



Microbiology

Lecture No:..22.....

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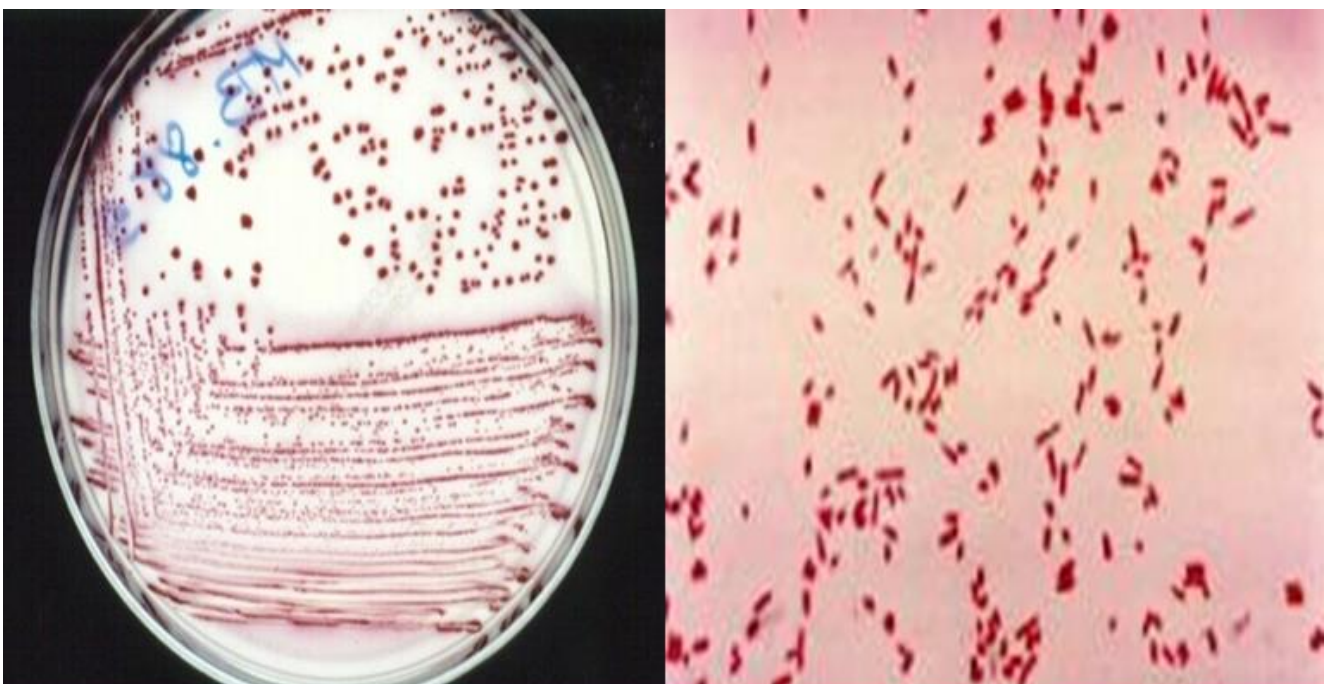
Enteric bacteria (cont.)

-In the previous lecture, general characteristics of this group of bacteria were discussed. Some of these bacteria are considered as part of the intestinal flora, others as opportunistic pathogens which under certain conditions can escape the intestine to reach other parts of the body like the urinary tract or the blood and cause infection, also, the obligate pathogens that can spread infections in community and contribute to outbreaks of certain diseases.

-There are some important biological characteristics of bacteria which help in easy distinguishing between the different species of a particular group of bacteria; the most important one is the Lactose Fermentation which is related to all the Enteric bacteria species.

⇒ Lactose fermentation can be easily done in the lab by using the MaConkey agar medium (named so according to the Scottish scientist who developed it). This medium is used to differentiate between the enteric bacteria which ferment lactose and the other enteric which cannot ferment lactose. This helps in classification of bacteria in two different groups:

- 1) Lactose fermenters
- 2) Lactose non-fermenters



-As shown in the picture above, the lactose fermenter bacteria appear as red colonies in the agar due to fermentation of lactose. The original medium's dye is colorless. Therefore, colorless to red = lactose fermenters (+ve).

Lactose +ve bacteria are considered less pathogenic and are either commensal or opportunistic, while Lactose -ve bacteria are often considered as opportunistic pathogens or obligate pathogens.

-Another important test to distinguish between different types of gram -ve bacteria is the Oxidase test. All Enteric bacteria are oxidase -ve.

*Remember that enteric bacteria are also catalase +ve.

So, the first group of Enteric bacteria is:

I) Coliform group:

Coliform: type of gram -ve facultative anaerobe bacteria, found in the intestines especially the large intestine, represented mainly by Escherichia coli.

1) Escherichia coli: common intestinal bacterium which is a **Lactose fermenter**.

-Under normal conditions, it has no side effects on the intestines, but under certain conditions, it might escape from the intestines and may contaminate the lower part of the urethra for example, and reach the bladder and cause UTI. If it reaches the blood stream especially in **infants**, they will easily develop septicemia due to low immunity which develops slowly and insufficient antibodies. This could be fatal if not treated with specific anti-microbial drugs.

-Neonatal meningitis may also occur.

-Newborns can acquire Escherichia coli from their mothers within 24-48hrs.

-May contaminate the skin and during injuries might produce wound infection.

- Note: Escherichia coli bacteria are considered mostly as commensals rather than pathogenic to the intestines BUT throughout the years mutations occurred, and these mutations were associated with more

pathogenic (virulent) strains such as the types of E.coli which cause diarrhea, these account for only 10% of all intestinal E.coli.

- Diarrheagenic E.coli = 10%
- Diarrhea might be: simple watery diarrhea either with complications or not (sometimes causes death).

-Types of Diarrheagenic E.coli:

1) Enteropathogenic: (entero=intestines); when found in infants (1-6 months of age) will cause mild to chronic form of diarrhea.

- The virulent factor: Endotoxin LPS (lipopolysaccharide).

Diarrhea in infants is not a simple disease since they can lose significant amounts of their body fluids which affect their metabolizing activities and can cause hypotension, renal failure, etc..

According to WHO's statistics, at least 2-3million cases of infant deaths are caused by diarrhea, most of them related to Enteropathogenic Ecoli.

2) Enterotoxigenic: produce toxins ONLY when they are found in the intestines not outside, mostly cause watery diarrhea and maybe only mild bloody diarrhea.

Once it releases its toxins, the intestine responds by producing specific receptors for it.

- Enterotoxigenic E.coli can either produce Heat-Labile enterotoxins or Heat-Stable or both.
- Heat-Labile enterotoxins: inactivated by boiling temperature.
- Heat-Labile enterotoxins are mostly produced by E.coli found in the intestines of humans while Heat-Stable enterotoxins are mostly produced by E.coli found in the intestines of animals.
- Note: In countries with low standard of hygiene, Enterotoxigenic E.coli is acquired in young ages more than adults and when people travel from a

country with high standard of hygiene to a country with low standard of hygiene and eat contaminated food and vegetables or drink untreated water will develop Travelers' Diarrhea. (watery diarrhea).

- So, the first type of bacteria that affect travelers is the Enterotoxigenic E.coli, and this type already enhanced the immunity of people in the country with low standard of hygiene.
- Enterotoxigenic E.coli can be used as a measure of the standard of hygiene of any country.

3) Enterohaemorrhagic: a very dangerous type, resulted from eating hamburgers and grounded-meat due to the fact that these Enterohaemorrhagic E.coli originate mainly from the intestines of cows, and once they reach the humans' intestines through eating burgers or grounded-meat will suffer from bloody diarrhea.

- This type of bloody diarrhea can be so severe which may result in complications to the kidney called haemolytic-ureamic syndrome, as a result, kidney failure and death occurs.
There was a large outbreak for this type of bacteria in northern Germany about 2 years ago, which affected 6,000 people within one week and ended up killing 60.

-Finally, E.coli is used as indicator for detection of water and food fecal contamination.

2) Klebsiella-Enterobacter species:

- Second group of gram -ve facultative anaerobes which belong to the family Enterobacteriaceae.
- Klebsiella were discovered in relation to lung pneumonia.
- They are in fact part of the intestinal flora but are less abundant than escherichia coli (found in about 5% of the population's intestine).

- Enterobacter is another group but similar to Klebsiella and not easy to distinguish between them, because the biochemical characteristics of both are very similar, but ONLY by using the genetic molecular test we can distinguish between them.
- The importance of Klebsiella-Enterobacter: it's associated with large capsules, therefore once they reach the blood stream or anywhere they wouldn't be phagocytized and can cause serious infections especially in hospitalized patients through contaminated respiratory equipments, hence reach the lungs and cause K.pneumoniae and death.
- In intestines, they don't have much significance, and rarely associated with diseases, but only if they reach the blood stream or through wound injuries where they cause wound and lung infection.
- Note: E.coli, Klebsiella and Enterobacter are all considered as lactose fermenters and produce red colonies on the MaConkey agar.

3) Proteus-Providencia species:

- Lactose non-fermenters (-ve), transparent colonies on MaConkey agar.
- They are found in the intestinal tract in percentages less than E.coli and Klebsiella-Enterobacter and sometimes might not be found in the intestines.
- If they are found in the intestines especially in the intestines of elderly women, might reach the urinary tract and cause UTI, reach the blood stream and cause septicemia, as well as nosocomial infections in hospitalized patients.

-Note about all coliform bacteria shown above: they all have special virulent factors that are also used for adherence and attachment to the surface of the intestines or the mucosa of the urinary tract and they are:

1) E.coli: Has large number of fimbriae.

2) Klebsiella-Enterobacter: Klebsiella only has large capsules (no fimbriae) while Enterobacter has slime-layer. The large capsules are important to resist the phagocytic activity as well as helping in adherence.

3) Proteus-Providencia: Both have large number of fimbriae.

II) Pseudomonas group:

- Gram –ve bacilli, considered as aerobe to facultative anaerobe, **Lactose non-fermenter**, not part of the Enterobacteriaceae (not true enteric bacteria), might be found under normal conditions in the intestines of humans but not common like the coliform group.
- Pseudomonas group consists of many species which might produce infections in humans. But one type is responsible for around 95% of all Pseudomonas' infections called Pseudomonas aeruginosa.
 - P.aeruginosa: especially in certain categories of patients, like patients with any skin damage due to burns.
 - Also common in hospitalized patients associated with nosocomial infections, respiratory tract infections and UTI.

-Why this organism in particular, is more associated with hospitalized patients and in burn cases than other E.coli bacteria which are more abundant in the intestines than the P.aeruginosa?

- Simply because the group of P.aeruginosa produces a variety of extracellular enzymes, toxins and blue-green pigmentation or blue-yellow pigmentation (depends on the strain).
- These pigments are due to the production of a dye which is an antibiotic-like substance called Pyocyanin, which can inhibit the growth of other coliform bacteria and kill them. So it survives on the expense of other organisms.

-P.aeruginosa is known to survive in moist environments, detergents and disinfectants like alcohols, since their cell wall is not easily penetrated. So it

contaminates anti-septic agents, therefore it is highly virulent and dangerous organism if associated with patients who are immuno-deficient. Also, with burn cases as well as external otitis media during swimming, and may reach the blood stream and cause sepsis or reach the lungs and cause pneumonia.

-*P.aeruginosa* compared to the coliform group is more resistant to antimicrobial drugs and develops this resistance more rapidly, so infections by this organism are difficult to be treated and could be fatal.

It is more dangerous as it produces toxins and extracellular enzymes which can easily damage the tissue and spread during infection.

III) Salmonella group:

- Large group belongs to the Enterobacteriaceae family.
- Gram –ve facultative anaerobic bacteria, **Lactose non-fermenter.**
- Presence of endotoxins: they are special because they are associated with variety of polysaccharides.
- More than 2000 serotypes, each serotype is associated with specific polysaccharide, and needs a specific antibody.
- Difficult to fight all these serotypes because it is difficult to produce 2000 specific antibodies. But that doesn't mean that we're highly susceptible to infections because some serotypes are less pathogenic than the others.
- Only two specific antigens are important in relation to Salmonella are O-antigen (somatic antigen) and H-antigen (H: flagella).

-Because of the large number of serotypes that are difficult to be remembered, all types of Salmonella are classified into two major groups:

1) Gastroenteritis/ Food-poisoning Salmonella:

- Can be represented by *Salmonella enterica* (in relation to the intestines) or represented as *Salmonella enteritidis* (associated with infection that produce a form of enteritis).

- Some serotypes of Salmonella might produce systemic infections, might reach the blood stream and cause infection and might spread to the liver, gallbladder and to all parts of the body.
- Gastroenteritis: stomach + intestines, so there will be effects on the stomach in addition to effects on the intestines, thus having vomiting and diarrhea.
- Vomiting and diarrhea are important for the diagnosis of food poisoning by Salmonella.
- Gastroenteritis Salmonella is not only found in the intestines of humans but is found in all types of animals, and there are strains that only affect animals but not humans and vice versa.
- Most affected animals: farm chickens, up to 50% of farm chickens in our country are infected by Salmonella but not all are dangerous to humans, some strains are dangerous when they reach the human's intestines and cause gastroenteritis, and other strains might kill the chickens or animals.
- For any moving creature on the earth, it has a specific type of salmonella; birds have their type, camels have their own type... etc. As we said, we have 2000 serotypes of salmonella.

-Gastroenteritis due to salmonella or food-poisoning (non-typhoidal) salmonella, often associated with vomiting, diarrhea and mostly self-limited in healthy adults; so no need for antibiotics since the duration of diarrhea won't exceed 24-48 hours. While in cases of immuno-compromised patients especially infants and elderly patients, it can be very dangerous and causes sepsis or meningitis and kills the patients.

2) Typhoidal Salmonella: to be discussed in the next lecture.

Ladies and gentlemen, this is Anas Zughayer at your service.