Antonie van Leeuwenhoek was a Dutch merchant and amateur scientist (1632-1723) He used a primitive microscope to look at stagnant water and scrapings of teeth and noticed small life-forms which he called “animalcules”.

John Tyndall (1820-1893) advocated that bacteria are killed if exposed to high temperatures.

Joseph Lister (1827-1912) recognised the role of air-borne microorganisms in post-surgical infections.

Louis Pasteur (1822-1895) experimented with different ways to prevent dust (and therefor bacteria) entering food. In 1863 Pasteur saved the French wine industry by showing that vats of spoiled wine was contaminated with acid producing bacteria. He proved that these contaminants can be destroyed by raising the temperature for a short period up to 60 degrees Fahrenheit. (Thank Goodness!) This process is known as pasteurization and is commonly used in milk today. He also developed the first vaccine against rabies. Pasteur is known as “The Father of Microbiology”

So we see the role that micro-organisms play in disease is a fact that has been discussed and researched for hundreds of years. Micro-organisms that cause disease are called pathogens. They are the unseen enemy of the oral healthcare workers, but forewarned is forearmed.

Microorganisms can be grouped in:

1. Bacteria
2. Algae
3. Protozoa
4. Fungi
5. Viruses

Other micro-organisms include rickettsia (causing typhus) and prions (causing Creutzfeldt-Jakob disease and might play a role in Alzheimer’s disease)

The first 4 are easily recognised under a microscope, while viruses are smaller and can only be seen under an electron-microscope.
Let's look at the microorganisms that will affect our lives in the dental surgery.

1. **Bacteria:**

Bacteria is the name used for a large number of one-celled microorganisms that is grouped together. They can have different shapes and sizes and groupings. Pathogenic bacteria grow best at 37 deg Celcius in a moist dark environment.

Healthy humans host a variety of bacteria at all times. The skin, respiratory tract and digestive tract are inhabited by harmless bacteria called normal flora. They help with our metabolism and prevent (fight) harmful bacteria from entering.

Infections occur when bacteria that occur naturally in one part of the body enter another part of the body and become harmful. E.g. cystitis (urinary tract/ bladder infection) is caused by Escherichia coli, a bacterium that is found in the normal flora of the intestine.

**Shape of bacteria:**

- **Spherical (cocci)**
  Cocci are round and reproduce by dividing into two. If they form a chain, it is called streptococci. Well known infections caused by streptococci are sore throat (strep throat), tonsillitis, pneumonia and endocarditis (infection of the heart valve). If they group in a cluster, it is called staphylococci. They commonly play a role in boils and other skin infections as well as endocarditis and pneumonia.

- **Rod-shaped bacteria (Bacilli)**
  Causes amongst other things TB

- **Spiral (Spirochete)**
They have flexible cell walls and are able to move. Common diseases caused by spirochetes are Lyme disease and syphilis.

Danish bacteriologist Hans Christian Gram developed in 1884 a method to separate bacteria in groups. Bacteria that stain purple in a mixture of crystal violet dye, iodine solution, alcohol solution and safranin dye are called Gram positive, those who don’t stain are called Gram negative and those that are not consistent is called Gram variable (like Mycobacterium Tuberculosis). This information helps the doctor to choose the most efficient anti-microbial therapy.

Bacteria that need oxygen to survive are called aerobes and those who survive best in the absence of oxygen are called anaerobes. Facultative anaerobes can grow in the presence or absence of oxygen.

Some bacteria form a capsule that forms a protective layer covering the cell wall. They are usually capable of causing serious disease, due to their resistance to the body’s defence mechanisms. One such a rascal is Streptococci Mutans - a leading role-player in tooth decay. This capsule also interferes with the working of antibiotic treatment.

Some bacteria have the ability to change under unfavourable conditions into highly resistant spores. The bacteria stay alive inside the spore but are inactive. As spores, they cannot cause disease or reproduce. When the conditions improve, the bacteria become active and are capable of causing disease again. Spores represent the most resistant form of life known and can resist extreme heat and dryness. That is why we do spore tests to check the effectiveness of techniques used to sterilize our instruments. Tetanus is caused by a spore-forming bacillus.

**Bacterial diseases**

**Tuberculosis (TB)**
According to the World Health Organisation, TB is one of the leading causes of death in infectious diseases worldwide. HIV and TB often occur together. HIV patients have weakened immune systems and are therefore highly susceptible for TB. Of the two, TB poses a bigger risk for the dental team. One of the reasons is because the TB bacillus is able to withstand disinfectants that kill many other bacteria. That is why we have to look at the kill-time for TB on the labels of our surface disinfectants.
**Legionnaires’ disease**

Legionnaires’ disease is caused by the Legionella pneumophila. Bacteria are transmitted through aerosols and aspiration of contaminated water. L pneumophilia has been found to live in lakes, spas, air conditioning systems, shower heads, water distillation systems and the biofilm found in dental unit waterlines. Dental personnel have been found to have higher levels of antibodies of L pneumophila than the general public- which indicates exposure and resistance to the organism. The less serious form of infection is called Pontiac fever. It has flu-like symptoms like head ache, high fever, dry cough, chills, diarrhoea, chest and abdominal pain. Legionnaires’ disease is more serious and causes severe pneumonia. In immune compromised or elderly persons it can be fatal.

**Tetanus (lockjaw)**

This spore forming bacteria is found in soil, dust or animal or human faeces. It is transmitted through a wound or break in the skin – like puncture wound from an instrument.

**Syphilis**

Syphilis is a sexually transmitted disease that is caused by a spirochete Treponema pallidum. The bacteria are quite fragile outside the body, but cross-infection may occur when coming in contact with chancre sores. They appear during the first stage of the disease and are highly infectious on contact. The second stage is also infectious.

**Signs to look out for**

- Split papules at the corners of the mouth.
- Greyish white, moist, mucus- patches on the tongue, roof of the mouth or tonsils (looks almost like a white snail trial and is highly infective)
- Generalised red measles-like rash, pox-like postures, oozing sores and hair falling out of the scalp

The third stage of the disease is called latent syphilis and may occur after the disease has been dormant for years. This stage could be fatal.
2. Algae

Algae range from small single cell organisms to large multi-cell organisms. (Like seaweed and kelp) It is found in fresh and sea water and due to chlorophyll and pigments may appear greenish, red or brown. Most algae does not cause human disease.

3. Protozoa

Protozoa is a large number of single cell organisms that do not have a rigid cell wall. It is found in fresh and marine water. It can form a cyst to survive outside their hosts for long periods of time. The thick wall of the cyst makes them resistant to drying. Most protozoa don't cause disease, but some may cause damage/infections to humans.

4. Fungi

Fungi are plants such as mushrooms, yeasts and moulds that lack chlorophyll. The most common fungi found in the oral cavity are Candida - known to us as thrush. It affects mostly the very young, very old, and very ill patients. It might also occur under dentures. The skin looks like it is covered by a thin layer of cottage cheese and when wiped away; the skin looks red and raw and might also bleed a little. It is easily treated with anti-fungal preparations.

5. Viruses

Although viruses are much smaller than bacteria, they are far more potent and can be fatal. A virus can only live and multiply inside the host cell. It invades the host cell, replicate itself and then destroy the host cell to be released into the body.

Some viruses are rather fussy and attack only specific cells e.g. the HIV affects cells known as CD4 cells and the hepatitis virus attack liver cells.

Other viruses can affect more than one organ, like the mumps virus that can infect the thyroid, ovaries, testicles and pancreas.

Unfortunately some viruses have the ability to cross the placenta and infect the foetus e.g. HIV and Cytomegalovirus-a herpes virus that can cause blindness, mental retardation and impaired hearing in new-borns.

Some viruses can be latent (dormant) in the host and only become active when triggered by e.g. stress, infection from another virus and ultraviolet light (think of Herpes simplex1 or the common cold sore) a virus can be latent for many years. Hep C has a latency period of up to 25 years.

Viruses have the ability to mutate (develop an ability to survive better in the current situation). This ability makes it very difficult to treat diseases caused by viruses. Therefore
There are 5 types of viral Hepatitis. Each one is caused by a different virus.

Hepatitis A virus (HAV) is present in the faeces of infected persons and is most often transmitted through consumption of contaminated water or food. Certain sex practices can also spread HAV. Infections are in many cases mild, with most people making a full recovery and remaining immune from further HAV infections. However, HAV infections can also be severe and life threatening. Most people in areas of the world with poor sanitation have been infected with this virus. Safe and effective vaccines are available to prevent HAV.

Hepatitis B virus (HBV) is transmitted through exposure to infective blood, semen, and other body fluids. It can cause prolonged illness, permanent liver damage, cirrhosis of the liver and even liver cancer and death. HBV can be transmitted from infected mothers to infants at the time of birth or from family member to infant in early childhood. Transmission may also occur through transfusions of HBV-contaminated blood and blood products, contaminated instruments during medical/dental procedures, and through injection drug use. HBV poses a risk to healthcare workers who sustain accidental needle stick injuries while caring for infected-HBV patients. Patients that are HBV carriers might not have had the symptoms of the disease, but are still potentially infective. Safe and effective vaccines are available for health care workers to prevent HBV.

Hepatitis C virus (HCV) is mostly transmitted through exposure to infective blood. This may happen through transfusions of HCV-contaminated blood and blood products, contaminated injections during medical/dental procedures, and through injection drug use. Sexual transmission is also possible, but is much less common. There is no vaccine for HCV.

Hepatitis D virus (HDV) infections occur only in those who are infected with HBV. The dual infection of HDV and HBV can result in a more serious disease and worse outcome. Hepatitis B vaccines provide protection from HDV infection.

Hepatitis E virus (HEV) is mostly transmitted through consumption of contaminated water or food. HEV is a common cause of hepatitis outbreaks in developing parts of the world and is increasingly recognized as an important cause of disease in developed countries.
Safe and effective vaccines to prevent HEV infection have been developed but are not widely available.

To help you remember how this virus is transmitted, remember the consonants are blood-borne strains (Hep B,C,D) while the vowels (Hep A and E) are transmitted through ingesting contaminated food or water. (fecal-oral)

**Human immunodeficiency virus (HIV)**

HIV stands for human immunodeficiency virus. If left untreated, HIV can lead to AIDS (acquired immunodeficiency syndrome).

According to the WHO, at the end of 2014, approximately 36.9 million people were living with HIV/AIDS. 2.6 million were children.

Unlike some other viruses, the human body can’t get rid of HIV completely. So once you have HIV, you have it for life.

HIV attacks the body’s immune system, specifically the CD4 cells (T cells), which help the immune system fight off infections. If left untreated, HIV reduces the number of CD4 cells (T cells) in the body, making the person more likely to get infections or infection-related cancers. Over time, HIV can destroy so many of these cells that the body can’t fight off infections and disease. These opportunistic infections or cancers take advantage of a very weak immune system and signal that the person has AIDS, the last state of HIV infection.

No effective cure for HIV currently exists, but with proper treatment and medical care, HIV can be controlled. The medicine used to treat HIV is called antiretroviral therapy or ART. If taken the right way, every day, it can dramatically prolong the lives of many people with HIV, keep them healthy, and greatly lower their chance of transmitting the virus to others. Today, a person who is diagnosed with HIV, treated before the disease is far advanced, and stays on treatment can live a nearly as long as someone who does not have HIV.

Antiretroviral should be taken after accidental exposure.

[https://www.youtube.com/watch?v=odRyv7V8LAE](https://www.youtube.com/watch?v=odRyv7V8LAE)

**Herpesviruses**

The herpesvirus is a double stranded DNA virus that cause infections like chicken pox, CMV, herpes, shingles, measles and Karposi’s sarcoma.

There are four major herpes viruses:
- Herpes simplex viruses -- more commonly known as herpes -- are categorized into two types: herpes type 1 (HSV-1, or oral herpes) and herpes type 2 (HSV-2, or genital herpes). Most commonly, herpes type 1 cause's sores around the mouth and lips. HSV-1 can cause genital herpes, but most cases of genital
herpes are caused by herpes type 2. In HSV-2, the infected person may have sores around the genitals or rectum. Although HSV-2 sores may occur in other locations, these sores usually are found below the waist.

- Herpes zoster (HZV) causes shingles and chickenpox.
- Cytomegalovirus (CMV) a kind of herpesvirus which usually produces very mild symptoms in an infected person but may cause severe neurological damage in people with weakened immune systems and in the new-born.
- Epstein-Barr virus a herpesvirus causing glandular fever and associated with certain cancers, for example Burkitt's lymphoma.

**West Nile virus**

West Nile virus (WNV) is most commonly transmitted to humans by mosquitoes. You can reduce your risk of being infected with WNV by using insect repellent and wearing protective clothing to prevent mosquito bites. There are no medications to treat or vaccines to prevent WNV infection. Fortunately, most people infected with WNV will have no symptoms. About 1 in 5 people who are infected will develop a fever with other symptoms. Less than 1% of infected people develop a serious, sometimes fatal, neurologic illness. It causes inflammation of the brain and spinal cord.

For more information on the prevalence of this disease you can read this interesting article: [http://wwwnc.cdc.gov/eid/article/18/12/11-1208_article](http://wwwnc.cdc.gov/eid/article/18/12/11-1208_article)

**Avian Influenza Viruses**

- Avian influenza (AI) is an infectious viral disease of birds (especially wild water fowl such as ducks and geese), often causing no apparent signs of illness. AI viruses can sometimes spread to domestic poultry and cause large-scale outbreaks of serious disease. Some of these AI viruses have also been reported to cross the species barrier and cause disease or subclinical infections in humans and other mammals. The majority of human cases of A(H5N1) and A(H7N9) infection have been associated with direct or indirect contact with infected live or dead poultry. There is no evidence that the disease can be spread to people through properly cooked food.

With all this information in mind, not only is the dental team exposed, but we are also at risk of spreading disease to family, friends and patients if we are not careful.

According to the occupational Health and Safety Act, 85 of 1993 and the Occupational Health and Safety Amendment Act, 181 of 1993 it is the employer’s responsibility to provide, as far as reasonably possible, a safe working environment. Personal protective equipment (PPE) must be provided to employees free of charge. PPE includes masks, gloves, protective eyewear and clothing.

It is the duty of every employee- not just the assistant or hygienist- to follow the employer’s instructions and to familiarise themselves with precautionary measures taken to protect the employees.
OSHA, the Occupational Safety and Health Administration, developed a Bloodborne Pathogen Standard to prevent avoidable risks in the practice. Please read through it here: https://www.osha.gov/OshDoc/data_BloodborneFacts/bbfact01.pdf

and watch this video: https://www.youtube.com/watch?v=gLeTNOVfh8o

**What is the risk of infection after an occupational exposure?**

**Hepatitis B Virus (HBV)**

Health care workers who have received hepatitis B vaccine and have developed immunity to the virus are at virtually no risk for infection. For an unvaccinated person, the risk from a single needle stick or a cut exposure to HBV-infected blood ranges from 6%–30% and depends on the hepatitis B e antigen (HBeAg) status of the source individual. Individuals who are both hepatitis B surface antigen (HBsAg) positive and HBeAg positive have more viruses in their blood and are more likely to transmit HBV.

**Hepatitis C Virus (HCV)**

Based on limited studies, the estimated risk for infection after a needle stick or cut exposure to HCV-infected blood is approximately 1.8%. The risk following a blood splash is unknown but is believed to be very small; however, HCV infection from such an exposure has been reported.

**Human Immunodeficiency Virus (HIV)**

- The average risk for HIV infection after a needle stick or cut exposure to HIV-infected blood is 0.3% (about 1 in 300). Stated another way, 99.7% of needle stick/cut exposures to HIV-contaminated blood do not lead to infection.
- The risk after exposure of the eye, nose, or mouth to HIV-infected blood is estimated to be, on average, 0.1% (1 in 1,000).
- The risk after exposure of the skin to HIV-infected blood is estimated to be less than 0.1%. A small amount of blood on intact skin probably poses no risk at all. There have been no documented cases of HIV transmission due to an exposure involving a small amount of blood on intact skin (a few drops of blood on skin for a short period of time). The risk may be higher if the skin is damaged (for example, by a recent cut), if the contact involves a large area of skin, or if the contact is prolonged.

You can read the full article:
http://www.cdc.gov/oralhealth/infectioncontrol/faq/bloodborne_exposures.htm

**To do list:**
If your practice does not have an exposure control plan, use the information in the document below to draw one up. Discuss it with your boss and implement it in your practice - not just for your own sake, but also for the sake your family and colleagues.

https://dentallearning.org/course/OSHADental/BBP.pdf

Sources:
http://www.who.int/features/qa/76/en/
http://www.who.int/mediacentre/factsheets/avian_influenza/en/
http://www.cdc.gov/std/syphilis/images.htm
Modern dental Assisting  Torres and Ehrlich
Infection Prevention and Control Audit-Feedback for Oral Health Care in SA  Dr J Oosthuysen (this book is a must-have in any practice)

Question time:

1. Who was known as the Father of Microbiology?
   a. Antonie van Leeuwenhoek
   b. John Tyndall
   c. Louis Pasteur

2. Why is microbiology important for the dental staff?
   a. We learn how to use a microscope
   b. We get a better understanding of the importance of infection control
   c. It gives us a better understanding of dental materials

3. Who was the first to record that microorganism plays a role in surgical procedures?
   a. Antonie van Leeuwenhoek
   b. Joseph Lister
   c. Louis Pasteur

4. Which can be the primary shape of bacteria?
   a. Circular
   b. Bacillus-like
   c. All of the above

5. What is the name for the staining process for separating bacteria?
   a. Gram test
   b. Pathology test
   c. Scratch test

6. What is the term for bacteria the needs oxygen to survive?
   a. Aerobic
b. Anaerobic
c. Facultative organisms

7. What is the most resistant form of bacterial life?
   a. Virus
   b. Spore
   c. Fungi

8. Candida is a
   a. Virus
   b. Spore
   c. Fungi

9. Blood borne pathogens are micro-organisms are present in human blood that
   a. Can cause disease in humans
   b. Is contagious
   c. All of the above

10. Bacteria cause which of the following dental disease?
    a. Caries
    b. Periodontitis
    c. Both

11. Which of the following diseases are blood-born?
    a. Hepatitis A
    b. Hepatitis B
    c. Hepatitis C

12. Pontiac fever is a type of which disease?
    a. Tuberculosis
    b. Legionnaires’ disease
    c. HIV

13. Dental staff are exposed to L pneumophila through
    a. Blood exposure
    b. Aerosols
    c. Needle stick injuries

14. Which of these diseases are caused by bacteria?
    a. Tetanus
    b. TB
    c. Both

15. The first oral sign of syphilis is
    a. Gingivitis
    b. Chancre sore
    c. Cold sore

16. Herpes simplex virus type 1 is also known as
    a. Genital herpes
    b. Oral herpes
    c. Chicken pox

17. The Herpes zoster virus causes
    a. Genital herpes
    b. Oral herpes
c. Chicken pox

18. To reproduce, the HIV uses
   a. Reverse transcriptase
   b. T helper cells
   c. Protein

19. Which virus is needed for coinfection with HDV?
   a. HAV
   b. HBV
   c. HCV

20. Dental staff **should** be vaccinated against
   a. HBV
   b. Herpes
   c. TB

21. AI is transmitted to humans through
   a. Aerosols
   b. Contact with live fowls
   c. Eating contaminated food

22. OSHA’s Blood-borne Pathogens Standard requires employers to
   a. Establish an exposure control plan
   b. To differentiate between infectious and non-infectious blood and OPIM
   c. All of the above

23. OSHA’s Blood-borne Pathogens Standards requires of employers to
   a. Provide PPE free of charge
   b. Make HBV vaccinations available to employees
   c. All of the above

24. Which of the following are generally not expected to be contaminated with blood borne pathogens?
   a. Saliva
   b. Vomit
   c. Skin tissue

25. Which of the following statements are incorrect?
   Blood borne pathogens can be transmitted through
   a. cuts, scratches, blisters
   b. mucous membranes like mouth, eyes, nose
   c. skin contact

26. The chance of a vaccinated person contracting HBV after a single exposure to blood borne pathogens are
   a. Almost zero
   b. 6-30%
   c. 100%

27. HCV can be transmitted through a blood splatter in the eye
   a. True
   b. False
   c. Uncertain
28. The chances of contracting HIV through a needle stick injury is
   a. High
   b. Low
   c. Average

29. The employer is responsible for the occupational safety of employees
   a. True
   b. False
   c. Partly true

30. As employees, we are responsible for our own occupational safety
    a. True
    b. False
    c. Partly true