Notes on” gene mutation” from previous lecture:

-Mutation is one way in which the bacterium DNA can be altered.

-Mutation is a change in the nucleotide. Consequently, a change will occur in the product or the phenotype of a gene.

- Mutations can be spontaneous; due to the changes of electro-chemical orientation.

- Mutations can be induced; external effect which exerts its effect on the nucleotide sequence to produce a mutation.

\*These external factors causing mutation could be chemical or physical.

\*\*Chemical factors include chemical mutagens.

Chemical mutagens are of many types, those include:

1. Bromouracil: analogue of thymine but doesn’t actually take its place so it becomes functionally disabled (the sequence of nucleotide is definitely disturbed).
2. Amino purine: analogue of adenine; takes the place of adenine and the function of the nucleotide will be lost.

Also, there are types that alter the nucleotides themselves like:

1. Nitrous oxide: cause nucleotide deamination which will disturb the structure and hence the function.
2. Alkylating agents: adding/removing alkyl groups to the DNA sequence. Sterilizing agents use this method to kill bacteria.
3. Acridine dyes: insertion or deletion leading to frame shift mutations.

Physical Agents:

1. Heat: disrupts the chemical structure of the nucleotide and may cause death of bacteria. If present in small amounts then it produces changes in the nucleotides leading to mutations.
2. UV
3. Radiation

\*Both UV and radiation are factors disrupting the sequence of DNA and will lead to mutations.

**Gene transfer**

* Gene transfer is another mean by which DNA is altered.
* DNA is not changing but being transferred (acquiring DNA).
* Unidirectional gene transfer is the transfer of DNA from bacteria (donor) to another bacterium (recipient). This depends on the means by which the transfer occurs. There should be some type of homology, which means that the two bacteria (donor and recipient) must be related in a way. For example: having similar DNA sequence.
* Amount of DNA transferred is usually small.
* There are three ways by which the transfer occurs:

1. ***Transformation:***

* Also know as legitimate, homologous, general recombination.

–most primitive

-does not occur very often

-is not a significant mechanism compared to others in the aspect of variation that is found in the DNA of bacteria

-Does not contribute a lot to the diversity of DNA in bacteria

-In case the bacteria’s sitting medium is liquid, bits of DNA are found around it. In that medium, DNA can be gained passively from the environment into the cell and hence incorporated. For this to happen, bacteria should be very similar in their nucleotide sequence.

- Environmental factors that should be present for the bacteria to be permissive and be able to incorporate the DNA:

a) Overcrowding of bacteria

b) Lack of nutrients

\*transformation will probably occur in the stationary phase. This is because the bacteria under the environmental factors mentioned above is competent and is able to absorb DNA from the environment.

1. ***Transduction:***

- Transduction is the transmission of DNA material through a virus

- Viruses can infect humans, plants, bacteria.

- Viruses infecting bacteria are called phages.

-Bacteria could be infected by a virus from the environment or another bacteria.

-Viruses infect bacteria in two ways (two cycles of phages in bacteria):

a) Lytic cycle: takes over the machinery of the bacterial cell; breaks the cell completely, makes the ribosomes and all other parts of the bacteria process new virus material and eventually reverses and the virus is released to the outside to infect more cells.

b) lysogenic cycle: Virus is incorporated in the DNA of the chromosome (becomes part of the DNA). For example: herpes virus and HIV. Because they don’t kill the cell immediately, they are also known as temperate. At first, the DNA incorporated doesn’t affect the cell, but at a later stage, the cell can become active and lead to the lysis of the cell and produce a virus.

\*How does the DNA transmit the cell from one bacteria to another? Through the virus, in two ways:

1. Restricted:

* Occurs in cases of temperate phages
* When the phage is activated and starts replicating, it might take a small amount of DNA from the chromosome of the bacteria from either end, and that will be replicated with its own and packaged to form a new virus and is then transmitted to a new bacterial cell. Why is it called restricted? Because it is restricted to the amount of the DNA taken from the chromosome of the bacteria (only a side of the chromosome is taken and replicated with the virus).

1. Generalized:

* Occurs in the lytic phages.
* Lytic virus destroys the cell and breaks up the **entire** DNA. When the virus replicates, it will produce a shell for the virus. Some shells are stuffed with virus while others are stuffed with pieces of DNA from the bacteria. When the cell is lysed, the virus will be released to infect cells, and the DNA fragments stuffed in the virus will be incorporated in the DNA of the infected cell.
* Why is it called generalized? Because the entire DNA is broken down, and transferred from one bacterium to another.
* Taking the structure of a phage into consideration, the DNA of the virus is stored in the shell (head). Viruses with empty shells stuff bacterium DNA.
* In conclusion, both shells (with virus and those with bacterial DNA) are infectious.
* Lots of gene transfer occurs from one bacterium to another.
* During transduction, some bacteria may not be pathogenic (do not have the ability to produce a certain toxin) but it may be acquire the ability to do so through a phage.
* Example 1: diphtheria toxin is not toxic but if it is infected by a phage it will acquire the toxic gene. The toxic gene is responsible for the production of the toxin. The toxin is then secreted and this will cause the pathology.
* Example 2: streptococcus pyogenes can produce toxins of symptoms causing sore throat.
* Example 3: erythrogenic toxin causes rashes and infection (acquired by transduction).
* Example 4: resistance to penicillin in staphylococci by means of plasmid.

1. ***Conjugation* :**

* Conjugation occurs through plasmids.
* Plasmids are circular DNA present in the cell.
* Number of plasmids in a cell may vary.
* Plasmids (made of DNA) can replicate themselves (independent).
* Episome: when the plasmid becomes incorporated in the chromosome of bacteria.
* Two classes of plasmids:

1) conjugative: can transmit the cell to another bacteria

2) non-conjugative: cannot transmit the cell to other bacteria alone. This is because usually the plasmid has a little bit of DNA called the F-factor (fertility factor). The F-factor is the one responsible for the production of the pilli (sex pilli) and the transfer of the DNA of the plasmid from one bacterium to another.

* If the plasmid has the F-factor we indicate it as F+, if it doesn’t we indicate it as F- .
* In case of conjugation, the conjugative plasmid is the donor (F1), and the other bacterium is the recipient (F-).
* Once the plasmid is transferred, the recipient becomes F+ (why? the DNA of donor replicates in the recipient).
* Note: f-factor could be in the plasmid or in the plasmid in a chromosome (episome).
* During conjugation a copy of the sex factor is made, one of its strands is transferred and then in the recipient it is copied to give another strand (it is then when the recipient becomes F+). Why is only one strand transferred? So that the donor remains F+.
* Note: F- can be become F+, but F+ CANNOT become F-.
* When the f-factor is found on an episome we call it integrated. Characteristic given is: High frequency recombination Hfr.
* When conjugation occurs through a Hfr, the plasmid tries to transmit itself and at the same time tries to drag the chromosome with it. (Refer to the figure found on “physiological states of F factor “slide). The red plasmid is incorporated within the chromosome and is now known as the high frequency recombination.
* If the Hfr tries to split the plasmid into another cell, it tries to drag with it as much genome as possible. (transmition +conjugation of the plasmid +part of the chromosome of the bacteria).

Functions of plasmids:

-plasmids are capable of adding new properties to the bacteria that has received the plasmid.

1) R plasmids, for example staphylococci becomes resistant to penicillin when it is conjugated to an R plasmid.

2) May acquire resistance to heavy metals (heavy metals are not good for bacteria)

3) Some bacteria start producing toxins because of the plasmid.

4) Start producing bacteriocinogenic plasmids.

-bacteriocins are carriers that produce bacteria. Those suppress the growth of other bacteria (advantage). Hence, the normal flora (harmless bacteria on our skin which prevent –by their presence- the growth of other pathogenic bacteria) is able to do its function due to the presence of bacteriocinogenic plasmids.

\*\*Mechanisms of action of resistance plasmids will be covered when we take antibiotics.

**Note:** the outer membrane of the gram –ve bacteria reduces the uptake of antibiotics because it forms an extra barrier.

Transposons:

Jumping genes; mainly sequence of nucleotides and are most likely found in introns. Usually do not affect the genome. May cause problems if they jump on the exons area.

Genetic engineering: (not important)

Manipulating the genes of an organism. May be used to correct a disease in bacteria or yeast. Example: hepatitis B vaccine is genetically engineered and is actually HTS antigen which was transferred into yeast. The yeast then started producing HTS.

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