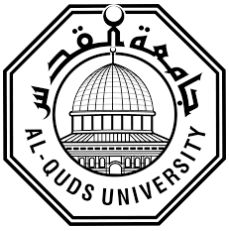

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Transduction: the genes (the DNA) is transferred by a bacteriophage.
Small and double stranded DNA (pieces of fragmented bacterial DNA) is brought from a donor cell into a recipient cell by a bacteriophage.

This is how B-lactamase (resistance to B-lactam antibiotics, resistance to bensilene...) can be transferred between staph. aureus cells by transduction via bacteriophage.

Bacteria can exchange genetic information ether by transformation or transduction or conjugation (we will talk about it later).

To talk about transduction, we must first start with how bacteriophage bind to bacteria cell not all bacteriophage enters the bacteria cell, it ingects its genome, after that the virus takes charge of this cell, it controls the synthesis, so just synthesis of viral protein and replication of viral genome will be in the cell.

So during this process, there will be a break up of the bacterial DNA (chopping of the bacteria DNA) more synthesis of viral proteins such as protein coats, tails and replication of viral genomes.

In the end, there will be an "assembling" or "packaging" which means that the genome is entered into the protein coat and this is spontaneous (doesn't need energy) (assembling to produce the viral particles). During this process, occasionally the bacteriophage will enter the lyse bacterial genes.

The DNA segments are enough to be packaged inside the head piece (protein coat).

One in one thousand phages is carrying a piece of a bacterial DNA, so we call it a transducing phage. The bacteriophage has bacterial genes; when it binds to another cell it will inject its DNA, this DNA can be incorporated into the chromosome.

*** What is one in one thousand phage?**
It's a transducing phage that is a phage which is carrying bacterial genes.

When viral replication occurs in the cell, one bacterial phage will replicate and this will give rise to many bacteriophages.

Now, this cell is lysed, and the bacteriophage doesn't have viral genes, it's only bacterial genes but it will pipe to a cell and transfer genes to this cell, this can't do viral replication because there isn't viral DNA, but it's transferring bacterial genes so this is how the genes for B-lactumase (enzymes break down the antibiotics) can be transferred.

*** What happens when a bacteriophage infects a bacterial cell?**

Sometimes the bacteriophage integrates into bacterial chromosome (doesn't enter the lytic cycle) and it's lysogenized.

Lysogeny is important in medical microbiology because some toxins (produced by bacteria) are actually viral genes coding for these toxins.
E.g.: Cholera

*** How is bacteria toxin coded by viral genes?**
We have some strains which cause the toxins and other strains that are nontoxic.

The difference between this strain and another strain is that this strain is lysogenized (it's carrying viral genes). Such as Clostridium botulinum.

* Not all bacteriophage can do that

Another important example is **Streptococcus pyogenes**, lysogenic strains produce toxins and erythrogenic toxins. This is responsible for a disease called **scarlet fever .**
Only lysogenic strains can cause scarlet fever

The another example is **Vibrio cholera** toxin, it's produced by a lysogenic strain of **Vibrio cholera**.

Conjugation:

F factors (Fertility plasmid) can undergo conjugation.
The F factor (F plasmid) that has the genes is usually the larger plasmid, they carry genes for the protein required for sex pili.

The sex pilus is also called **conjugation tube**, it's a tube in which the process of conjugation occurs.
When conjugation occurs: First, this plasmid (double stranded DNA) has to be nicked (a cut must be in one of the strands) because this strand (a part from one strand of bacterial DNA) will be transferred along the conjugation tube to the recipient cell.
During that, synthesis of the complementary strand in the donor cell, and the recipient cell will combine the transfered strand with its chromosome or plasmid and synthesis a complementary strand to it.

At the end of conjugation this cell **(F-)** will be **(F+)**, it's carrying a copy of the plasmid and now it's able to do conjugation with other cells.

The amazing thing about conjugation is that it can happen in colonies.
(the bacteria should be close proximately in conjugation)

***** Conjugation can occur between different species.

If it transfers the complete chromosome it is called high frequency recombination (Hfr).

*** Which form of genetic exchange is the most common?**
Conjugation

* Transduction also occurs in nature.

* Transformation only occurs between certain species.
(the least common in nature is transformation)

* Many experiments depend on transformation.

If we have **transformation** and enter foreign DNA in eukaryotic cells we call it **transfection.**

* Transformation is if we use bacterial cells.

* Transfection is when purified bacterial DNA is injected into the nucleus of a eukaryotic cell.

* When the plasmid is outside in the cytoplasm we call it; fertility factor.

Why is the Hfr cell recombination?

Because it can go under conjugation with **F-** cells and in this case, the nick will be in the chromosome and the plasmid will help transfer genes from one bacterial cell to the other at a very high rate.

* These bacterial genes must recombine to give the new characteristic. (الصفة الجديدة)

Gene transfer within the bacterial cells:

Segments of DNA can move from plasmid to plasmid or from plasmid to chromosome.

These segments are called **Transposons** or **Jumping genes.**

The genes in these transposons may code for toxin production or antibiotic resistance. Transposons are not capable of independent replication. They differ from plasmids in that they can replicate independently.

The characteristics of jumping genes:

- It's a segment of DNA, both sides of the segment have interval repeats (flanked by inverted repeats)

Inverted repeats (IR genes): are sequences which are the same but in opposite directions.

* Inverted repeats are important because integration or removal can occur easily.

*يوجد انزيم وظيفته عمل قطع او عمل ال lygation

* There is repressor gene which regulates synthesis of both transposase and the gene product of the fourth domain and a gene product which codes for transposase, which is the enzyme that mediates the excision and integration process.

* The fourth domain is an enzyme - mediating antibiotics resistance.

Programmed Rearrangement:

Here we talk about certain bacteria such as **Neisseria gonorrhoeae**, **Borrelia recurrentis** and **Trypanosomes.**

*N. gonorrhoeae is the bacteria that causes **gonorrhea disease**.*

*Borrelia recurrentis is the bacteria which causes **Relapsing fever disease**.*

(*Borrelia:* it's a spirochaete bacterium, *recurrentis:* it keeps coming back.)

*** What kind of disease is gonorrhea?**

It's a sexually transmitted disease.

*** Fever can become infected and reinfected and reinfected and reinfected ……. Why??**

Because it keeps changing its surface and details (you can't become immune to it) (there isn't a vaccine for it).

Neisseria gonorrhoeae and Borrelia are bacteria
Trypanosomes are protozoa but they have a flagella and they cause African sleeping sickness.

The common thing about these is that they keep changing their surface and genes.

The Trypanosomes, all of them, can undergo gene rearrangement.

*** What happens inside these organisms?**
We have this locus, (it may be contain gene1) gene1 could be transcribed into mRNA1 which is translated to protein1, which represents Antigen1. This locus is called the expression "locus".

- Downstream from its gene there are many many genes which can be a copy of this gene or the gene itself can move from this locus to another locus. After it is transcribed and translated it will end with a different protein.

Antigenic variation occurs in other organisms like viruses such as HIV and Influenza.

Normal Flora:

One of the most important lectures, here we are talking mostly about bacteria.

Normal flora is mostly bacteria, which inhabits our body (in external or internal surfaces) …… external such as skin and it exists in any internal surfaces (vagina, mouth…) **except the urethra.**

Resident population & Transient population:

مقيم **Resident population:** which is always present in a given site (is our normal flora).

انتقالي **Transient population:** ex: when we eat food, the food moves down via esophagus and carries some of the other flora.

Also, when we widen our anus, the perineum skin will contain some thicker flora; this is the Transient population.

Another ex: when we brush our teeth and we have some gingivitis (inflammation gingival التهاب اللثة) , some of the other flora will go into the blood stream.

Another ex: when we cough or sneeze; other flora may transit around the mouth or our hands.

Carriers: (is a very important term to understand)

A carrier, is person who is carrying a pathogen.

This person is a reservoir for transmitting this pathogen to susceptible individuals (حساس/ سريع التأثر بالعدوى)
Also, a carrier may be a person who recovered from a disease.
ex: people who have got typhoid and recover from it….
3% of typhoid patients who have recovered become ***Chronic carriers*** **.**

اذا قمنا بعد خلايا الجسم وعد البكتيريا في الجسم فإن عدد البكتيريا راح يكون اكثر من عدد خلايا الجسم

Humans are more microbial (in cell members) in composition than mammalian.

*We have large number of normal microbial flora that exist in the skin, oral cavity, small intestine (10^5 – 10^7), large intestine (10^9 – 10^11) (the number is increasing)

* The largest amount of normal flora exists in the colon.

* In the stomach we have transient flora not resident.

*This normal flora is very important to us in health and in disease
مهمة لصحتنا لكن بنفس الوقت ممكن تعمللنا مشاكل اذا انتقلت من مكانها الى مكان اخر لا يجب ان تكون فيه .... سوف تسبب لنا المرض

* It's opportunistic (انتهازية) … as long as our immune system is working, it's under control. But when the immune system is low (as with cancer patients or with people who take radiation or chemotherapy…) the same normal flora in the colon can make a perforation in the colon and it may extend to other sites.

Immune system is very important to keep it in check.

The Role of the resident flora in our body: (the function);

- Host nutrition:
  It provides vitamine B12 and vitamine K to the body
- It helps us digest our food:
  People who have abnormalities in normal flora, they will have a problem in digesting food.
- Presence of the bacteria in specific sites (like colon, oropharynx, vagina…) prevents colonization by other Bacteria.

*As long as normal flora occupies all the sites, it becomes hard for the pathogen to cause an infection.

- It competes for receptors or binding sites.

- It competes for nutrients.

- It produces antibiotics or bacteriocins (a toxin produced by the bacteria to kill other bacteria).
However antibiotics are: things produced by living organisms which kill other living organisms like penicillin, sulforines, …
– It produces toxic products which kill other bacteria.
– They stimulate production of natural antibodies. These antibodies can cross react with pathogenic organisms.

Antibiotic : مضاد حيوي ; living organism produce them
Antibody : اجسام مضادة ; Immune system produce these antibodies

Normal flora may produce diseases under certain circumstances such as:

- N.F. introduced into bloodstream or tissues.
  Streptococci viridans is introduced into the bloodstream following tooth extraction or tonsillectomy.
- Bacteroides of the large intestines are introduced into the peritoneal cavity.

Bacterioides are one of the important anaerobic which exict in the colon.

- Members of the resident flora when they are found in disease are called **opportunists.**
  They can cause diseases in immunocompromised + debilitated individuals.
  (immunocompromised: immune system is not optimal; is not working very well/properly)
  (debilitated: they have a problem which affects their immune system)

Where is our Normal flora found?

- Mouth
- Upper respiratory tract (URT): throat, nose, nasopharynx, mouth

* In the respiratory tract after the nasopharynx we can't find normal flora …
- the larynx doesn't have normal flora
- above the larynx there is normal flora
- below the larynx there isn't normal flora
- epiglottis doesn't have normal flora
- oral cavity (nose, nasopharynx , mouth) has normal flora

- In GI :

- epiglottis doesn't have normal flora
- esophagus doesn't have normal flora
- stomach doesn't have normal flora
- intestines have normal flora
- down to the colon, there will be more normal flora

- Vagina
- Skin
- Conjunctive of the eye
- Outer ear only

- urethra doesn't have normal flora

Role of the normal mouth flora in dental cavities (تسوس الاسنان):

- A cavity is a disintegration of teeth
  – surface enamel is demineralized

The bacteria in the mouth is OK as long as it's under control, if we keep this bacteria and we don't brush our teeth it will cause common plaque.

At night when we are sleeping for a long time and there are remains of food on the teeth, the bacteria will break down this food and produce acid. The acid which is produced will demineralize the enamel (this is the beginning of the cavity)

- If we don't maintain good oral hygiene, this enamel will slowly be disintegrated (decomposed) and it may move from the enamel to the dentin and cement.

- The 1st step is production of plaque
  S.mutans produce gelatinous and this is made up of glucans
- The 2nd step: The bacteria in the plaque will break down food to acid (lower PH); demineralization; it initiates cavities.

Development of caries depend on many factors:

- Genetic
- Hormonal: pregnant women are more likely to suffer cavities because of the imbalance in their hormones.
- Nutritional
- Other factors

We can control cavities by doing these things:

1. Removal of plaque by brushing our teeth everyday and visiting the dentist at least one every few months.
2. Limitation of sucrose intake.
3. Reduction of acid production by maintaining oral hygiene.
4. Good nutrition – adequate protein.
5. Fluoride application to teeth or in water.