Watch Those Biofilms!

Design a flyer, brochure, powerpoint, or Prezi – The purpose of this project is to educate the public about biofilms. This project will count as a test grade. Utilize the documents given to you as resources to answer the following questions:

1. What is a biofilm?

2. Explain the composition (include a description of the EPS)

3. How does biofilm form?

4. How quickly do biofilms form?

5. Where are biofilms found?

6. List some positive and some negative effects of biofilms.

7. How do biofilms delay wound healing?

8. Identify at least 3 microorganisms that form biofilms and the diseases associated with the biofilm formation.

9. Explain the treatment options for the diseases (identified in #8) for patients that have contracted the disease.

Use relevant pictures to make it more appealing. You can draw your own images or import them from the Internet. Make sure you reference the sources in the text and list them at end of your brochure. You must cite all resources using MLA or APA format. If internet resources are utilized, you must include the url for the website. Examples are provide below:


Websites that may help with citation formatting:

http://www.citationmachine.net/

http://owl.english.purdue.edu/owl/resource/560/01/
BACKGROUND INFORMATION:

**Dental plaque** is classified as a biofilm. According to Marsh, Dental plaque can be defined as the diverse community of **microorganisms** found on the tooth surface as a biofilm, embedded in an **extracellular matrix** of **polymers** of host and microbial origin.

Microorganisms from the oral cavity may attach and develop **biofilms** on components of mechanical heart valves and damaged heart valve and surrounding tissues of the heart, leading to a condition known as **endocarditis**.

**Biofilm Structure and Function**

A biofilm is any group of microorganisms in which cells stick to each other on a surface. Bacteria occur in two states in nature, as **planktonic** individuals and as a group of organisms in a biofilm. A biofilm is composed of bacteria and other microorganisms that are embedded in a self-produced matrix of **extracellular polymeric substance (EPS)**. This gives biofilm a slimy feeling and it is made out of extracellular DNA, proteins and **polysaccharides**. The biofilm is formed when microorganisms recognize attachment sites, when there are nutritional or other molecular cues. Studies have shown that large groups of genes are differently regulated in the organisms when they are in a biofilm as compared to being planktonic. Interestingly enough, the bacteria can communicate with each other through **quorum sensing** and will be able to allow the biofilm to function as a unit, increasing the chance of survival even in **sub-optimal conditions**. As a matter of fact biofilms often form in response to environmental crises.

Biofilms may be found on living and non-living substances and they are prevalent in natural, industrial and hospital settings. Some examples are showers, toilets, water and sewage pipes, within the body, in rivers, on boat hulls, etc.

Biofilms can have a positive impact on its surroundings: biofilms are used for sewage treatment and to remove petroleum from contaminated waters, help us process foods in our digestive tract. But there are also many negative impacts and they can be very challenging in treating diseases. Due to the structure and the different **genetic expression**, bacteria growing in a biofilm are highly resistant to antibiotics, up to 1,000 times more resistant than the same bacteria not growing in a biofilm. Standard antibiotic therapy is often useless. Even increased amounts of antibiotics will not affect the biofilm because they cannot penetrate it. Some of the surface bacteria may die, but the ones on the inside survive and continue to create havoc.

Current objectives on biofilm research focus on prevention, avoiding re-growth, better imaging and lab cultures for identification and determining characteristics, and genetic expression of the microbes.

**Research of Biofilm on Chronic Wounds by Dr. Schultz at University of Florida:**

The wound healing process has four stages: **hemostasis** (blood clot forms), **Inflammation** (blood vessels then dilate to allow essential cells; antibodies, white blood cells, **growth factors**, enzymes and nutrients to reach the wounded area), **proliferation** (the wound is ‘rebuilt’ with new granulation tissue) and maturation (remodeling with collagen).

When a wound gets stuck in the inflammatory phase, it is called a chronic wound. A chronic wound is the ideal environment for biofilm, which establishes itself quickly and delays or inhibits healing of the wound. 60% of **biopsies** of chronic wounds have biofilm, whereas only 6% of **acute** (normal) wound have it.

The biofilm is difficult to treat, because antibiotics cannot penetrate it to eradicate it. One of the main pathogens is **Pseudomonas aeruginosa**. This microbe is ubiquitous and harmless on our intact skin, but it forms a pathogenic biofilm in wounds. Planktonic **P. aeruginosa** is easily killed by antibiotics such as Tobramycin, but the antibiotics cannot kill the biofilm version.
Wound biofilms are currently treated by removing the biofilm first (either by scraping it off, or suctioning it off) and then trying to prevent the re-formation of the film with antibiotics, effective dressings, antimicrobials and/or antiseptics.

It has been shown that biofilm takes 3 days to establish itself either initially or after removal. During this window treatment needs to get started and then it needs to be continued daily until wound healing occurs. A big help in preventing bacteria from attaching to the wound and forming the biofilm has been special gauze called Biofilm, which was developed by Dr. Schultz. Since Biofilm does not secrete any substances, it prevents bacteria from growing on the dressing and shedding onto the wound surface, while protecting surrounding tissues. The mechanism it does so is by a bound cationic polymer that disrupts the bacterial membrane. The biofilm has been successfully used in even the most difficult infections, including MRSA, *Staphylococcus aureus* and *Pseudomonas* infections.

Dr. Schultz is currently working on the suction technique, in which he applies suction with different antimicrobial agents to pigskin that has been infected with *Pseudomonas*, to see if delivering antimicrobials along with the suction will decrease the biofilm, speed up healing time and decrease pain of the treatment.

**VOCABULARY:**

**Acute:** having a sudden onset, sharp rise, and short course  
**Antimicrobial:** antimicrobial is an agent that kills microorganisms or inhibits their growth.  
**Biofilm:** A biofilm is any group of microorganisms in which cells stick to each other on a surface. These adherent cells are frequently embedded within a self-produced matrix of extracellular polymeric substance (EPS).  
**Biopsy:** is a sample of tissue taken from the body in order to examine it more closely. A doctor should recommend a biopsy when an initial test suggests an area of tissue in the body isn't normal.  
**Cationic polymer:** a natural or synthetic compound of usually high molecular weight consisting of up to millions of repeated positively charged linked units, each a relatively light and simple molecule.  
**Dental plaque:** biofilm that develops naturally on the teeth  
**Dressing:** A dressing is an adjunct used by a person for application to a wound to promote healing and/or prevent further harm. A dressing is designed to be in direct contact with the wound, which makes it different from a bandage, which is primarily used to hold a dressing in place.  
**Endocarditis:** is an inflammation of the inner layer of the heart, the endocardium. It usually involves the heart valves.  
**Genetic expression:** is the process by which information from a gene is used in the synthesis of a functional gene product. These products are often proteins, but in non-protein coding genes such as rRNA genes or tRNA genes, the product is a functional RNA. The process of gene expression is used by all known life  
**Hemostasis:** is a process, which causes bleeding to stop.  
**Inflammation:** is the body's attempt at self-protection; the aim being to remove harmful stimuli, including damaged cells, irritants, or pathogens - and begin the healing process.  
**Oral cavity:** the inside of the mouth.  
**Planktonic:** state in which bacteria are free-living and not associated with a biofilm.  
**Polysaccharides:** Large carbohydrates. Usually made out of hundreds of subunits, Examples are starches and cellulose.  
**Proliferation:** To grow or multiply by rapidly producing new tissue, parts, cells, or offspring  
**Quorum sensing:** system of stimulus and response correlated to population density. Many species of bacteria use quorum sensing to coordinate gene expression according to the density of their local population.
Check Your Understanding on Biofilms

1. Free living bacterial cells are said to be _______________
   a. Planktonic
   b. Ascribed
   c. Liberated
   d. Sessile
   f. Biofilmed

2. What role do biofilms **NOT** play? Please choose the incorrect statement:
   a. Biofilm can play a role in chronic conditions
   b. Biofilms protects bacteria from chemical disinfectants
   c. Biofilms can make many antibiotics less effective
   d. A biofilm helps prevent bacteria from attaching to any one specific surface

3. Dental plaque is one of the best-known examples of a biofilm. What organism is known to be involved with the formation of dental plaques?
   a. B. cereus
   b. S mutans
   c. S. viridans
   d. E. coli
   e. N. subflava

4. In which of the following conditions would you not expect to find a biofilm
   a. On a wet rock
   b. In the lungs
   c. On a dried out log
   d. On the fiberglass surface of a boat

5. The function of the EPS is to
   a. Control environmental policy
   b. Protect body cells from biofilm
   c. Destroy bacterial cell membrane
   d. Attach, protect and nourish the biofilm

Wrap up Questions – Biofilms

1. If you had a choice, would you rather have an infection of planktonic bacteria or bacteria in a biofilm. Why?

2. Why do bacteria act differently in a biofilm than when they are planktonic? Explain at least two reasons.
3. Can you treat chronic wounds with just antibiotics? Elaborate

4. How does Biofilm differ from normal gauze so that it inhibits bacterial growth?

5. You are treating a chronic wound of a 72-year-old diabetic male. It has been open for three weeks and has not healed. You just found out about Bioguard and want to give it a try. How would you “prep” the wound prior to applying the gauze?

6. Explain in terms of biofilm, why it is not a good idea to go to bed without brushing your teeth.

7. *Pseudomonas* are a formidable challenge as biofilms in chronic wounds. But they live harmlessly on our skin. Can you explain that?