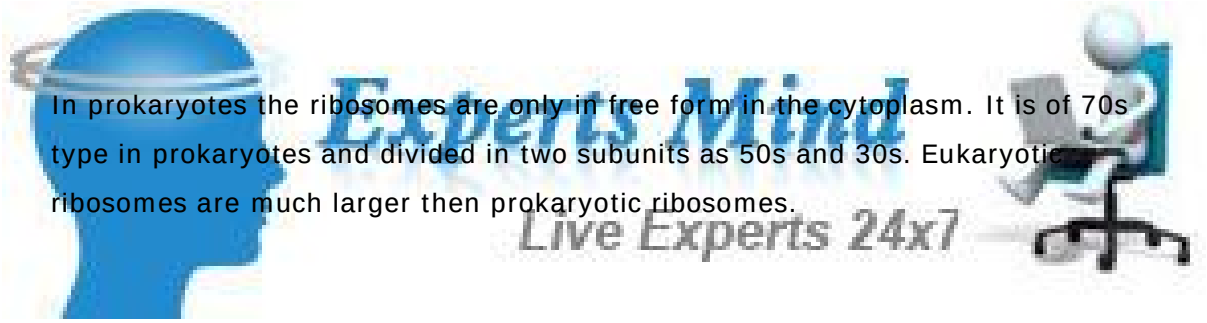
1. Mitochondria are the result of endocytosis of aerobic bacteria.
2. Chloroplasts are the result of endocytosis of photosynthetic bacteria.

Symbiosis occurs when two different species benefit one another. When an organism actually lives inside the other it's called endosymbiosis. The endosymbiotic theory describes how a large host cell and ingested bacteria could easily become dependent on one another for survival, resulting in a permanent relationship.

3. Compare and contrast prokaryotic and eukaryotic ribosomes. Why is the difference in ribosomes so important for us to understand? How can we use these differences to our advantage? (1 point)

Answer:

In eukaryotes ribosomes are either free in the cytoplasm. Sometimes, they are attached to the outer membrane of endoplasmic reticulum through ribophorins and 60s larger subunits. In the cytoplasm of eukaryotes 80s ribosomes. The two subunits are 60s type and 40s type. Eukaryotes also have 70s ribosomes in mitochondria and chloroplast.



In prokaryotes the ribosomes are only in free form in the cytoplasm. It is of 70s type in prokaryotes and divided in two subunits as 50s and 30s. Eukaryotic ribosomes are much larger then prokaryotic ribosomes.

4. List and briefly describe the characteristics of the four types of eukaryotes of medical significance. Provide at least one way each type of eukaryote affects human health. (2 points)

Answer:

Virus is the most common eukaryotic organism employed in the attenuated vaccines. Attenuated vaccines are created by keeping alive and reducing the virulence of a pathogen. By the process of attenuation, an infectious agent becomes harmless and less virulent. Toxoid vaccines are made from inactivated toxic compounds that cause illness rather than the micro-organism. Examples of toxoid-based vaccines are tetanus and diphtheria.

1. Oral polio vaccine (OPV) is a live-attenuated vaccine, produced by the passage of the virus through non-human cells

2. The measles-mumps-rubella-varicella combo i.e MMRV vaccine is consist attenuated live measles(genus Morbillivirus) virus.

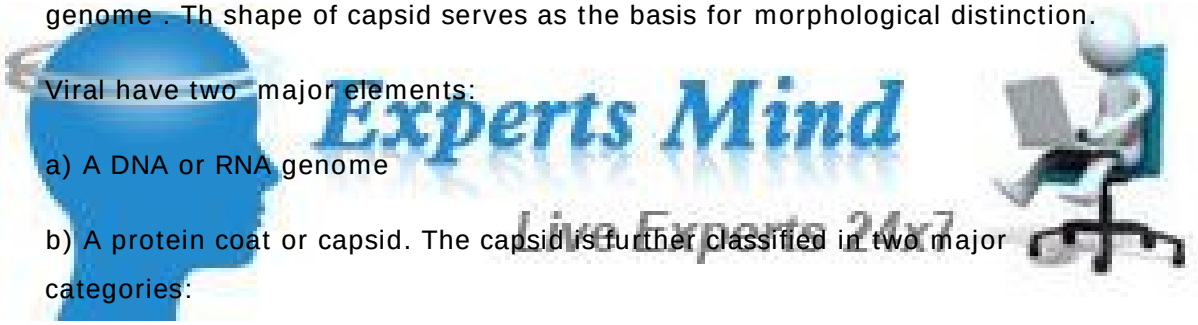
3. Ty21a is a live typhoid vaccine made from Ty2 Salmonella Typhi strain

4. Bacillus Calmette Guerin is a vaccine against tuberculosis that is prepared from a strain of the attenuated live bovine tuberculosis bacillus, (Mycobacterium bovis).

1. What is the basic structure of a virus? How do each of those structures play a role in disease? (1 point)

Answer:

Virus consist a nucleic acid surrounded by a protective coat of protein called a capsid. They are enclosed in an envelope made of lipid, which is derived from the host cell membrane. The capsid is made from proteins encoded by the viral genome . Th shape of capsid serves as the basis for morphological distinction.



Viral have two major elements:

a) A DNA or RNA genome

b) A protein coat or capsid. The capsid is further classified in two major categories:

i) A helical form, where proteins form a cylindrical tube around the genome.

ii) A Icosohedral form, where genome is compacted within a 20-sided complex of proteins.

Some viruses such as bacterial T-phages, have a contractile sheath that can act as a syringe and numerous tail fibers to assist in attaching to the cell wall play important role in infecting the host.

Answer:

HIV and other retroviruses are enveloped. They have a capsid is surrounded by a phospholipid membrane, which is derived from the host cell.

2. List and describe the steps of a viral infection. What happens during each of the stages? (2 points)

Answer:

Virus infect host cells in two stages:attachment and penetration.

Viruses attach itself to the host cells by way of cellular receptors..

Stages of viral infection and replication are:

1. Viruses attach itself to the host cells by way of cellular receptors. A cell cannot be infected unless it expresses the molecule that serves as a receptor for that particular virus on its outer surface.
2. Virus injects its genome into host cell. Viral genome starts replication using the host's cellular machinery.
3. After replication all viral components and enzymes are produced and assembled in the host cell.
4. After maturation, newly produced viruses are released from the host cell and start attaching to other cells.

3. Why are bacteriophages so important in human health if they can only infect bacteria? If this type of virus can't attach to and infect a human cell, why do these types of viruses matter to us? (1 point)

Answer:

They prey only on bacteria, never on human cells or those of any more complex organism. Bacteriophages act a therapeutic agent. They are naturally occurring viruses that can infect and kill bacteria. The bacteriophages are found in human and animal intestines.

Even among their bacterial hosts, bacteriophages are highly specific, with most infecting only a single species of bacteria. In many cases, only specific strains within that species are infected.

Bacteriophage infection is of two types:

a) Lytic: The bacteriophage infect the host cell, reprogram and then destroying the infected cell.

b) Lysogenic: The bacteriophage genome is integrated into the bacterial genome and passed on to future generations of bacteria.

Bacteriophages are important because they can be used as therapeutic agents against harmful bacteria.

4. What are some of the ways viruses can be helpful to humans? You can use the examples we discussed n class or go do some of your own research. Make sure to include a website or a reference if you look for your own examples so I can look it over too. (1 point)

Answer:

Viruses, sometimes prove to be very helpful to humans. For example, Lytic bacteriophages are the type used for therapeutic agents. As, it will produce hundreds of new bacteriophages from an infected bacterial cell in a matter of hours and destroy more of the target bacteria. They are target specific. Without their target, they are simply small lumps of protein and nucleic acid which can be removed by the normal clearance processes of the body.

References :

1. Varnam A. H, Evans M. G., 2000. Environmental microbiology. Manson Publishing.
2. Brock T. D. , 1999. Milestones in microbiology. ASM Press.
3. Durieux A., Simon J.P, 2001. Applied microbiology. Springer.
4. Glazer A. N., Nikaid H., 2007. Microbial biotechnology: fundamentals of applied microbiology.Cambridge University Press.
5. Laskin A. I., Gadd G.M., Sariaslani S., 2011, Advances in Applied Microbiology. Academic Press.