**MICROBIOLOGY**

**What is Microbiology?**

This term was introduced by French chemist Louis Pasteur.

Microorganisms (also referred to as microbes) are minute living things that are usually not seen by the naked eye. Example includes bacteria, viruses, fungi and protozoa.

Some of them are pathogenic (disease causing) while others are not (normal flora). They are available in nearly every environment, including soil, water, food, air plants, animals, human beings.

**Definition of Microbiology**

Microbiology is the study of microorganisms (the simple form of life visible only with a microscope)

It is a branch of science that embraces all the properties of microorganisms. Some of them are single celled while others occur as multicellular. Those such as viruses have no true cellular appearance. Some microbes are aerobic, others anaerobic some manufacture their physiologic needs from atmospheric sources of nitrogen and carbon dioxide.

Microscopic organisms have a tremendous impact on all life.

The term microbiology stands for:

Micro- too small to be seen with a naked eye

Bio- means life

Ology- stands for “study of “

**Medical microbiology**

Medical microbiology is the branch of medicine which is concerned with the prevention, diagnosis and treatment of infections and communicable diseases in humans, as well as cause and epidemiology. It is the study of microbes such as bacteria, fungi, viruses, parasites and protozoans which causes human illness and their role in the disease.

**Definition of terms in microbiology**

* Etiology **–**Is identification of the causative agent of decease
* Epidemiology Treatment of diseases using chemical compounds.
* Pathogen – is a microorganism capable of causing disease.
* Infection control**-**Measures to reduce spread of infectious disease.
* Opportunist pathogen - is an agent capable of causing disease only when the hosts resistance is compromised
* Pathogenicity - Is the ability of the infectious agent to cause disease.
* Virulence - is the quantitative ability of an organism to cause disease virulence organism cause disease when introduced into the host in small numbers
* Infection - is the multiplication of an infectious agent / organism within the body even if the person is asymptomatic multiplication of the normal flora bacteria is not considered an infection.
* Invasion - is the process by which the microbes enter the hosts cells or tissues, and spread in the body.
* Adherence - is the process by which the bacteria stick to the surfaces of host cells, as they enter the body in their infection process.
* Non – pathogen - is a microorganism that does not cause disease. They may be part of the normal flora
* Carrier - is a person or , animal with asymptomatic infection that can be transmitted to another susceptible person or animal
* Toxigenicity - is the ability of a microorganism to produce toxin that contributes to the development of the disease.
* II. Microbes- another name for microorganisms.

**HISTORICAL BACKGROUND OF MICROBIOLOGY**

Introduction

Origin of Microbiology

In ancient times, epidemic and endemic diseases were regarded as supernatural in origin. Some people thought that they were sent by gods to punish man’s wrong doings, and that treatment comprised of offering sacrifices to the gods

Important discoveries in microbiology

1. Antoni Van Leeuwenhoek (1673- 1723)

He was a Dutch. He started of the history of microbiology. He discovered little animals which he found in water while examining rain-water and teeth scrapings under his home made Microscope. Making a microscope and magnifying lenses was his hobby.

1. Marc Antony Von Penciz (1762)

Was a Viennese physician who published a thesis which he stated that it was his belief that disease was caused by living organisms and that each disease had its own organisms He also believed that the organism multiplied within the body and he suggested that they might be transferred from person to person to person through the air.

1. Edward Jenner (1796)

Was an English physician. He introduced the modern method of vaccination to prevent small pox. He also noted that milkmaids who contracted cow-pox while milking were subsequently immunized to small –pox.

He performed a vaccination against small-pox by transferring materials from cow-pox pustule on the hand of a milk maid to the arm of a small boy named James Phipps. Six weeks later, the boy was inoculated with small pox & failed to develop the disease.

1. Louis Pasteur 1822-1895

He was a French Scientist (Chemistry). His work on fermentation proved that the breakdown of sugar to alcohol was the result of the action of microorganism. He devised the process of destroying bacteria known as pasteurization. He proved that disease of wine could be prevented without altering the flavor by heating the wine for a short time to a temperature (of 55 to 60 degrees centigrade) a little more than halfway between freezing and boiling point. The process known as Pasteurization. Is employed throughout the world today to preserve milk & other perishable foods. He developed aseptic techniques, - Sterilization .He also discovered anthrax vaccine. He discovered the rabies infection. He took the brain cultures of infected dogs. From several experiments, he produced a dosage against rabies in healthy dogs. Later, he was able to immunize rabies in a child with this preparation from the dog’s brain. He died in 1895 .Was buried at the Pasteur institute in Paris, where he had been as a director. His germ theory of disease replaces Fate and sins. That many diseases are caused by microbes in the body and not sins, by character or by poverty etc. He is known as the “father of microbiology.”

5) Robert Koch (1876)

Was a German bacteriologist (Scientist) He identified microbes that caused Anthrax in 1867, tuberculosis in 1882 and cholera in 1883 .He discovered the mycobacterium and vibrio cholerae. He introduced the use of solid culture media. (Developed pure culture methods) He discovered the tuberculin used for experience in investigation. He formulated staining methods in accordance with methods used today . Also developed the hanging drop method for studying bacterial motility as used today. He is known as the father of bacteriology

6) Han Christian Gram 1884

Was a Danish physician working in Berlin. He introduced a method of differential staining known as Gram’s method. It is used for staining bacteria. He noted that after staining bacteria with methyl violet while others do not (later take counter stain Neutral Red).

7) Joseph Lister (1867)

He was a British surgeon and a pioneer of antiseptic surgery. He promoted the idea of sterile surgery while working at the Glasgow Royal Infirmary (a hospital or a place or institution to take care of the sick)

He instructed the surgeons under his responsibility to wear clean gloves and wash their hands before and after operations with 5 % carbolic acid solution, which he introduced.

The instruments were also washed and sterile in the same solution. In the operating theatre. He used carbolic acid (phenol) to disinfect wounds and disinfected operation site. The use of carbolic acid led to a reduction in post-operative and made surgery safer for patients.

He concluded that wound infections were as a result of microbes.

He is also known as the “father of antiseptic surgery”

8) Ziehl Ziehl and Friederich Neelsen (1892)

Ziehl and Neelsen developed the modern method of staining mycobacterium tuberculous tubercle – bacilli. It is used today and is referred to as Ziehl – Neelsen staining.

9) Sir Alexander Fleming. (1928)

He was a Scottish bacteriologist. Some piece of green mould fell upon oe of his cultures and it seemed to have some antibacterial effect. This mould – penicillin notatum, in his report, had some inhibition effect on the development of certain bacteria. He called the substance ‘Penicillin.’ Fleming’s own life at one time was saved from an overwhelming pneumonia by the very agent he had discovered. Thus he made an accidental discovery that a fungus penicillin produces a substance which destroys bacteria.

**The Golden Age of Microbiology** (1857 -1914)

In the beginning with pasteur’s work discoveries included the relationship between :

* microbes and disease
* microbes and immunity
* microbes and anti-microbial drugs.

2 **CLASSIFICATIONS OF MICROORGANISMS**

**Introduction**

Microorganisms classification is important in identifying, various microorganisms that cause disease to enable cure, prevention and control

Objectives

By the end of the session, the learners will be able to

-Describe the different methods of microorganism classification -Outline classification of bacteria . –Outline classification of protozoa viruses.

**1) Eukaryotic genera**

1. including sporozoa, flagallae and amoeba
2. Fungi – Mold like yeast, like Dimorphic true yeast.

Eukaryotes contains organelles and Nucleus which is bounded by a nuclear membrane [which is semi permeable] cells in this group lack a cell membrane except in plants which have cell walls. They have multiple diploid chromosomes and nucleosomes. Many eukaryotic microorganisms have organelles called flagella [e.g.Trichomonas vaginalis] or cilia [e.g. in Blantidium coli] that move with a wave like motion to propel the cell through the water.

2) **Prokaryotic Geneva**

E.g. Bacteria, micro plasmas Rickettsia organisms

Is simpler than the Eukaryotic cell, with one exemption .the cell envelope [membrane] is more complex

They have no membrane enclosed nucleus

Have no cell organelles

Have a cell wall composed of peptidoglycan

Are haploid with single chromosomes.

Microorganisms may be

1. **TAXONOMIC CLASSIFIATION OF MICROBES**

Taxonomy -is a system for organizing classifying and naming living things

Taxonomy consists of three components namely;

Classification

Nomenclature

Identification

1. **Classification**

Allows the orderly grouping of organisms .classification arranges the organisms into taxonomic groups based on similarities or relationships

It is based on experiments, observations, biochemical tests, physiological tests, genetic identification and morphological properties.

In taxonomic classification all living things are classified into the following:-

* Kingdom –there are 5 kingdoms: Monera, Protoctista, fungi, plantae, animalia
* Phylum or division
* Class
* Order
* Family
* Genus
* Specious

**(2)Nomenclature**

Nomenclature /naming of microorganisms

Is the naming of organisms, the scientific name of an animal or plant is composed of two words that are in Latin form (binomial nomenclature)

Binomial means two names; the first name begins with a capital letter and donates the genus

The second name begins with a small letter and donates the species

Example: staphylococcus aureas indicates a bacterium belonging to the genus staphylococci and species aureus

Genus noun, always capitalized

Species adjective, lower case

Both italicized or underlined

Staphylococcus aureus (S. aureus)

Escherichia coli (E. coli)

**3. Identification**

* microorganism are best identified by staining methods (reactions)
* Culture characteristics
* Biochemical
* Immunological difference

**B) BIOLOGICAL CLASSIFICATION OF MICROORGANISMS**

Broadly classified as:

* Bacteria
* Viruses
* Fungi
* Protozoa
* Algae
* Slime Molds
* Archaebacteria

**Classification of bacteria**

The different groups of bacteria are mainly distinguished by the microscopic observation of their morphology and staining reactions. Bacteria cause most of the infections seen in the hospitals

1. **Morphology**

The size, shape and cell arrangement of various bacteria are easily observed using the light

microscope .

Bacteria vary widely in size – ranging from spheres measuring about 0.2 um in diameter to spiral 10.0 um long or even longer.

Division of the bacteria

* Filament bacteria (Actinomycetes). They are capable of true branching. They produce a type of mycellium. A few are pathogens. Some produce antibiotics.
* True bacteria – multiply by simple binary fission (dividing into two equal parts). Are the most medical important bacteria. Are classified on basis of their shape as cocci, bacilli.
* Spirochetes- divide by transverse binary fission.
* Mycoplasmas- lack a rigid cell wall.
* Rickettsia –chlamydiae are

1. **Staining**

Stains combine chemically with the bacterial protoplasm . commonly used stains are salts.

Basic stains- consists of coloured cation with a colourless anion e.g methylene blue chloride.

Acids stains are the reverse e.g sodium + eosinate.

Bacterial cells are rich in nucleic acid bearing negative charges as phosphate groups. These combine with the positively charged basic dyes, acidic dyes do not stain bacterial cell and hence can be used to stain background material a contrasting colour (negatively )

Graham stain procedure – is important for identifying bacteria.

Acidic fast staining – for acid fast bacteria e.g mycobacteria and some of the related actinomycetes

**VIRUSES**

Are the smallest of the infective organisms (agents)

Have a single structure that is not comparable with that of the cell.

They are subcellular organisms i.e. they have only nucleic acid by a protein coat

They live and grow in living cells of other organisms

They are small (50-300nm)

They are unable to replicate (reproduce independently) they invade the host cells and use their cellular machinery to replicate.

Examples of diseases caused by viruses include –influenza, chicken pox(varicella),Herpes Rhinovirus ,HIV /AIDS, Corvid-19, Ebola, measles, Hepatitis, Mumps, polio.

They are often difficult to treat .vaccines are available for many viruses. Viruses mutate easily creating new forms of same virus.

**VIROIDS**

More simpler than viruses

They are protein free fragments of single –stranded circular RNA that cause disease in plants.

**PRIONS**

Is another class of infectious particles.

They are causative agents of fata neuron degenerative disorder in animals and human beings. They are believable to be naturally occurring host cell membrane, glycoproteins that undergo confirmative changes to an infectious isoform

**Properties of microorganisms**

**Learning objectives**

- By the end of the session, leaners will be able to describe the properties / characteristics of bacteria, viruses and fungi.

- List common bacterial and viral diseases and their causes.

**Introduction**

Microorganism are the smallest organisms on earth. They are microscopic.

They may be single celled or multi- cellular. Some are aerobic while others anaerobic. Some have chlorophyll and therefore make their own food (photosynthetic).

Some are prokaryotic e.g. bacteria and archaea, while others are eukaryotic.

**Properties of Bacteria**

* Are unicellular free living organism
* They have both DNA and RNA
* They are capable of performing all essential process of life such as metabolism, growth and replication.
* They have a rigid cell wall made of muracic acid.
* Only approximately 4 % of bacteria are harmful

**Bacterial cell wall**

The cell wall of the bacteria determines its shape.

It is made up of a substance called peptidoglycan (a network of amino acids and CHO’s i.e. carbohydrates.)

The Gram stain attaches to the peptidoglycan layer (cell wall).

How are bacteria distinguished?

* By difference in their shape and surface structure.
* By response to gram stain.
* By nutritional requirements.

1. **Classification of bacteria according shape**.

On the basis of shape, bacteria are classified under- cocci, bacilli, and spirals.

1. **Cocci**

Are round (spherical)

The term cocci is derived from the word ‘kakkos,’ meaning berry,

depending on the arrangement on the arrangement of the individual organisms.

Types of cocci

* Staphylococci – occur in clumps/clusters like bunches of grapes.
* Streptococci – are arranged in chains.
* Diplococci – forming pairs.

Tetrads and Sarcinas – arranged in groups of four and cubical packet of eight cells respectively.

1. **Bacilli**

They are cylindrical or Rod shaped organisms.

The term ‘bacilli’ originates from the word baculus meaning Rods.

Types of bacilli

* Coccobacilli – e.g. Brucella.
* Corynebacteria – in which the Chinese letter arrangement is seen.
* Vibrio – Are comma shaped, curved rods and derive the name from their characteristic vibratory movement.

1. **Spirals -** spirochaetes.

‘Speria’ means coil, ‘chaetes’ means hair.

They are relatively longer, thin, flexible organisms having several coils.

1. **Classification of bacteria according to Gram Stain**.

Bacteria are also classified according to the staining method, either as

-Gram positive, or

-Gram negative.

This was first discovered by Gram in 1884. It is used to study the morphologic appearance of bacteria.

-Gram negative cells have a cell membrane, a thin layer of peptidoglycan and an outer membrane made up of proteins, phospholipids and lipopolysaccharides.

(Gram stained red.)

-Gram positive cells have a cell membrane and a very thick layer of peptidoglycan but no outer membrane.

Bacteria are named using the binomial system of Taxonomic Classification. The information given usually describes an organism, identifies a habitat and Honors a scientist or researcher.

**Gram positive cocci**

Include:

* Staphylococci – cause simple to deep lesions, osteomyelitis, septicaemia, urinary tract infection.
* Streptococci – cause tonsillitis, pharyngitis, otitis media, acute rheumatism.
* Enterococci –

**Gram positive bacilli**

Include :

a) - Clostridium

C. dificile – causes severe Gastro Enteritis.

C. tetani – causes Tetanus.

C. perfringens – causes Gas Gangrene.

C. botulinum – causes food poisoning.

b) - Bacillus anthrasis – causes Anthrax.

c) – Corynebacterium diphtheria – causes Diphtheria.

**Gram negative cocci**

Include:

1. Neisseria Meningitis – responsible for causing Meningococcal Meningitis.
2. Neisseria ghonorrhoeae – causes Gonorrhoea (a sexually transmissible infection).

**Gram negative bacilli**

Escherichia coli.

Klebsiella pneumoniae.

Salmonella typhi – typhoid fever.

Shigella – bacillary dysentery.

Mycobacterium tuberculosis and leprosy.

Bordetella Pertusis – whooping cough.

Yersinia pestis – Plague.

Vibrio cholerae – cholera.

Helicobacter pylori.

Haemophilus influenza – among others.

**Classification of protozoa**

- Eukaryotic organism

- Are found in soil and water.

- Are the leading cause of mortality in developing world.

Protozoa are small, single celled animals. They belong to the animal kingdom four classes of protozoa include

* Class: Rhizopoda
* Class: Mastigophora
* Class: Ciliata
* Class: Sporozoa

Class: Rhizopoda

Include Entamoeba histolytica, which causes amoeba dysentery.

These organism move by means of protoplasmic projections called pseudopodia.

Class Mastiogophora

Example include trichomonas vaginalis which causes vaginal itching and discharges

They move by means of undulating membranes or flagella.

Class: ciliate

They move beating of number of cilia. Examples include balantidium coli which causes balantidium dysentery.

Class: Sporozoa.

Are non-motile organisms. They live parasitically within the cell of the host. They include

Host. They include plasmodium group which cause malaria

**FUNGI**

* Have cell wall that contains chitin - a polysaccharide.
* Are complex large organism.
* They are divided into yeast and moulds. Yeast are single celled. They reproduce by budding, while moulds are large multicellular organisms. They produce spores.

The study of Fungi is referred to as mycology.

There are more than 50,000 species of fungi. Most of these species are beneficial to man through breaking down and recycling organic matter to produce medicine, food and spirits.

All fungi are pathogenic are exogenous and their natural habitats being water, soil and organic debris. Many fungal diseases are opportunistic. The fungi can also cause systemic infections.

Human –fungus interactions

**Beneficial effects of Fungi**.

Decomposition-nutrient of carbon recycling

Biosynthetic factories-Production of drugs, antibiotics, alcohol, acids, food, fermented products, mushrooms.

Model organisms for biochemical and genetic studies.

**Harmful Effects of Fungi.**

Destruction of food, paper &cloth.

Animal & human diseases, including allergies . Plant diseases

**Saprophytic fungi**

Derive food from dead decaying organic matter. Secret digestive enzymes into dead plant of animal matter which decompose this matter to absorbable nutrients for the fungi &other living organisms.

**Parasitic fungi**

Are harmful. Derive their nutrients from the horst.

**Beneficial Fungi**

Mushrooms. Food production e.g. cheese ,beer, wine) Medicine productions The immunosuppressant drug cyclosporine

**Example of fungi**

Microsporidia. Chytridiomycota Blastocladiomycota Zoopagomycotina Glomeromycota Ascomycota

**Diseases Caused by fungi**

Candidiasis. Tineacapitis/Corporis/pedis Aspergillosis (respiratory disease) Blastomycosis-lung/skin disease. Pneumocystis-pneumonia (pcp) Histoplasmosis (inhaling spores found in droppings of birds &bats .mild respiratory signs & symptoms.

**Differences between viruses and bacteria**

Viruses are small in size than bacteria

Viruses can grow only in living cells and tissue

The virus resist the action of antibiotics and other agents that destroy bacteria.

The virus have reproductive process that are different from the simple binary fission of the bacteria.

Virus particle contains only one kind of nucleic acid, thus DNA or RNA but not both

The virus is covered by a protein coat called capsid unlike the bacterial cell wall

The viruses consist in the their simplest form of an outer coat of protein and an inner core of nucleic acid which is either DNA or RNA

**SUMMARY**

Micro-organisms classification in summary can be taken in many forms. It can be classification by:

1) Cell structure.

2) Cell shape (morphology).

3) Gram stain.

4) Growth pattern.

5) Oxygen requirements.

By cell structure

Prokaryotes.

Eukaryotes.

By cell shape\_(Morphology ).

Spheres-Cocci (round).

Rods\_bacilli(rod-shaped).

Spirals-spirilla-spyrochetes.(spiral-shaped).

Fungi have a rounded body called spores.

Virus –vary in shapes and sizes.

By Gram stain-Gram positive or cell appear blue

Gram negative cells appear red.

CLASSIFICATION BY GROWTH PATTERN.

Number of cells that have increased.

CELL DIVISION BY BINARY FISSION.

A transverse septum is formed that separates from the original cell into two independent cells.Yeast cells dive by budding,i.e, a small new cell developes on the surface of an existing cell.

By Oxygen requirements.

Aerobic-Live and thrive only in the presence of oxygen.

Anaerobic-Can live and thrive in the absence of free oxygen. Found in body cavities or wounds.

Facultative- growth both in aerobic and anaerobic conditions.

Micro aerophilic- survive in low or no oxygen.

**OTHER METHODS OF CLASSIFICATION.**

-Whether they cause disease, pathogens.

-By optimal temperature for growth,(Thermophillic 50-70oc, Mesophillic 20-45oc, Psycrophillic 10-20oc).

-Ability to form endospores.

-Acid tolerance-acidophillic.

-Salt tolerance-halophillic.

-Dry conditions-xerophillic.

-Nutrient requirements-oligotrophic, eutrophic

**CLINICAL IMPORTANCE OF MICROORGANISMS**

* Microbes are involved in processes like breaking down of food we eat (metabolism) and help keeping us healthy by fighting off harmful intruders. i.e., help in diseases prevention.
* Help in production of medicine ‘antibiotics and vaccines’. Every year antibiotics and vaccines saves millions of lives around the world.

Antibiotics are substances that kill certain bacteria or stop there growth.

Vaccination activate our immune system against harmful microorganisms. The dead weakened or particles of microbes are introduced into our systems, usually through an injection. As a result, the immune system build up antibodies that protect us from specific microbial disease.

* Penicillin from fungi
* Tetracycline, erythromycin, streptomycin, rifampicin, from Actinomycetes (bacteria).
* Bacitracin of polymyxin from Bacilles and Paenibacillus species.

- Treatment of cancer -immunotherapy- use of specific type of microorganisms in treatment

- This stimulates the immune system to selectively eliminate the cancer cells.

* Nearly 2000 different microbes cause diseases.
* 10 Billion infections occur yearly world
* 10 million deaths result from wide infections each year globally

-Cause diseases **–** Microorganisms can spoil food supplies, contaminate drinking water, initiate allergic responses, contaminate the environment, cause infectious diseases to human beings

* Medical diagnosis-In analysis of microorganism. The current trend in improved pathogens separation and detection methods. The bio-samples containing microbes (blood, urine, lymph stool, CSF) are analyzed.
* For teaching and reserve purposes - Microbial physiology is aimed at studying microbial growth, microbial metabolism and microbial cell structure.
* In microbial genetics- The study of how genes are organized and regulated in microbes in relation to their cellular function.

**Why study microbiology**

* Microbes lives in us, on us and near everywhere around us.
* They have a major impact on our health and environment
* They play an important role in many of the foods we eat and the medicine we take.
* Microorganism are needed for decomposition of dead organisms of waste products

Recycle nutrients back into the environment –Nitrates, phosphates (sewage treatment plants called saprophytes.

* Microbes produce various food products cheese, yoghurt, vinegar, bread, beer, wine etc.
* They are also used to produce antibiotics such as penicillin from Mold (fungi) discovered in 1928 by Alexander Fleming.
* Bacteria synthesis chemicals that our bodies needs but it cannot synthesize e.g E.coli.in synthesis of vitamin B for metabolism of vitamin K for blood clotting .(Escherichia coli- Dr. Escherich. Coli is from the word colon (intestine).

**Importance of microbiology**

* Has role in investigation, diagnosis, and treatment of patients suffering from infectious diseases.
* In Infection Prevention and Control Programs.
* In public health and communicable diseases prevention and epidemiology.
* Medical Research .
* The scientific and administrative direction of a diagnostic microbiology laboratory

**Beneficial effects of microorganisms -**

* Recycling of vital elements
* Sewage treatment
* Biomedication
* Insect pest control
* Biotechnology.

**-Recycling of vital elements**

* Bacteria play a vital role returning CO2 to the atmosphere when they decompose organic waste .
* Algae and cyanobacteria recycle Oxygen to the air during photosynthesis.
* Sulphur and phosphorus are stored in the earth’s crust - Microorganisms convert these elements into forms that can be used by plant and animals.

**-Sewage treatment**

* In Sewage- microbes are used in waste decomposition and treatment . Treatment involves both physical and chemical treatment with actions of beneficial microbes.
* The liquid and organic materials are converted into byproducts (CO2, Nitrates, Phosphates, Sulfates).

**-Biomedication**

* Use of microbes to clean up pollutants of toxic wastes.
* Some bacteria turns pollutants into energy sources (biogas Rx plants).
* Other bacteria produce enzymes which break down toxins to less harmful substances.

**- Insect and pest control**

Bacteria is put in dusting powder that is applied to crops which are eaten by insects. The powder produces toxic protein crystals in GIT of insects.e.g. Bacillus species for control of corn borers, cabbage worms and tobacco budworms.

**Biotechnology**

Def: - is technology that uses living organisms (or parts of organisms) to make or modify products to improve plants/animal, or to develop microbes for specific uses.

Microbes can be manipulated to produce enzymes and proteins they normally wouldn’t produce (e.g. insulin, human growth hormone, interferon).

Microbes used in the production of foods and chemicals i.e.

* Acidophilus –cocoa, cheese, soy sauce, green olives.
* Yeast- beer, wine, whisky.
* Production of chemicals – e.g. acetic acid, citric acid, acetone, ethanol.

**DIVISION OF MICROBIOLOGY**

* Bacteriology- Study of bacteria.
* Mycology –study of fungi
* Virology-study of viruses
* Immunology-study of a hosts specific defenses to a pathogen.
* Phycology-study of algae
* Parasitological-study of parasites
* Protozology-study of protozoa

**BRANCHES OF STUDY WITHIN MICROBIOLOGY**

Microbiology is studied under the following branches:-

1. Public health microbiology-which includes bacteriology, virology, parasitology, protozology, phycology and mycology.
2. Immunology.
3. Food dairy and aquatic microbiology
4. Biotechnology
5. Genetic engineering

**NORMAL FLORA**

* Human beings are also covered with microbes (bacteria, some parasites, fungi).
* They can be resident or transient.
* They are present on the skin, upper respiratory tract, overall cavity, intestines (esp. colon), reproductive tract.

Normal flora are absent in almost all internal organs i.e. peritoneum, lower respiratory tract, cerebrospinal fluid, pericardium, muscle tissue, blood and tissue fluid, meninges.

**WHEN CAN MICROOGANISMS CAUSE DISEASES?**

* When pathogens are introduced to the body.
* When a person is immunocompromised
* When normal flora is introduced to an area of the body where they are not normally found

**Sources of microorganisms**

**Reservoirs –**A reservoir is where microorganisms live, find there nutrients moisture and environmental conditions necessary for its growth.

Examples of microbial reservoir include:-

**Environment**- Soil eg.for tetanus.

Water for typhoid

Air for pneumonia, tuberculosis.

**Animals** – Cattle for anthrax.

Poultry for salmonella.

**Humans**- Respiratory tract

Gastrointestinal Tract for Rotavirus, gastro-enteritics.

Patients themselves are a source of microorganisms, through their body fluids, wounds and skin lesions.

**Invasive in instruments-** Invasive equipment are also sources of microorganisms if not properly decontaminated.

**MODES OF TRANSMISSION OF INFECTION**

The 5(five) main modes of transmission

1. Contact
2. Droplet
3. Air
4. Common vehicle
5. Vector

**(II)** **Contact Transmission**

Contact transmission is divided into two sub groups:

(a)Direct contact transmission

(b)Indirect contact transmission

-Direct contact transmission, these is direct body to body contact and physical transfer of microorganisms between an infected person and the susceptible host.

Forms of direct contact transmission include sexual intercourse, performing of procedures that involve direct personal contact such as for the health workers activities with patients body fluid/blood with unprotected.

-Indirect Contact transmission involves contact between a susceptible host and a contaminated intermediate object, usually inanimate (non-living) such as contaminated instruments.

For example in cholera, objects such as utensils, beddings .Contaminated and unwashed hands, gloves that are not changed between patients.

**(II) Droplet Transmission**

The source person releases the droplets through coughing; sneezing; talking and during some procedure such as suction.

Droplet transmission occurs when droplets are propelled a short distance through the air and deposited on the susceptible host conjunctiva, nasal cavity or mouth.

For transmission to occur, the susceptible host and the source must be within one meter (3 feet) from one another.

**(III) Airborne Transmission**

This occurs by dissemination of airborne droplet nuclei (small-particle residue) of evaporated droplets that contain microorganism and remains suspended in the air for long periods of time or dust particles that contain the infectious agent.

Airborne microorganisms can be dispersed widely by air currents and can be inhaled by susceptible host within the same room or some distance from the the source patient depending on the environmental factors.

Microorganisms transmitted by airborne transmission include mycobacterium tuberculosis, rubella among others.

Control of airborne transmission is the most difficult because it requires control of airflow through special ventilation system

**(IV) Common vehicle Transmission**

Common vehicle transmission refers to the transmission of infection to multiple hosts by contaminated items (vehicle).

This mode can result in explosive outbreaks.

Vehicles for transmission include:

* Food-can transmit Salmonellosis
* Water-can transmit Dysentery
* Blood-can transmit Hepatitis C and HIV
* Equipment and devices

**(V). Vector-Borne transmission**

Vectors such as mosquitoes, flies, fleas, rats etc. are involved in the transmission of microorganisms. This transmission can be prevented by control of vectors.

**THE CONCEPT OF INFECTION**

**Learning Objectives**

By the end of the session learners will be able to:

-Describe the stages of development of an infection.

-Define various terms related to infection.

-Describe the phases an infectious disease.

**The concept of infection**

**Infection-**is invasion by and multiplication of pathogenic microorganisms in a body. The invasion may produce tissue injury and progress to disease through toxins or cellular mechanism.

**Stages in development of infection**

1. Acquisition
2. Adhesion to the host cell
3. Penetration of cells
4. Multiplication in tissues
5. Damage to tissues
6. Spread to other tissues
7. Resolution or death
8. **Acquisition ,Adhesion and Penetration**

The microorganisms adhere to the cell and then penetrate it. The microbe uses various methods to achieve this:-

-use of special hairs on their surfaces

-use of Fimbriae (thin appendages used in attachment) or Pilli(thin appendages used in genetic exchange)

-secretion of sticky substances e.g. dextran

-By production of slim (e.g. biofilm)

**2. Multiplication in the host**

After penetration, the microbe multiplies in the host cell and overpowers the host’s defenses so as to cause disease.

The virus has the ability to switch the metabolism of the cell to the production of viral components.

**3. Tissue Damage**

Pathogenic microorganisms cause disease by damaging the host’s tissues. Damage occurs due to release of enzymes or substances that destroy cells or tissues in the local area.

**4. Spread to other tissues**

Some infections remain at the site of invasion, causing symptoms related to invasion of epithelial tissue at the particular site (e.g. shigella invadesthe GIT)

Some microorganisms spread once they have established in a particular site. (E.g. Salmonella typhi established itself in the GIT then spreads through blood and causes fever)

**5. Resolution or Death**

The function of the cell may be disrupted OR the cell may be destroyed when new microbes are released.

The effects depend on the particular microbe and the location of the infected cells (e.g. polio virus infects motor neuron cell & shuts down protein synthesis causing the death of neurons & paralysis of the muscles that they innervate)

The infection may resolve (death of the pathogen) due to;

-Improved host defenses.

-Antibiotic therapy.

**Definition of Terms**

**-Pathogens-**are microbial species that invade and damage tissue to cause disease

**-Pathogenicity-**Is the capacity of microorganism to cause disease

-Some microorganisms cause a single disease (e.g. dostridium tetanus-tetanus)

-Others cause a range of diseases:eg. Staphylococcus Auer can cause: skin infections, wound infection, pneumonia and Osteomyelitis.

Some pathogen cause infections that becomes severe in debilitated people

Opportunistic pathogens cause disease in individuals with impaired defenses (e.g. pneumocystis carinii, a normal flora in healthy people but causes PCP in immune-compromised people)

**Primary Infection**

An infection that develops in an otherwise healthy individual

**Secondary Infection**

An infection that develops in an individual who is already infected with a different pathogen

**Acute Infection**

An infection characterized by sudden onset, rapid progression, and often severe symptoms.

**Chronic Infection**

An infection characterized by delayed onset and slow progression

**Localized Infection**

Is an infection that is stricted to a specific location or region within the body of the host.

**Systemic Infection**

Is an infection that has spread to several regions or areas in the body of the host

**Clinical Infection**

An infection with obvious observable or detectable symptoms

**Subclinical Infection**

An infection with few or no obvious symptom

**NOSOCOMIAL INFECTIONS**

Nosocomial infections-are the Hospital Acquired Infections.(HAIS)

-Is an infection which was neither present nor incubating at the time of admission

-Is an infection that appears between 48 hours & 4 days following admission to a hospital or other health care facility

-36% of these infections are preventable through the adherence to strict guidelines by health care workers when caring for patients.

-Occurs in most modern hospitals.

**HAIs-common bacteria**

* Staphylococa-wound,respiratory,GIT infections
* Escherichia E coli-(E.coli)-wound & UTIs
* Salmonella-food poisoning
* Streptococci-wound, throat & UTIs
* Proteus-wound & UTIs

**HAIs-common viruses**

* Hepatitis A-Infectious hepatitis
* Hepatitis B-serum hepatitis
* Human immune deficiency virus (HIV)-acquire immunodeficiency

**Effects of Nosocomial Infections**

**To the patient**

* Prolonged hospital cost
* Increased hospital cost
* Psychological and emotional trauma
* Complications(MRSA/MDRO/Death

**To the Hospital**

* Economic impact.(staff absence from work due to infection)
* Demotivated staff due to recurrent infection
* Reduced bed availability
* Bad publicity & litigation

**PHASES OF INFECTIOUS DISEASE**

* **Incubation Period**-refers to the time between infection and appearance of signs and symptoms
* **The prodromal phase-**a stage in which the pathogens begin to invade tissues, marked by early non-specific symptoms
* **The invasive phase-**when the individual begins to experience the typical signs and symptoms of the disease
* **The decline phase-**is when the host defenses overcome pathogens ;signs and symptoms subside
* **The convalescence period-**the stage during which tissue damage is repaired and the patient regains strength. Recovering individuals may transmit pathogens to others.

**IMMUNIOLOGY**

**Immunology-** Is the study of body defenses against pathogenic organisms.

**Immunity-** Is the body’s specific protection response to a foreign agent i.e. the body defense against inversion.

The immune system is programmed to eliminate foreign substances such as microbes, toxins cellular mutations when it operate effectively, it protects against a wide variety of infectious agents, as well as from abnormal body cell. When it fails, malfunctions, or disabled diseases like cancer, HIV may arise.

The immune response occurs at genetics of cellular levels.

The specialized cells and proteins are designed to identify and destroy foreign invaders. The immune system is able to differentiate between material that is normal component of the body ‘self’ and material that is not native to the body. (non-self).

**The major components of the immune system** include the central and the peripheral organs, tissues and cells.

-Bonne marrow for production of WBCs involved in immunity (e.g. B and T lymphocytes, Neutrophils, monocytes etc.).

-Lymphoid tissue including the spleen, the lymph and the lymph nodes (lymph nodes are centers of immune cells proliferation.)

The immune system works around the clock in thousands of different ways. We notice our immune system when it fails for some reason or when something that has a side effect we can see or feel occurs.eg.

* Sneezing following dust or pollen grains or wool.
* Anaphylactic reaction following bee stings.
* Organs /tissues transplant rejection.
* Enlargement of lymph nodes
* Formation of pus on an infected toe.
* Blood reaction in transfusion.

**HISTORICAL BACKGROUND OF IMMUNOLOGY**

1. 1890, Emil Von Behring and Shibasaburo Kitasato discovered that Serum of vaccinated individuals contained “antibodies” that bound specifically to the relevant pathogen. (Specific defense ).
2. The relevance of the above idea was reinforced by Judes Bordet’s discovery of “complement “in 1899.
3. Metchnikoff discovered that many microorganisms could be engulfed and digested by phagocyte cells called “macrophages”, as a non-specific defense.
4. 1960, James Gowans identified lymphocytes as cells responsible for generating immune responses.

5)Edward James (1878) discovered that inoculation with cowpox or vaccinia induced protection against small pox –a process called vaccination.

**NB . Vaccination** is the inoculation of healthy individuals with attenuated (weakened) pathogens to induce immunity.

This led the WHO to declare eradication of small pox in 1979.

* 1. In 1880s, Louise Pasteur devised a vaccine against cholera in children, and rabies vaccine against rabies in a boy.
  2. In the 19thCentuary, Robert Koch proved that infectious disease are caused by pathogenic micro-organisms, each one responsible for a particular disease.

**TYPES OF IMMUNITY/ARMS OF THE IMMUNE SYSTEMS.**

There are two general types of immune system:-

1. Natural /Innate /Non-specific Immunity.
2. Acquired/Adaptive/Specific Immunity.

**Natural immunity**-it is the first line of host defense.

-It provides a broad defense for infection.

-It is present at birth.

-Provides non-specific defense.

-It responds in the similar way to foreign invaders from one encounter to the next, regardless of the number of times the invader is encountered.

-Some of this immunity is inherited.

-It has no memory .It does not remember prior contact with an antigen.

-The natural immune system response to pathogens is by:-

1. Elimination e.g. by macrophages, Natural killer cells .
2. Promotion of development of acquired immunity.

**RESPONSES IN NATURAL IMMUNITY**

|  |
| --- |
|  |
|  |

**COMPONENTS OF NATURAL IMMUNITY**

|  |
| --- |
|  |

**1ST LINE 2ND LINE**

(I). Mechanical /physical (I).Cells - Natural killer cells

(ii) Chemical barriers. . - Phagocytes.

(iii). Normal Flora (ii.) Soluble factors

(iii).Inflammatory barriers.

Responses in Natural Immunity.

**Components of Innate Immunity**

**(A). FIRST LINE OF NATURAL IMMUNITY.**

1. Mechanical barriers.
2. Chemical and biochemical barriers
3. Normal Flora.

**1). Mechanical barriers /Physical barriers.**

* Intact skin: -Provides mechanical barriers to pathogen.

-Provides bacterial secretion (epidemis).

* Mucous membranes-Mechanical barriers to pathogen
* Mucous secretions-Traps micro-organisms in the GIT and respiratory tract.
* Cilia- The hairs that propel debris-loaded mucus away from lower Respiratory tract.
* Tears and blinking reflex.

**2). Chemical and biochemical barriers**

* Gastric juice (acid)-contains HCL acid and pepsin(proteins digestive enzymes).
* Acid PH in the adult Vagina –inhibit bacterial and fungal growth.
* Sweat and sebaceous secretions.
* Hydrolytic enzymes in the saliva.
* Proteolytic enzyme in small intestines.
* Lysozyme in tears.

**3). Normal bacteria flora**

Competition with pathogens for essential nutrients.

Production of inhibitory substances.

**(B). SECOND LINE OF NATURAL IMMUNITY.**

It is about 1) Cells-Natural killer cells.

-Phagocytes.

2). Soluble factors.

3). Inflammatory barriers.

**I). Cells**

**Natural killer cells** –Are lymphocytes.

Function-Cytotoxic for- viral infected cells, Bacterial, fungal, parasitic infection.

**Phagocytes –**Are specializedcells for capture, ingestion and destruction of invading microorganisms. They include Neutrophils, Macrophages e.g.

-Monocytes in blood

-Histocytes in connective tissue.

-Fixed reticulo-endothelial cells in the liver, spleen, lymph.

**II). Soluble factors**

* -Acute phase proteins e.g. Fibrin.
* Components (proteins in serum, body fluids).
* Interferons-proteins against viral infections
* Beta lysine-antibacterial proteins from platelets.
* Lysozyme-Hydrolyze cell wall etc.,

**III). Inflammatory Barriers/Response.**

Inflammation is caused by tissue injury or invading organism.

Inflammatory response is a result of chemical mediators e.g. Histamines, Bradykinin, Prostaglandins, cytokines.

These chemical mediators lead to:-

* Minimizing blood loss
* Walling off the invading organisms
* Activation of phagocytes.
* Promotion of formation of fibrous scar tissue.
* Regeneration of injured tissue.

**IMMUNE REGULATION**

A successful immune response eliminates the responsible antigen.

If the immune response fails to clear an antigen, the host is considered to be immunodeficient (immunocompromised).

If the immune response is misdirected, allergies, asthma or auto-immune disease results thus the immune system recognize one’s own cells or tissues as ‘foreign’ rather than as self, and attack them.

Therefore, there must be regulatory mechanisms in place to suppress or halt the immune response. The regulation is achieved by the production of cytokines and transformation of growth factor that inhibits macrophage activation.

Natural immunity could effectively combat infections. However, many pathogenic-microbes have evolved that resist natural immunity.

Therefore, Acquired Immunity is necessary to defend against these resistant antigens.

IMPORTANCE OF IMMUNOLOGY

* Immunotherapeutic vaccines in disease control.
* Clinical transplantation-organ transplant in life saving.
* Anthropological studies to determine migration patterns.
* Paternity identity & criminal identification (use of DNA profiles)
* Immunodiagnostics in the treatment and management of patients including underlying mechanisms in the disease process.
* Evolutionary trends from innate to adaptive immunity.
* In clinical, dentistry, pharmacy & basic sciences.

BRANCHES OF IMMUNOLOGY

1. Basic Immunology
2. Immunochemistry
3. Cellular (cells) and Molecular (Molecule) Immunology.
4. Clinical Immunology

-Immunodeficiency; Allergic and Hypersensitivity, Autoimmune Disease; Reproductive immunology.

-Immunohematology; tumor Immunology and clinical Transplantation.

**ACQUIRED - (ADAPTIVE /SPECIFIC IMMUNITY)**

This immunity is acquired during the lifetime of an individual.

It develops as a result of prior exposure to an antigen through an immunization (vaccination) or by contracting the disease.

The immune response (immunity) is generated (produced) by the body weeks or months after the exposure to the disease or vaccine, the body produces an immune response for sufficient defense and re-exposure protection.

Acquired immunity differs from the initiate immunity in that it does not present at birth but it is acquired during lifetime. It is specific for a single type of microorganism. It also has memory of the previous exposures to disease or immunization.

Acquired immunity may be;

-Active

-Passive

**Active immunity**

It is the body resistance developed as a result of antigenic stimulus.

Active immunity may be;

- Natural active immunity

Is acquired after an infection or recovery from a disease

- Artificial active immunity

It may be acquired by vaccination. (Inoculation) e.g. BCG, Measles vaccine which are the bacteria, viruses or their products introduced into the human body to include body immunity.

This immunity lasts many years or even lifetime

**Passive Immunity**

Here, the subject (individual) is immunized by prepared antibodies & body cells do not take any active part in the production of immunity.

Types of passive Immunity

-Natural passive immunity

This involves transmission of antibodies from mother to fetus during intra-uterine life. The antibodies are conveyed to the fetus through the placenta, breast milk (colostrum of the mother) during first few months of life

Breastfed infants resist establishment of entero viruses in the alimentary canal.

These antibodies last for few weeks and protect infants from diphtheria, tetanus, measles, and mumps etc.

-Artificial passive immunity

Immunization here is produced by injection, and is passive. Antibodies remain effective for 10 days only.Serum of animals that have been immunized is injected to produce immunity.

**HERD IMMUNITY**

There is overall level of immunity in the community. It is relevant in the control of epidemic diseases. When herd immunity is low epidemics are likely to occur on introduction of suitable pathogens.

The term herd immunity means large proportions of individuals in a community are immune to pathogen.

**Difference between active & passive immunity**

|  |  |  |
| --- | --- | --- |
| NO. | ACTIVE IMMUNITY | PASSIVE IMMUNITY |
| 1. | Produced actively by hosts immune system | Received passively by the host. No participation of host’s immune system. |
| 2. | Induced by infection or by injection of microbe (immune) | Conferred by introduction of antibody vaccine (ready-made) |
| 3. | Provides durable immunity effective antibody /protein) | Provides temporary immunity with less effective protection. |
| 4. | Immunity takes weeks or months to develop | Immunity is effective immediately. |
| 5. | Immunological memory is present –ready for next exposures of antigens | Immunological memory is absent. |
| 6. | Not applicable to immune-deficient hosts. | Application to immunodeficient hosts. |
| 7. | Used as a prophylaxis to increase body resistance. | Used for treatment of acute infection. |
| 8. | Both the cell mediated & humoral immunity take part (cells involved in immunity plus antibodies) | Exclusively humoral immunity is involved. (antibodies only involved) |
| 9. | No inheritance of immunity | May be inherited from mother. |

In contrast to the rapid but not specify natural immune response, the acquired immunity relies on the recognition of specific foreign antigen.

Both active and passive acquired immunity involve humoral and cellular (Cell mediated) immune responses.

ACQUIRED (ADAPTIVE) IMMUNE RESPONSES

Is a broadly divided into two mechanisms:-

Cell-medicated response-This involves T-Cell activation.

Mechanisms involving B-cell maturation & production of antibodies.

Bone Marrow

|  |
| --- |
| Lymphoblast |

|  |
| --- |
| Thymus |

|  |
| --- |
| Bone marrow maturation |

|  |
| --- |
| T-lymphocyte maturation |

|  |
| --- |
| Regulatory  T-Cells |

|  |
| --- |
| B-Lymphocytes |

|  |
| --- |
| Effect T-Cells |

|  |
| --- |
| Memory Cells |

|  |
| --- |
| Plasma |

|  |
| --- |
| Helper Cells |

|  |
| --- |
| Cytotoxic Cells |

|  |
| --- |
| Suppressor Cells |

|  |
| --- |
| Antibodies |

HUMORAL RESPONSE CELLULAR (Cell mediate Response)

ACQUIRED /ADAPTIVE IMMUNITY’S RESPONSE TO INVASION

When body is invaded or attacked by bacteria, viruses or other pathogens, it has three means of defense.

1. The phagocyte immune response (1st line)
2. The humoral (antibody) immune response
3. The Cellular immune response (3rd line)

**1st line: Phagocytic Immune Response**

Primarily involves white blood cells (WBCs)-i.e. Granulocytes & macrophages. They have the ability to ingest foreign particles & destroy the invading agent.

They also remove body’s own dying or dead cells of defense.

**2nd line: Humoral Immune Response (Antibody response)**It begins with B-lymphocytes. These lymphocytes have the ability to transform themselves into plasma cells that manufacture antibodies.

These antibodies are highly specific proteins that are transported in the blood stream and attempt to disable the invaders.

**3rd line: Cellular Immune Response.**

It involves the T-lymphocytes. These lymphocytes can turn into special cytotoxic (or killer) t-cells that can attack the pathogens. The invading or attacking organism that is responsible for stimulating the antibody production is called an antigen (or an immunogen). Once produced, an antibody is released into the blood stream and carried to the attacking organism. There it combines with the antigen, binding with it like an interlocking well.

**HUMORAL IMMUNE RESPONSE**

Characterized by production of Antibodies by the B- lymphocytes in response to a specific antigen though ultimately The B- lymphocyte produces antibodies, both the of natural immunity and the special T- cells lymphocytes of cellular immunity are involved in recognizing foreign substances and producing antibodies.

**Antigen recognition**

B-lymphocytes recognize invading antigens in more than one way and respond in several ways as well. Additionally, The B lymphocytes appear to respond to some antigens by triggering antibodies formation directly. In response to other antigens, however, they need assistance of T cells to trigger antibody formation.

T cells [or T-lymphocytes ], battle for surveillance system, disappear throughout the body, recycle through the general circulation and lymphatic systems. With the assistance of MQS, the T lymphocytes pick up the foreign invader. The T- lymphocytes pick up the Antigenic message, or “blueprint” of the antigen and returns to the nearest lymph Node with that message.

**production of B lymphocytes**

B lymphocytes stored in the lymph Nodes are subdivided into thousands of clones, each responsive to a single group of antigens having almost identical characteristics. When the antigenic messages carried back to the lymph nod, specific clones of the B lymphocytes are stimulated to enlarge, divide, proliferate, and differentiate into plasma Sims capable of producing specific antibodies to the antigen.

other b lymphocytes differentiate into B lymphocyte clones with the memory for the antigen. This memory cells are Responsible for the more exaggerated and rapid immune response in a person who repeatedly exposed to the Same Antigen.

**Role of antibodies**

Large proteins called immunoglobulins because they are found in the globulin fraction of plasma proteins.

All immunoglobulins are glycoproteins

Agent body has two subunits, each of which contains a late under heavy peptide chain.

The subunits are held together by disulfide bonds.

Each subunit has a portion that serves as a binding site for specific antigen referred to us fab Fragment. This site provides the “ lock” portion that is highly specific for an antigen.

An additional portion, known as the FC fragment, allows the antibody molecule to take part in the compliment system.

The antibody molecule has at least two combining sites, or fab Fragments.

ONE AB can cross link between AG causing them to bind or clump together that is agglutination.

Agglutination, helps to clear the body of invading organisms by facilitating phagocytosis.

Some antibodies assist in removing ag though opsonization. In this process, the antigen antibody molecule is coated with a strict substance that also facilitates phagocytosis.

**Types of immunoglobulins**

Five different types

IGA, igd, IGE, IgG and I GM

Classification is based on chemical structure and biologic role of the individual Ig.

The Table below summarizes major characteristics

Antibodies also promote the release of vasoactive Substances, Such as histamine and slowReacting substance, two of the chemical mediators of the inflammatory response.

Antibodies do not function in isolation but rather mobilize at the components of the immune system to defend against the invader.their usual role is to focus components of the natural immune system to the invader. This includes activation of the complement meant system and activation of phagocytosis.

**antigen antibody binding**

the portion of the antigen were involved in binding with the antibody is referred to As antigenic determinant. The binding of fab fragments [antibody binding site ] to the antigenic determinant can be likened to a lock and key situation.

The most efficient immunologic response occur when antibody and antigen fit Exactly.

Perfect can occur in an antibody that was produced in response to a different antigen. This phenomenon known as crossreactivity. For example, in acute rheumatic fever, the antibody produced against streptococcus pyogenes In the upper respiratory tract Make cross react with the patients heart tissue, leading to heart valve Damage.

**Role of T lycophytes**

Two major categories of effector T cells are

Helper T cells and cychotoxic T . These cells participate in destroying foreign organisms

Other T cells include

Suppressor T cells and memory T cells.

T cells interact closely with B cells, indicating that human align cellular in immune response act in concert.

**Cellular immune response**

T lymphocytes [or T cells] Are primarily responsible for cellular immunity

Stem cells continuously migrate from the bone marrow to the thymus gland, where they develop into T cells. T cells continue to develop in thymus gland, despite partial degeneration of the thymus gland that in puberty.

Several types of T cells exist, each with designated roles in the defense against bacteria, Viruses, fungi, parasites, and malignant cells. T cells attack foreign invaders directly.

Cellular reactions are initiated by the binding of antigen with an antigen receptor located on the surface of a T cell. This may occur with or without the assistance of macrophages.

The T cells then carry the antigenic message or blueprint, with the lymph nodes, for the production of other T cells is stimulated. Some T cells remain in the in the lymph node, retain a memory for the antigen. Other T cells migrate from lymph nodes into the general circulatory system and ultimately to the tissues, where they remain until they come into contact with their respective antigen or die.

Helper T cells are activated upon recognition of antigens and stimulate the rest of immune system. When activated helper T cells secret cytokines The trust and activate bissells, cytotoxic T cells, natural killer cells, macrophages and other cells of the immune system.

Separate subpopulation of helper T cells produce different types of cytokines and determined whether the immune response will be production of antibodies or cell mediated immune response. Helper T cells produce lymphokines, One category of cytokines. This lymphokines activate other T cells [ Interleukin- 2 [ I L – 2 ] ], natural and cytotoxic T cells [ interferon gamma ] former and other inflammatory cells [ tumor necrosis factor ]. Helper T cells produce I L – 4 and I L – 5, lymphokines That activate the cells to grow and differentiate.

cytotoxic T cells [ killer T cells ] attack the antigen directly by altering the cell membrane and causing cell lysis [ disintegration ] and releasing cytolytic enzymes and cytokines. Lymphokines Can recruit, activate, and regulate other lymphocytes and WBCS. These cells then assists in destroying an invading Organism. Suppressor T cells, decreases b cells production thereby keeping the immune response at a level that is compatible with health.

Memory cells are responsible for recognizing antigen from previous exposure and mounting an immune response.

Lymphocytes originate from stem cells in the bone marrow

B lymphocytes mature in the bone marrow therefore entering bloodstream

Whereas T lymphocytes Mature in the thymus, Where they also differentiate into cells with various functions.

**Humoral versus cellular response**

Compare and contrast humoral I’m cellular immunity of the adaptive immunity

**the complement system**

A group of More than 30 plasma proteins which comprise the primary soluble components of innate immunity ; circulating in inactive form.

Rapidly activated in response to infection, without induction or recall of adaptive immunity.

However, the presence of adaptive immunity response, complement proteins interact with both it’s soluble on cellular components [ antibodies, lymphocytes, activated macrophages, dendritic ].

Complement has three major physiologic function

- the body against bacteria infection

-Bridging natural and acquired immunity

-Undisposed Singh of immune complexes and the byproducts associated with inflammation

Activation pathway for the complement system: the

- classic pathway

- alternate pathway and

- lectin pathway.

**The complement system**

Infection results in activation of complement protein via a series of proteolytic Reactions that yield biologically active fragments.

This coupled proteolytic Reactions result in amplifying cascade, in which limited stimulation of proximal complement compliments results in massive activation of distal complement proteins

**Complement system:**

**Overview**

**Activation of complement system**

2 activation pathways are components of innate immunity: *alternative pathway, lectin pathway.*

The classical pathway of complement activation is part of the adaptive immune This phones dependent On Abs.

**Activation of classical pathway**

requires antigen antibody complexes

Complement component C1 binds to the FC region of the Ab[ I GM - most potent activator ]

C1 is a protese That cleaves C2 and C4 two form C3 convertase Of the classical path.

**Activation of the complement system**

All three activation pathways result in generation of enzymes complex which can cleave C3, called the C3 convertase

C3 -C3A + C 3B

Integration point of the complement system [ innate and adaptive immunity ]

Major amplification point

**Activation of the alternative pathway newlon**

* Soluble proteins of the alternative pathway [ B, D, P ] bind to repeatative structure on microbial surface, such as components of the cell wall.
* The complex of B, D and P forms the C3 convertase Of the alternative pathway.
* Recognition is selective for microbes, but not highly specific [ button recognition].

**Activation of the lectin pathway**

* The soluble plasma protein, Mannan binding Protein [MBP or MBL] binds to the sugar mannanWhich is restricted to the surface of certain microbes [ not on vertebrate cells]
* this leads to attachment of other complement proteins [ C4, C2 ] to form the C3 convertase Of the lectin pathway.

**Regulation of complement system**

Due to its potential for rapid implication, and the ability to activate complement proteins damage host tissues as well as microbes, strict regulation is needed.

Soluble inhibitors of complement - C1 inhibitor [ C1 INH coma C1 esterase inhibitor ] buttons and inactivate C1 - inhibitation of classical pathway.

Cellular inhibitor of complement - **decay accelerating factor** [ DAF ] and CD 59 are proteins present on mammalian cellsSo much inhibit the assembly of the MAC on host cells.

**Complement system- summary**

* Plasma proteins +Compliment receptors leukocytes+ regulatory proteins
* integral to innate immunity, also functions with the adaptive immune System.
* Amplification cascade that proceeds via coupled proteolytic reactions.

**Complement system – summary**

**Functions:**

* recruit inflammatory cells: C3A, C5a
* Opsonized pathogens: C3B, C3 BI
* Directly microbicidal:

**The complement system kills microbes via membrane attack complex [ Mac ].**

Regardless of the activation pathway, the complement destroys cells by altering or damaging the cell membrane of the ag, Well chemically attacking phagocytes to the AG [chemotaxis], under rendering the AG more vulnerable Do the phagocytosis [ opsonization ]. The complement system enhances inflammatory this points by releasing vasoactive substances.