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Microbiology

Doctor 2017 | Medicine | JU

◉ Sheet ○ Slides

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Revision in form of questions:

1- **W**hich of the following is the true order of ATP production from highest to lowest? (R stands for respiration)

1-Aerobic R in Eukaryotes **2-Anaerobic R** **3- fermentation** **4- Aerobic R in prokaryotes**

A- 1,3,2,4 B- 1,4,2,3 C- 4,1,2,3 D- 2,4,1,3

2- **T**he importance of knowing the pathway pyruvate takes is:

1-Defining bacteria type 2- There is no importance

3- **T**he pathway that starts with pyruvate and ends with ribose is:

a- EMP b- Entner Douderoff c- PENTOSE PHOSPHATE

Proteins and Lipids metabolism

- **Proteins :**

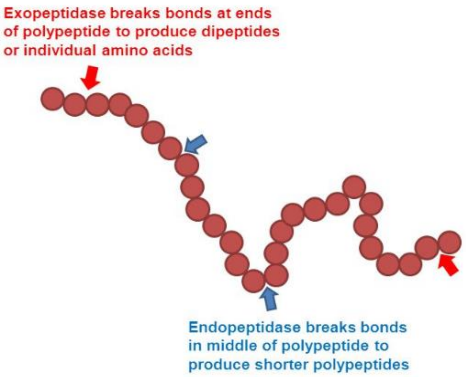
⇨ Metabolism of Proteins and lipids in Prokaryotes is similar to that in Eukaryotes.

⇨ Proteins are broken down by peptidases (proteinases) so that the resulted amino acids can enter the cell. These peptidases could be:

A- Exopeptidases: cuts down terminally.

(Can you remember Exopeptidases types from biochem course?)

B- Endopeptidases: cuts down internally.



⇨ These amino acids can be used:

1- Directly to synthesize proteins (by transcription and translation).
2- To synthesize other amino acids (e.g., synthesis of Tyr from Phe).
3- Enter Krebs cycle to produce energy (by enzymes that changes their shape).

⇨ Some amino acids are essential, which means they can't be synthesized by the cell. Every organism has its own essential amino acid. For instance, Val is essential for humans but may not be essential for other organisms.

⇨ A backbone is needed to synthesize amino acids, this backbone come from different metabolic pathways (CAC, glycolysis, pentose phosphate pathways).

⇨ Examples of backbones in CAC are:

Alphketoglutarate —(Transaminase)→ glutamic acid

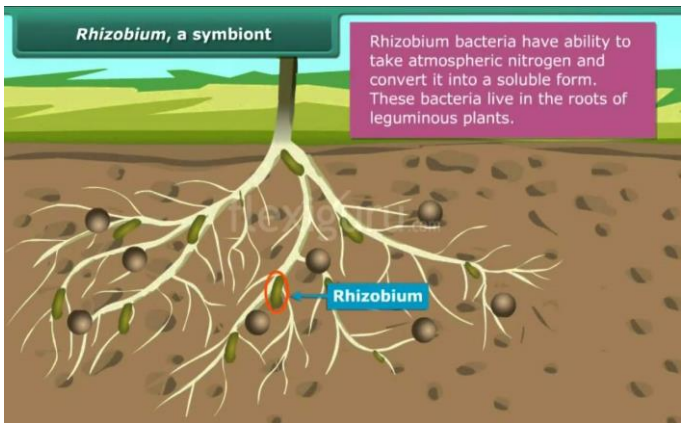
Oxaloacetate —(Transaminase)→ aspartic acid

⇨ In addition to that backbone, we will need Nitrogen to make our AA, which mostly comes from free NH_3. Other sources include taking the NH_3 from an already formed AA or a nucleotide (organic sources) by deaminases and aminotransferases.

⇨ Diazotrophes can turn N_2 Gas into ammonia in a process called Nitrogen fixation by nitrogenases. However, this process is costly in energy and that's why it's the last choice for the cell.

⇨ Diazotrophes are usually prokaryotes (some are bacteria, but most are archaea). These organisms are either:

1- Free living as ***Klebsiella pneumoniae***
2- Symbiotic Rhizobia (تكافلية). This bacteria forms nodules on the roots of legumes (بقوليات). Here, the bacteria can use some enzymes from the plant, while the plant can use the fixed nitrogen.



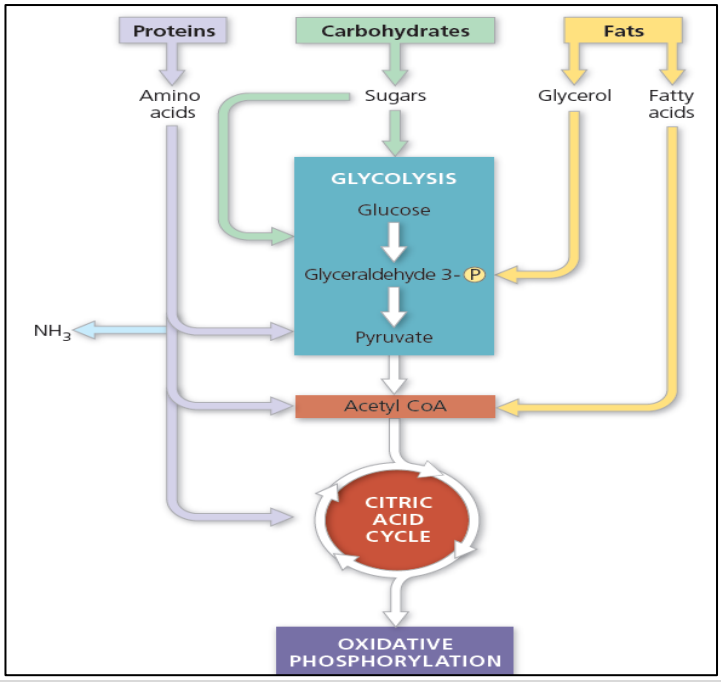
Note: When the legume dies, these nodules will break down. Therefore, the soil becomes rich in nitrogen. Farmers use this method for good soil instead of fertilizers which are dangerous.

- **Lipids :**

⇨ They are also broken down before entering the cell (by lipases/phospholipases).

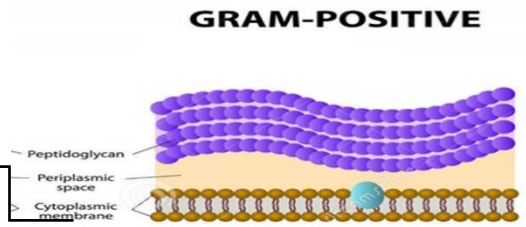
⇨ Breaking down lipids results in

A- Glycerol can be converted to pyruvic acid.
B- Fatty acids, which can fit to Krebs cycle by a process known as Beta-oxidation.

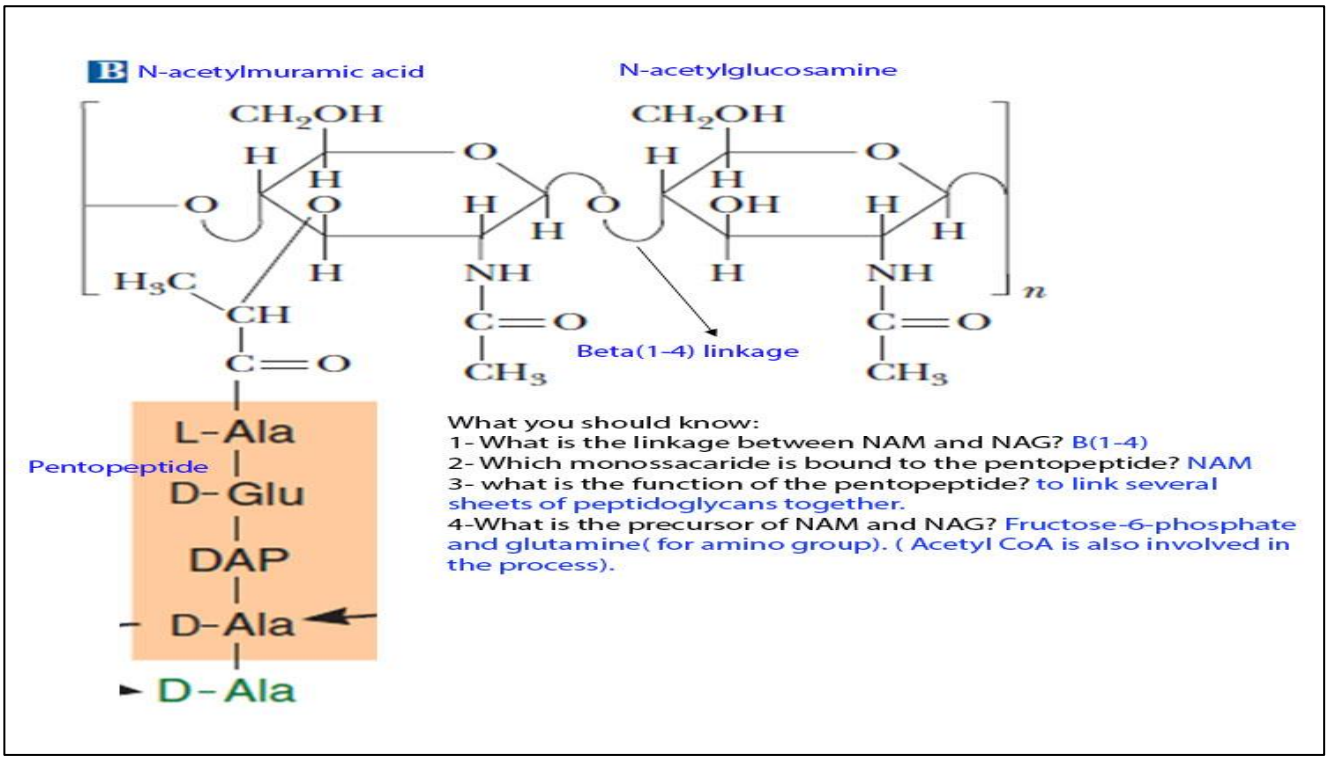


Cell Wall synthesis

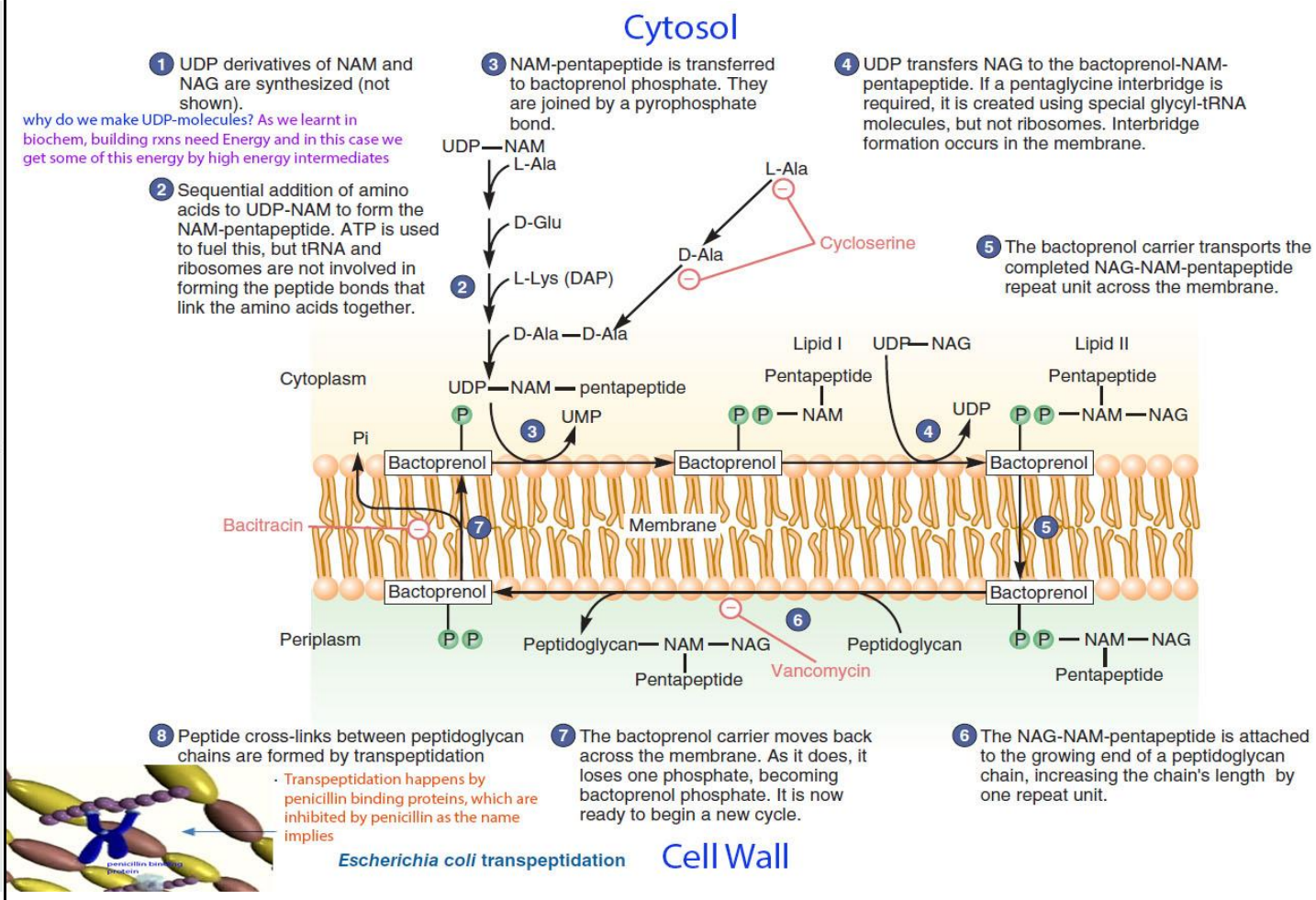
Remember the arrangement of layers in **a gram-positive** bacterium:
Cell membrane>periplasmic space> peptidoglycan

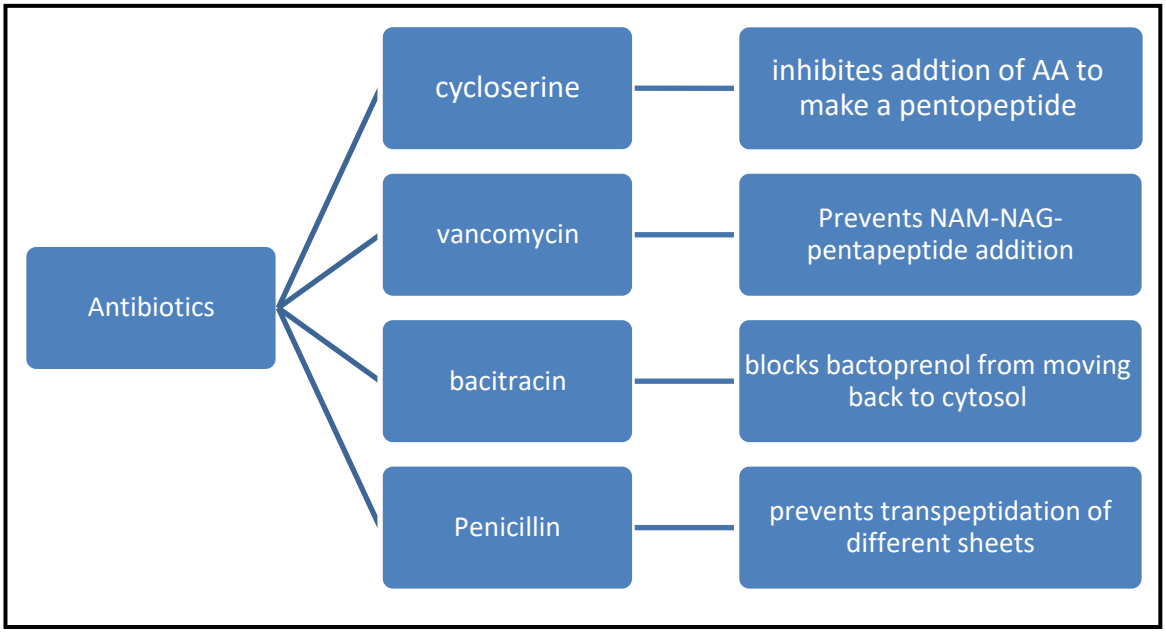


⇨ Peptidoglycan is made by a peptide part and a sugar part :



⇨ There is high osmotic pressure in the bacteria cells, which can be measured in atm unit. This high osmotic pressure causes the cell to lyse, if the cell wall is damaged (think of it as a football) .


Cytosol
1 UDP derivatives of NAM and NAG are synthesized (not shown).
why do we make UDP-molecules? As we learnt in biochem, building rxns need Energy and in this case we get some of this energy by high energy intermediates
2 Sequential addition of amino acids to UDP-NAM to form the NAM-pentapeptide. ATP is used to fuel this, but tRNA and ribosomes are not involved in forming the peptide bonds that link the amino acids together.
3 NAM-pentapeptide is transferred to bactoprenol phosphate. They are joined by a pyrophosphate bond.
4 UDP transfers NAG to the bactoprenol-NAM-pentapeptide. If a pentaglycine interbridge is required, it is created using special glycyl-tRNA molecules, but not ribosomes. Interbridge formation occurs in the membrane.
5 The bactoprenol carrier transports the completed NAG-NAM-pentapeptide repeat unit across the membrane.
UDP—NAM
L-Ala
D-Glu
L-Lys (DAP)
D-Ala—D-Ala
L-Ala
D-Ala
Cycloserine
Cytoplasm
UDP—NAM—pentapeptide
UMP
Pi
Bactoprenol
Lipid I
Pentapeptide
NAM
UDP—NAG
UDP
Lipid II
NAG
Bacitracin
Membrane
Periplasm
Peptidoglycan—NAM—NAG
Pentapeptide
Vancomycin
Peptidoglycan
8 Peptide cross-links between peptidoglycan chains are formed by transpeptidation
Transpeptidation happens by penicillin binding proteins, which are inhibited by penicillin as the name implies
7 The bactoprenol carrier moves back across the membrane. As it does, it loses one phosphate, becoming bactoprenol phosphate. It is now ready to begin a new cycle.
6 The NAG-NAM-pentapeptide is attached to the growing end of a peptidoglycan chain, increasing the chain's length by one repeat unit.
Escherichia coli transpeptidation
Cell Wall


Antibiotics
cycloserine
inhibites addtion of AA to make a pentopeptide
vancomycin
Prevents NAM-NAG-pentapeptide addition
bacitracin
blocks bactoprenol from moving back to cytosol
Penicillin
prevents transpeptidation of different sheets

Capsule and granule synthesis

Capsules are made of polysaccharide, they can be rigid or loose (slime layer). The formation of the capsule depends on the available nutrients for the cell (such as glucose and fructose).

⇨ The environment/available nutrients determine if the bacteria will form a capsule.

⇨ The Capsule is antiphagocytic, which means immune cells have difficulties in engulfing the bacteria.

⇨ If antibodies bind to the capsule, it will be easier for phagocytes to engulf the cell.

⇨ When some bacteria have an excessive nutrients, they form granules which are filled with these nutrients for hard times.