

microbiology

Sheet

Slide

number

4

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Naming of Bacteria:

(scientific name) composed of **genus**- and **species** -
--genus—it always starts with a capital letter and species always starts with a small letter.

Ex.1 Staphylococcus aureus:

Staphylococcus is the **genus**
aureus is the **species**.

Ex.2 humans (Homo sapiens):

Homo is the **genus**

Sapiens is the **species**.

Ex.3 Streptococcus pneumonia

Streptococcus is the **genus**

Pneumonia is the **species**.

**** There is NO Streptococcus aureus.**

Classifications of Bacteria:

- 1- Gram-positive \ Gram-negative.
- 2- Bacilli \ cocci
 Cocci: clustered \ chains...
- 3- Aerobic \ Anaerobic.
- 4- Spore forming \ Non spore forming

EX. E. coli: is gram-negative, non-spore forming and facultative anaerobic (neither aerobic nor anaerobic).

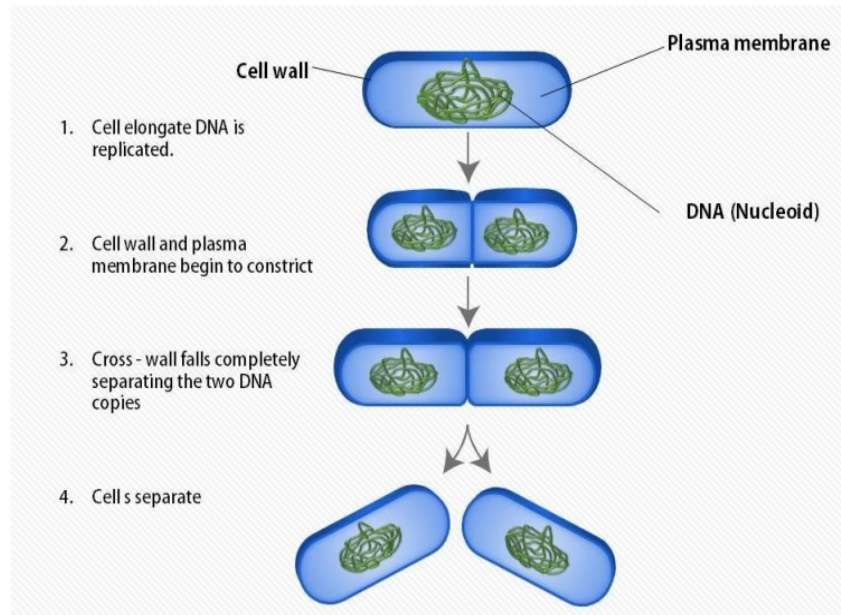
EX.2 Bacillus: is bacilli, gram-negative rod, aerobic and spore forming

Bacterial Physiology and Growth:

- Phases of bacterial growth
- Factors affecting bacterial growth

generation time:

- Bacteria reproduce by an asexual process (**Binary Fission**).

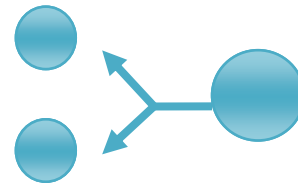


- Bacterial cell division to several cell (**single cell -> two identical cell -> four cell**) --> generation time.

Generation time or Doubling time: the interval of time between successive binary fission of a cell or population of cells.

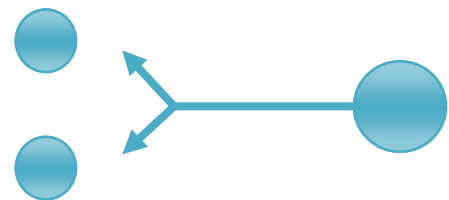
1. Short generation time :

Some bacteria such as *Escherichia coli* have very short generation time = 20-30 min.



2. Long generation time :

Mycobacterium tuberculosis needs 15 hours to produce two identical cells.



so generation time is not fixed for all bacterial cell, it's different according to species and is affected by temperature, PH, physical factor.

what the important of generation time ?

بنقدر نحسب عدد الخلايا الناتجة من الانقسام من خلاله مثلا (Escherichia coli) فترة تضاعفها تستغرق 20 دقيقة بعد 4 ساعات كم خلية تنتج؟

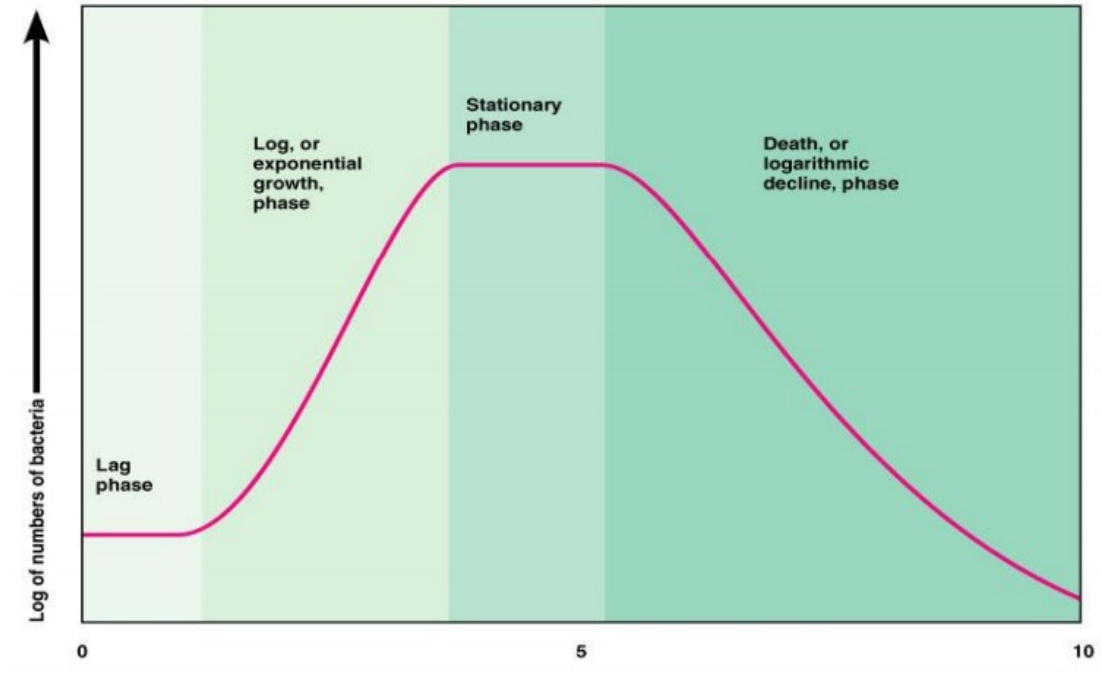
اولا بعرف كم فترة تضاعف بال 4 ساعات ...

$$(4 * 60)/20 = 12$$

تانيا بضرب عدد فترات التضاعف بعدد البكتيريا الي تتضاعف خلال هادي الفترة ...

طيب مثلا عنا (Mycobacterium tuberculosis) الي فترة تضاعفها كل 15 ساعة كم خلية تنتج بعد 4 ساعات الجواب صفر

Bacterial Growth Curve:



- **Lag phase:** the phase of a bacterial growth curve prior to binary fission, population numbers remain stable as bacteria prepare for division المرحلة الي بتكون اعداد البكتيريا مستقرة وتستعد للانقسام
- **Logarithmic phase (Exponential):** the phase of a bacterial growth curve when reproduction and growth are at their highest rates, double with each generation time Bacterial Growth Curve المرحلة الي اعداد البكتيريا بتزايد مستمر
- **Stationary phase:** the phase of a bacterial growth curve when the reproduction rate equals the death rate, stabilizing population المرحلة الي بتساوي فيها عدد البكتيريا الناتج من الانقسام بالي بموت

Population growth is limited by one of three factors:

1. exhaustion of available nutrients.
2. accumulation of inhibitory metabolites or end products.
3. exhaustion of space, in this case called a lack of "biological space". Bacterial Growth Curve

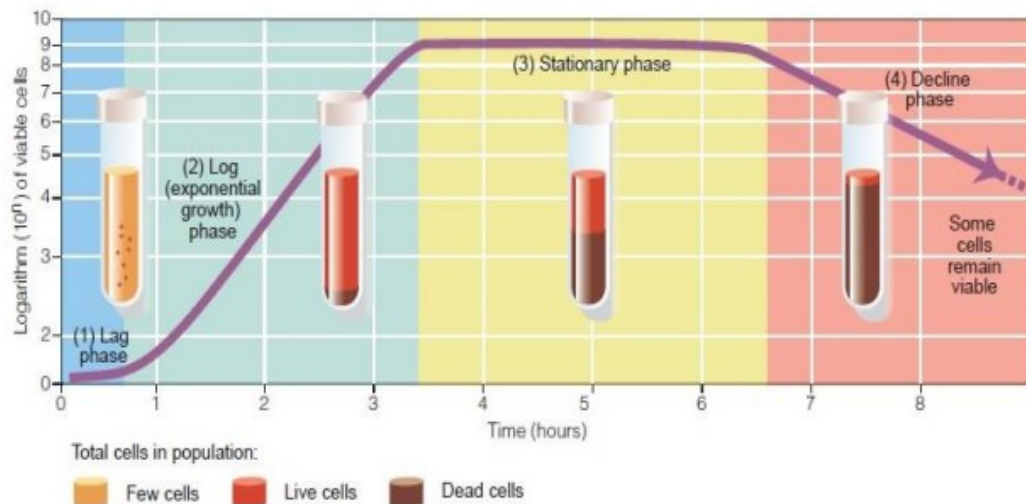
- **Decline phase (exponential death phase):** the period during which cell death becomes substantial. المرحلة الي بصير فيها عدد الخلايا الي يتموت اكثر بكثير للأسباب السابقة

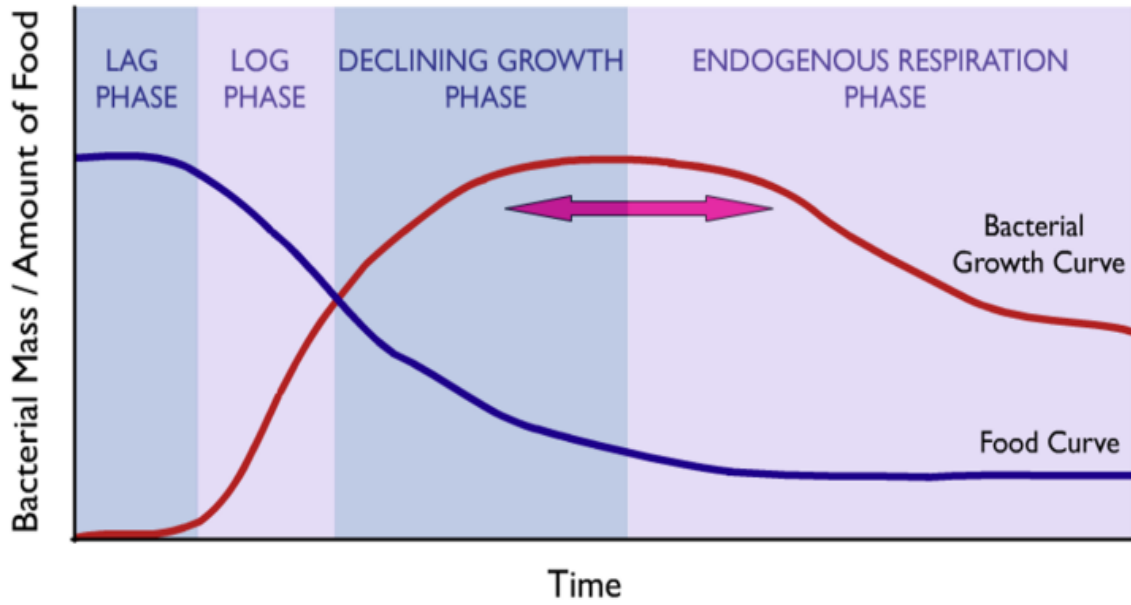
Note -> chemo stat: a system in which the chemical composition is kept at a controlled level

In this case, bacterial cells remain in Logarithmic Phase and do not move to Stationary phase.

a controlled level means:

- 1- Continues nutrients supply.
- 2- Continues removal Waste.





في هادي الصورة نلاحظ (Two curve) :

Bacterial Growth Curve -

Consumption food curve -

نلاحظ مع مرور الزمن بزيد عدد البكتيريا وبقلة عدد الطعام لفترة وبعدين برجع عدد البكتيريا يقل.

Factors effect Bacterial Growth :

1. Temperature.
2. PH.
3. O₂.
4. Pressure.
5. Nutrients.

The Effect of Temperature on bacterial Growth :

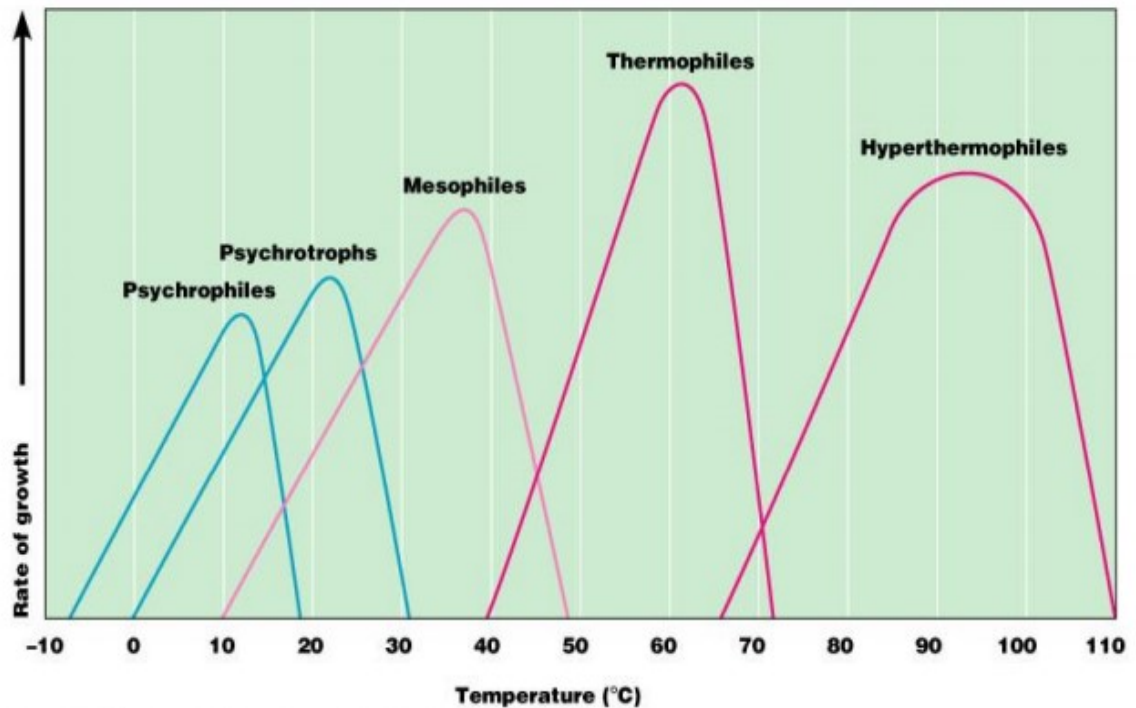
They divided into different groups such as:

1) Mesophilic: from 20-40 Degree.

Human bacterial cell live in Mesophilic such as normal flora

2) Psychrotrophs: less than 20 Degree (grow best at 15-20 degree)






3) Thermophiles: higher than 50 Degree (grow best at 50-60 degree)

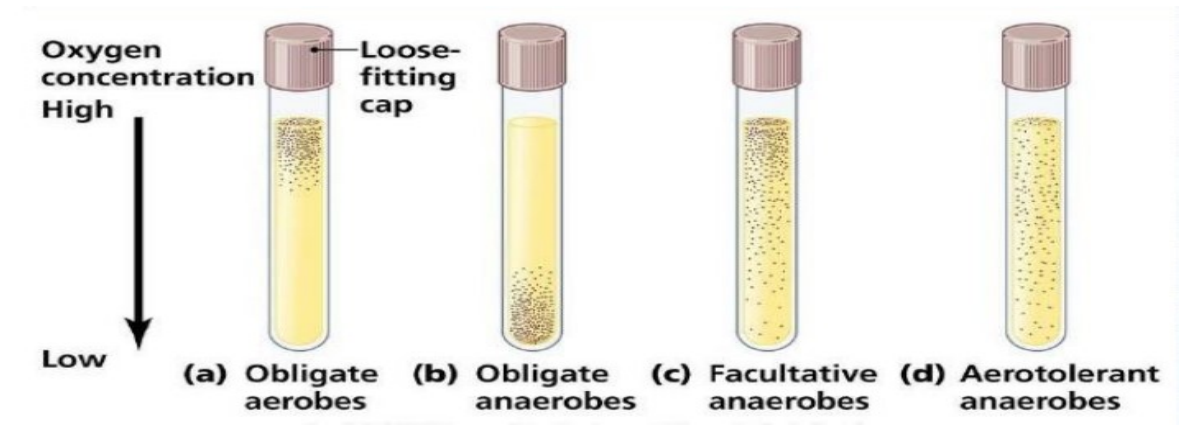


The Effect of oxygen on bacterial Growth:

1. Obligate aerobes
2. Facultative anaerobes
3. Obligate anaerobes
4. Aerotolerant anaerobes
5. Micro aerophiles

هاد الجدول جدا مهم بشرح كل اشي إله علاقة بالأوكسجين والبكتيريا مهم جدا

TABLE 6.1		The Effect of Oxygen on the Growth of Various Types of Bacteria				
	a. Obligate Aerobes	b. Facultative Anaerobes	c. Obligate Anaerobes	d. Aerotolerant Anaerobes	e. Micro-aerophiles	
Effect of Oxygen on Growth	Only aerobic growth; oxygen required.	Both aerobic and anaerobic growth; greater growth in presence of oxygen.	Only anaerobic growth; ceases in presence of oxygen.	Only anaerobic growth; but continues in presence of oxygen.	Only aerobic growth; oxygen required in low concentration.	
Bacterial Growth in Tube of Solid Growth Medium						
Explanation of Growth Patterns	Growth occurs only where high concentrations of oxygen have diffused into the medium.	Growth is best where most oxygen is present, but occurs throughout tube.	Growth occurs only where there is no oxygen.	Growth occurs evenly; oxygen has no effect.	Growth occurs only where a low concentration of oxygen has diffused into medium.	
Explanation of Oxygen's Effects	Presence of enzymes catalase and superoxide dismutase (SOD) allows toxic forms of oxygen to be neutralized; can use oxygen.	Presence of enzymes catalase and SOD allows toxic forms of oxygen to be neutralized; can use oxygen.	Lacks enzymes to neutralize harmful forms of oxygen; cannot tolerate oxygen.	Presence of one enzyme, SOD, allows harmful forms of oxygen to be partially neutralized; tolerates oxygen.	Produce lethal amounts of toxic forms of oxygen if exposed to normal atmospheric oxygen.	



Bacterial spores

They are for **survival**.

They are **resting cells**.

12 PART I Basic Bacteriology

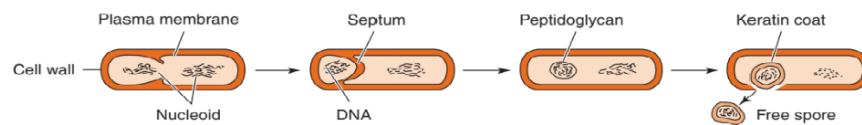


FIGURE 2-8 Bacterial spores. The spore contains the entire DNA genome of the bacterium surrounded by a thick, resistant coat.

Spores form inside the cell, which contain:

- 1- DNA
- 2- Small amounts of cytoplasm, cell membrane and peptidoglycan
- 3- Very small amount of water
- 4- **Keratinlike coat** that is responsible for spores resistancy to degradation(dehydration, heat , chemicals and radiation) it contains dipicolonic acid

There are two medically important genera which form spores

- 1- **Genus Bacillus.**
- 2- **Genus Clostridium.**

* Genera are the plural of genus.

as there is gram staining for bacteria, there is **spore staining** for spores.

- Clostridium:

Clostridium like and other clostridiums exist in nature as spores because they are **anaerobic**, and due to that they can't survive as normal cells so they form spores.

They are causes of serious infections:

- Clostridium tetani causes Tetanus disease.
- Clostridium prefringer causes Gas gangrene.

Mechanism of infection: these spores when they contaminate our wounds they cause the disease, when they enter the body and become in the tissue they convert to vegetative cells because they founded the right environment which is anaerobic (no oxygen). **For tetanus it could be a very small wound like a needle wound but for Gas gangrene it is a bad injury such as a nail or a dirty can or ironic piece wounds, the prefringers enter the devitalized tissue (trauma tissue) then the spores are activated and they start to generate from blood and tissue NOT from nutrients.**

* If we check the wounds there will be no spores detected.

- Bacillus:

An experiment in the lab will be having the Bacillus like subtilis and other bacteria like E.coli. They will be put in tubes in different temperatures (25. 37. 40) and left for 24 hours

* Bacillus is spore forming while E.coli is not.

Best growth will be recorded at physiological temperature (37) for both bacteria.

At 25 may grow and at 40 E.coli is probably dead (degraded) and Bacillus won't show growth(turbidity) . when temperature is lowered to 37c again E.coli won't show growth because it had been degraded by heat. Whereas bacillus will be growing again.

The reason is that bacillus forms spores at hard circumstances and it regenerates a full bacterium when nutrients and temperature are in an optimal value

If it was a liquid culture (liquid growth) = growth is seen as turbidity. For ex. URINE is normally clear but is there was urine tract infection; the urine will be turbid (bacterial growth).

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Ex.3 Streptococcus pneumonia

Streptococcus is the **genus**

Pneumonia is the **species**.

**** There is NO Streptococcus aureus.**

Diseases caused by bacteria:

- 1- Cholera
- 2- Chlamydia --- (very common STD) Chlamydia trachomatis.
- 3- Neisseria meningitis.
- 4- Syphilis ---treponema pallidum.
- 5- Tuberculosis ---- (TB) mycobacterium tuberculosis.

Remember:

- **Bacillus anthracis** --- anthrax.
- **Clostridium tetani** ---- tetanus.
- **Streptococcus pneumonia**---- pneumonia.
- **Bordello pertussis** ---- whooping cough A.K.A Pertussis.
- **Corynebacterium diphtheriae** ----diphtheria.
- **Streptococcus epidermidis** is a part of normal flora in skin.

VIRUS

structure:

- 1- **Either DNA or RNA.**
 - HIV is DNA.
 - Poliovirus is RNA.
- 2- **Sub cellular** (genome is surrounded by a protein coat called **capsid**. Genome + protein coat are called **nucleocapsid**)
 - some viruses have a structure around the coat called envelope (when the virus comes out of the host cell it takes a piece of the cell membrane or nuclear membrane and get mixed with viral proteins making the envelope)-host derived envelope – **viral envelope is a portion of the host cell membrane.**
- 3- **Obligate intracellular parasites.** (can't live without a host cell because it can't replicate with it's simple structure so it uses ribosomes and enzymes from the host cell)
- 4- **DNA could be singular or double stranded and could be linear or circular.**
RNA could be singular or double stranded and mostly linear.

Diseases caused by viruses:

- 1- Poliovirus ---- poliomyelitis (شلل الأطفال)
- 2- Rubella virus ---- measles (الحصبة)
- 3- Mumps virus ----- mumps (النكاف)
- 4- HIV ----AIDS
- 5- Influenza virus ---- influenza
- 6- Herpes---- genital herpes (can be STD)
- 7- West Nile virus-----encephalitis (transmitted by camels or so like, used to be only near the Nile river)

* Meningitis could be caused by virus or bacteria or fungi or parasite.

VIROIDS :

- 1- Smaller than viruses.
- 2- Basically they are single stranded and circular RNA only, **double stranded are called hairpin lobes because of the complement ability.**
- 3- They only infect plants , but there is only one type that infects human which is HepatitisD (HDV) known as delta agent in the past and it can only replicate with the presence of Hepatitis B virus using it's capsid.

- there is extensive sequence complementarity between HDV RNA and human liver cell RNA so HDV eventually causes cell death by sequestering cell's RNA and killing it .

Prions:

- 1- Smaller than viruses.
- 2- Composed of only one protein which has some carbohydrates in it.
- 3- They are infectious agents, they cause slow disease or we group them together and call them transmissible spongiform encephalopathies (TSEs), (they cause degenerative disease of the CNS and transmissible causing destruction of CNS by becoming a sponge like because of vacuoles after cell death causing permanent death after.
- 4- PrPc stands for (prion protein) and MW for it is 7000-3000

Diseases caused by prions

In humans:

- 1- Creutzfeldt Jakob syndrome (CJD).
- 2- Gerstmann Straussler Scheinker syndrome (GSS).
- 3- Fatal Familial Insomnia (FFI).

In sheep: Scrapie.

In cows: cow madness by Bovine Spongiform Encephalopathy.

Fungi

Eukaryote , can be single or multi cellular

-unicellular, **yeast** such as **Candida** (yeast fungus in the infection normally becomes a little multi cellular because the cells remain together so we call them pseudohyphae (the pods or daughter cells remain linked)) . candida is of our normal flora found in our bodies but can cause oral thrush in the very young or very old or people who has deficiency in immunity (you will see it right away on the tongue for little kids or white growth on people who wear dentures. For newborn infected, they can infect the mother and could be seen in skin scraping in infected in between skin folds or dipole rash in newborn.)

- Multi cellular fungi are known as **molds**(they are like chains we call one hypha and the group is called hyphae and a lot together are called mycelium) a lot of them are found in nature like

Asperger's fungus which can be seen in the corners of our homes because of humidity, it can be a cause of opportunistic infections allergy bronchopulmonary because the spores entered the lungs and cause symptoms like Asthma and can cause massive infections in immunocompromised like transplant patients or very very old terminal sick (Opportunistic = they usually don't cause disease but it does when immune system is weak.)

*Fungus science is called Micology

Parasites : uni or multi cellular

-Protozoa

no cell wall , only cell membrane.

- Entamoeba histolytica causes amoebic dysentery to distinguish it from bacillary dysentery which is caused by Shigella bacteria (rod shape)

- Symptoms include bloody feces and a lot of mucus because both cause inflammation causing destruction in the mucus and it is different than diarrhea (loose stool)

-Helminths :

Ex. Enterobius vermicularis which is a very small worm called pinworm mostly affects children in GI. The female lays its eggs in the child and he will have a very itchy anus (female is bigger than the male)

Ex.2 Schistosoma are flat worms and they cause Schistosomiasis also known as bilharzias

luckyly not found in our area but found in Egypt because of the existence of snails there.