Host- Parasite Relationship

This study to know the relationship between bacteria and the host.

There are three levels of that relationship:-

- **Commensalism:** The organism (parasite) colonize the host at different sites of the body, where a balance is achieved between them with only minor changes of the host. Neither the host nor the parasite is harmed.

- **Infection:** The organism establishes and colonizes the host can elicit an immune response but very minimal tissue damage and no clinical signs and symptoms of the disease.

- **Disease:** The establishment and colonization of the organisms into the host, development of an immune response and marked tissue damage and/or disturbance of the physiologic functions of the host enough to elicit the signs and symptoms of the disease.

Factors affecting the host-parasite relationship:

These factors can be recognized into:-


A- Microbial factors:

1- **Saprophytic bacteria:** are those which live freely in nature, on decaying organic matter, in soil or water.

2- **Opportunistic pathogens:** bacteria that do not causing a disease under normal conditions but in immunocompromized or when enter the body from another site than their normal habitat.

3- **Pathogenic bacteria:** bacteria which capable of causing disease.

*Pathogenicity:* it’s the capability of the organism to cause disease.

*Virulence:* it’s the degree of pathogenicity. The Virulence factors of bacteria are:
1- **Adherence factors:** certain bacteria have specialized structure e.g. fimbria or glycocalyx allows them to adhere to human cell causing the disease.  
2- **Invasion factors:** Invasion of tissue followed by inflammation, **so bacteria can cause a disease. This invasion is helped by:** **Enzymes secreted by bacteria** e.g. collagenase & lecithinase.  
   **Antiphagocytic factors:** e.g. capsule of pneumococci.  
3- **Toxin production.**  
   **Toxigenicity:** it’s the ability of the organism to produce toxins whether exotoxin or endotoxin. The major difference between the two types of toxins are outlined in the following table:-  
   **N.B. Toxoid:** Is the treatment of exotoxin by formalin to remove toxicity and keep antigenicity.
   An example of toxigenic bacteria is Corynebacterium diphtheria & Clostridium tetani.

<table>
<thead>
<tr>
<th>Exotoxin</th>
<th>Endotoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secreted by the living</td>
<td>It’s the integral part of the cell wall of gram negative organism liberated upon cell disintegration</td>
</tr>
<tr>
<td>organisms mainly gram positive</td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>Lipopolysaccharide</td>
</tr>
<tr>
<td>Very highly toxic</td>
<td>Low toxigenicity</td>
</tr>
<tr>
<td>Every individual toxin</td>
<td>All give fever &amp; shock.</td>
</tr>
<tr>
<td>has specific action.</td>
<td></td>
</tr>
<tr>
<td>Can be converted to toxoid.</td>
<td>Cannot.</td>
</tr>
<tr>
<td>Highly antigenic.</td>
<td>Poorly antigenic.</td>
</tr>
<tr>
<td>Unstable to temperature above 60oC</td>
<td>Stable to temp. above 60</td>
</tr>
</tbody>
</table>
The essential steps for the pathogen to enter into a relationship with the host are:-

1- **Entry** into the host by inhalation, ingestion or by inoculation through skin or mucus membrane.

2- **Establishment and reproduction** within the host, the organism from portal of entry may spread locally through tissues or spread via blood &lymphatic to reach target organs. **An effective mean for transmission** to new host must present then the organism leave the body through portal of exit

**B- Host factors:**

The most host factor that determine the outcome of the host parasite interaction is his resistance or immunity whether natural or acquired.

**Course of infectious diseases**

- The incubation period: Course of infectious diseases: it’s the interval between introduction of an organism to susceptible host and the onset of illness.
- The phase of illness: with the characteristic symptoms and signs follows the incubation period.
- The period of convalescence: After the illness subsides.

**Types of infectious diseases:**

- **Acute infections;** rapid onset short duration of illness.
- **Chronic infections;** Develop more slowly & long duration.
- **Latent infections:** never completely eliminated, become reactivated when immune response is decreased.
- **Carriers:** individuals harboring infectious agents for long time (months or years) spread pathogen continually even though they show no signs or symptoms of the disease.
**Bacterial Genetics**

Bacterial cell has a single circular chromosome composed of two polynucleotide chains of DNA twisted together in a double helix then replicated in each cell division. In each chain, purin and pyrimidin bases are arranged as G-C or A-T and the two chains are held together by hydrogen bonds between alternative bases. Each gene lying on the chromosome has specific character. And the set of genetic determinants carried by a cell is called its **genotype**. The observable properties of the cell are called **phenotype**.

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**MODEL OF DNA MOLECULE SHOWING THE INTERACTION AND HELICAL NATURE OF THE TWO STRANDS**

A: Adenine & T: Thymine & G: Guanine & C: Cytosine

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**Bacterial variation:**

**Phenotypic variation:** are the changes in bacterial characters under the influence of the environment with no genetic changes. Its reversible when the environmental cause is removed. Its not heritable e.g. S-R variation in colony appearance which leads to loss of antigenicity, loss of virulence and the organism easily phagocytosed.

**Genotypic variation:** is a heritable irreversible variation due to changes in genetic constitution. Genetic variation occurs through:
a- Mutation **without gene transfere.**

b- Transformation, conjugation and transduction **with gene transfere.**

**a-Mutation:**
It’s a change in base sequence of gene nucleotide leads to appearance of altered phenotype, mutation can occur by base substitution, deletion or insertion. Mutation can occur **spontaneously** or can be **induced** by mutagenic agents such as X-ray, U-V light).

**b-Gene transfere:**
it's an inter-strain transfere of DNA from donor to recipient bacterium .There are three mechanisms of gene transfere that alter the DNA gene content of bacteria:

- 1- Transformation.
- 2- Transduction.
- 3- Conjigation.

1- Transformation: it’s the uptake of naked fragments of DNA released from destructed bacterial cell by the recipient cell. then recombination with the bacterial chromosome takes place and transformation will occur which then express new genes.

2- Transduction: its transfere of chromosomal fragments from donor to recipient bacterium .There are two major types of transduction: a-

**Generalized Transduction:** During the lytic cycle of (bacteriophage).Piece of (donor) bacteria by accident is enclosed within the phage particle instead of normal phage DNA. When this phage infect another bacterium (recipient) ,the DNA from (donor) recombine with DNA of (recipient) ,so any length of chromosome can be transferred in this type of Transduction.

**Specialized or Restricted Transduction** This occurs during temperate (lysogenic) cycle of phage replication. .Few genes of bacterial chromosome that adjacent to insertion site of the bacteriophage are transferred i.e. transfere of specific DNA segments.
Conjugation: It involves two types of bacterial cells **donors** that have fertility factor(\(F\)), **recipient** lacking fertility factor(\(F^{-}\)) Sex pilus facilitates the transport of DNA between donor and recipient cell.

**PLASMIDS**
- Small extrachromosomal double stranded circular DNA.
- Replicate autonomously independent of cell chromosome.
- Dispensable (not necessary for cell life).
- Transmissible to other bacterial cells (by conjugation, transformation and transduction)

**TRANSPOSONS.**
- Short DNA sequences.
- Can be transferred from one genetic compartment to other one within the same bacterial cell.
- It is possible for a gene to undergo transposition between plasmids, from plasmid to chromosome and vice versa.

**RECOMBINANT DNA TECHNOLOGY**
- In the course of the process of conjugation, transformation and transduction, DNA is transferred from a donor to recipient bacterium then followed by DNA recombination.
- Cloning vectors; are used to carry and introduce foreign DNA fragments into a host cell e.g. plasmid & bacteriophage.

**Construction of DNA molecule**
Foreign DNA and a vector with sticky ends. hydrogen bonds are formed between complementary strands (hybrid DNA) then the recombinant plasmid is introduced into proper host by process of transformation.
Application of DNA technology:-

1- Production of important biological products in large amount and great purity such as: human insulin, monoclonal antibodies and interferons. & highly effective vaccines.

2- Diagnosis of infectious diseases by DNA probe.

3- Gene therapy. to treat immunodeficiency diseases by using gene delivery viruses.
Sterilization And Disinfection

**Sterilization**: Is complete destruction of all living microorganisms contaminating an article (including spores), whether pathogenic or nonpathogenic.

**Disinfection**: Elimination of pathogenic microorganisms on surfaces (not including spores) but too toxic & irritant to be applied directly to tissue.

**Sepsis**: Is the presence of pathogenic microbes in living tissues.

**Antiseptic**: A chemical substance less toxic or irritant than disinfectant & can be safely applied locally against pathogenic microbes on living tissues.

**Cleaning**: Is the removal of organic materials, dust that interfere with sterilization & disinfection it is done by using soap and water.

**Methods of Sterilization**:

*Five main methods are used:*

1- **HEAT**
   
   At temperature above 100 under carefully controlled conditions, is the most reliable & widely applicable method.
   
   - Dry heat
   - Moist heat

2- **Filtration**: To remove bacteria. From liquids that are reliable to be spoiled by heat.

3- **Ionizing Irradiation**: Both Beta & Gamma rays are employed.

4- **Sterilant gases**: As formaldehyde gas.

5- **Sterilant Liquids**: As glutaraldehyde (applied when no other method is available).
1- Heat:

a- Dry heat

- **Incineration**: It is a burning to destroy contaminated materials.
- **Direct flame**: For tips of forceps, scalpels, bacteriological loops and mouths of glass ware.
- **Hot air oven**: Metal chamber operated at temperature of 160°C–180°C for 1–2 hours. Used for materials not denaturated by high temperature such as glasswares-metallic instruments, oil and powders. (E.g. talcum powder).

b- Moist heat:

1-Moist heat at 100°C (Boiling & Steaming):

**Boiling:**

Articles may be disinfected by boiling in water for 20 min, all non sporing and some spores will be killed.

**Steaming:**

- Koch Steamer is used.
- Water is allowed to boil at normal atmospheric pressure. The steam temperature is 100°C will replace the air.
- Used to sterilize culture media e.g. media containing gelatin or carbohydrates that might be destroyed by exposure to higher temperature.
- These are steamed for 20–30 min, in each of 3 successive days.
- A method is known as intermittent steaming or **Tyndallization**
- On the first occasion vegetative bacteria are killed, any spores that survive, will germinate at 37°C for 24 hours. Then vegetative forms will be killed by the second or third steaming.
2- **Moist heat above 100C (steam under pressure):**

*The autoclave:*

It is a metal chamber with a closely fitting lid which is connected to (1) a steam discharge tap, (2) a safety valve and (3) a manometer.

To sterilize articles in the autoclave these direction will be as followed:

1- Water is placed in the bottom and the articles to be sterilized are placed on the top of the perforated tray above the level of water.

2- The lid is tightly closed, the water is heated electrically, the steam discharge tap, is opened and the safety valve is adjusted to double atmospheric pressure.

3- When steam is released in a continuous stream, which is indicating that no air is left inside the autoclave, the steam tap is closed.

4- When the steam pressure reaches (2 atmospheric), the safety valve will permit excess steam to escape.

5- The sterilization time is calculated (20 – 30 min).

6- The heater is turned off and the autoclave is allowed to cool down before opening the lid.
The autoclave is used to sterilize surgical instruments, bed linen, surgical dressing, gowns, cotton, gauze and any culture media not destroyed by heat.

**PRECAUTIONS**

1- Do not overloads the autoclave for better penetration of steam and contact with articles.

2- Make sure that, there is no air left inside before closing the steam tap.

3- Start timing from the moment the manometer read 2 atmospheric pressure.

4- Do not open the lid before the pressure goes down to one atmospheric pressure, otherwise the articles will be blown up and accident an happen.
How to test the efficiency of the autoclave:

- **Chemical method:** A glass tube contains a red indicator solution that turns green when an adequate temperature had been maintained for a sufficient period.

- **Biological method:** A preparation of dried bacterial spores is placed within the load and at the end of sterilization they are tested for viability. *Bacillus stearothermophilus* is usually used since its spores are killed at 120°C in about 10-20 minutes.

2- **STERILIZATION by IRRADIATION:**

Two types of ionizing radiation are commonly used for sterilization:

1) **Gamma rays:** which are emitted by radioactive elements such as cobalt-60.

2) **High energy electrons (B-rays):** which are produced by electron accelerators. Ionizing radiation has a high penetrating power and is, therefore, a practical means for sterilization of prepacked disposable items such as plastic syringes, gloves, catheters and I.V. infusion sets.

3- **STERILIZATION BY FILTRATION:**

Fluids can be rendered free of bacteria by passage through filters with a pore size of less than 0.45 um. It is used for preparation of fluids which would not withstand heat e.g. **antibiotics, hormones, vitamins**, etc. The most reliable filters used are the **membrane filters**. They filter rapidly, do not affect the filtrate in any way and adsorb very little of the substance being filtered.

Filters can be used to remove microorganisms from air supplied to critical sites such as operating theaters, drug factories, and laminar flow ventilation systems. High efficiency particulate air (HEPA) filter can
achieve 99.997%, arrestance to particles of 0.5 um, and can produce sterile air at the filter face.

4- STERILIZATION BY GASEOUS PROCESSES:

(1) ETHYLENE OXIDE: It is a highly penetrative, non corrosive, and microbicidal gas which is used for sterilization of heat-sensitive medical devices such as plastic syringes and catheters.

(2) FORMALDEHYDE GAS AND LOW TEMPERATURE STEAM:

The effect of the gas combines with that of the steam thermal effect which generated at sub atmospheric pressure. Although effective and kill spores, it requires safety measures which make this process inappropriate for routine hospital use.

5- Sterilant liquids: e.g. glutaraldehyde.

METHODS OF DISINFECTION: used for inanimate objects (tables, floor & utensils):

(1) Cleaning

Thorough cleaning is a successful disinfection method. A valuable method for disinfection is the detergents used in cleaning and the dilution effect of through rinsing further reduces the microbial load.

(2) Disinfection by moist heat:

- Washing or rinsing laundry or eating utensils in water at 70-80C for few minutes will kill most non-sporing micro-organisms.
- Exposure to boiling water (100C) for 20 minutes achieves high effective disinfection. It can be useful in emergencies if no sterilizer is available.
• **Pasteurization of milk** by heating at 63°C for 30 min. or at 72°C for 20 sec. destroys pathogenic organisms transmitted from diseased animals e.g. M.bovis, brucella and Salmonella.

(3) **Disinfection by Ultraviolet radiation:**

Is a low-energy, non-ionizing radiation with poor penetration power. It is produced by mercury lamps. It is used in operation rooms and laboratory safety cabinets.

(4) **Disinfection by chemicals:**

a) **Alcohols:** ethyl and isopropyl alcohol at 70% concentration are used as skin disinfectants.

b) **Aldehydes:** formaldehyde and glutaraldehyde are used to disinfect equipments that cannot be sterilized by heat such as endoscopes. Glutataldehyde is irritant to eyes, skin and respiratory mucosa.

c) **Biguanides:** Chlorhexidine is commonly used for disinfection of skin and mucous membrane (as a mouth wash). It is often combined with compatible detergents for hand washing or with alcohol as a hand rub.

d) **Halogens:**

1. **Hypochlorite** are used as laboratory disinfectants on bench surfaces and in discard pots.

2. **Chlorine** is used to disinfect water supply and to treat swimming pools.

3. **Iodophores** are better than iodine as they are less irritant and cause less staining. They are widely used in preoperative preparation of the skin.
e) **Phenolics**: are preferable for tuberculous material, for non-enveloped viruses, on metals and where much organic matter has to disinfect e.g. floors.

f) **Oxidizing agents**: as potassium permanganate and hydrogen peroxide which has limited application for the treatment of wounds.