Introduction to Microbiology

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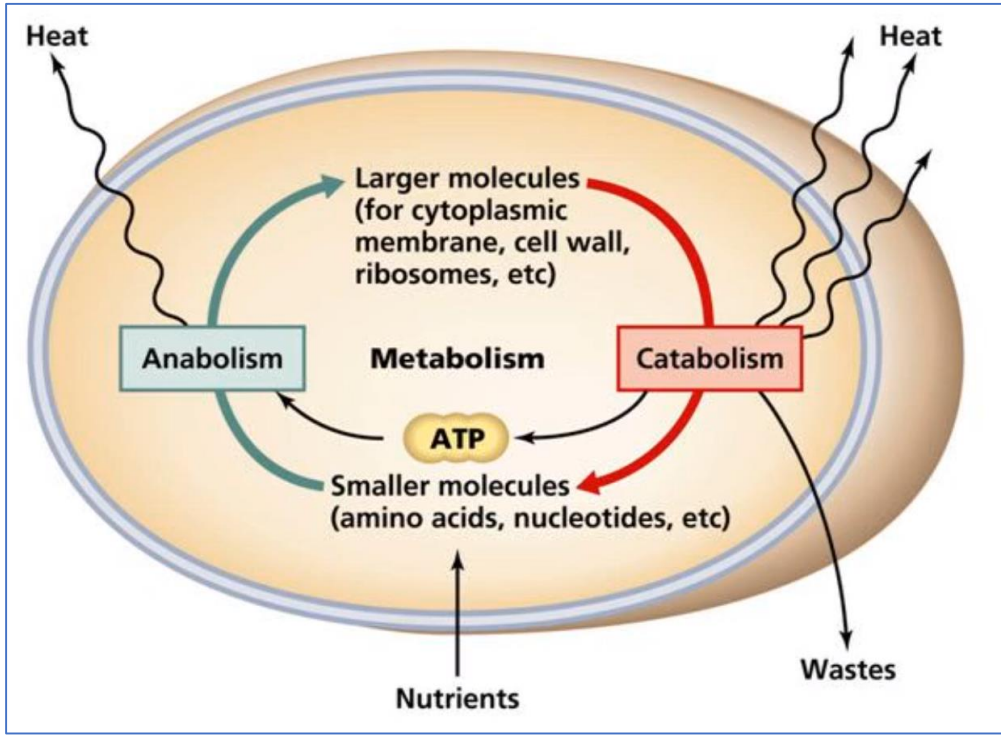
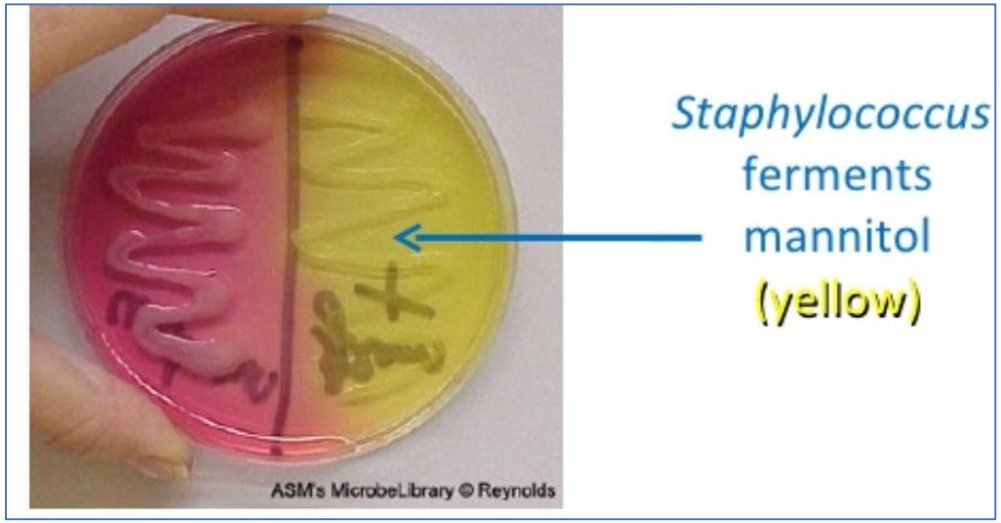
Lecture 6

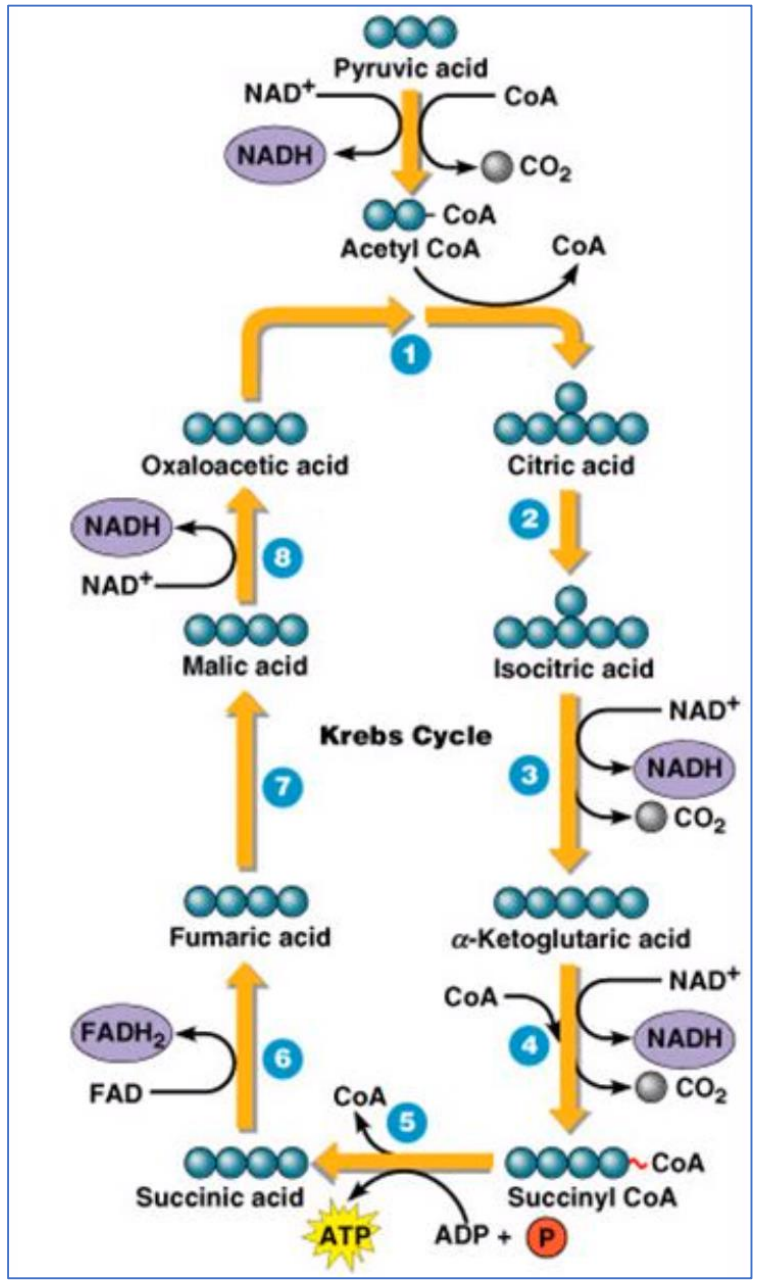
Bacterial metabolism

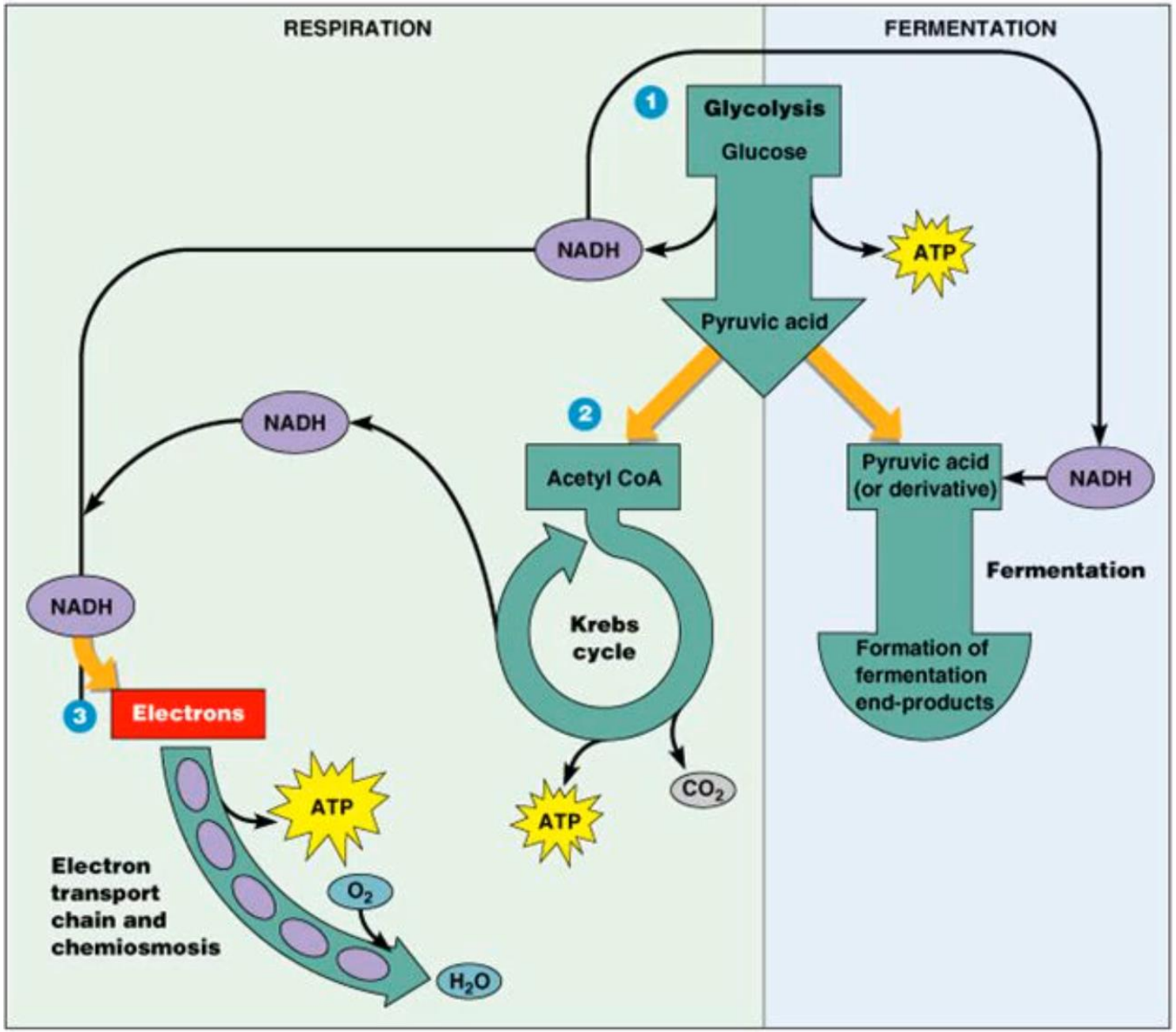
- All cells require energy to survive and grow, and it can be obtained from breakdown of molecules (catabolism).
- The energy can then be used to build cellular constituents (anabolism).
- Different bacteria use different metabolic pathways depending on the nutrients available in its environment.
- Growth requirements and metabolic byproducts may be used in classifying and identifying different bacteria.





Carbohydrates are a major energy source



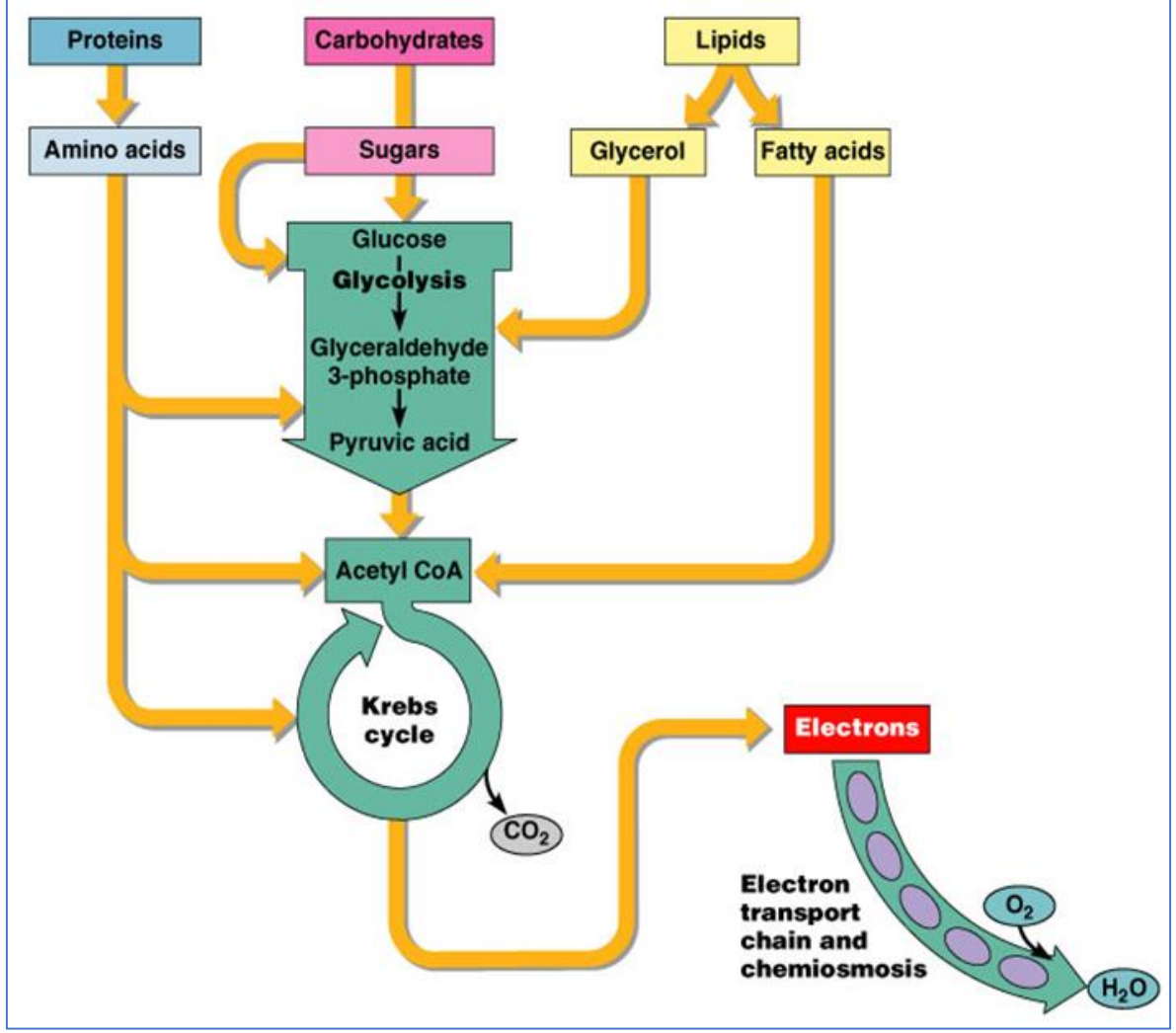


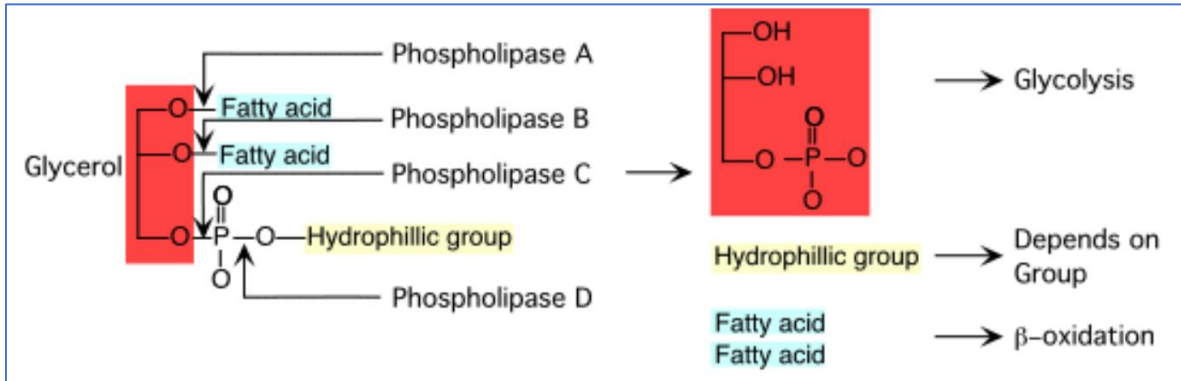
Protein and lipid metabolism

- Proteins are broken down by peptidases to amino acids permitting entry to the cell.

- Amino acids can then be used to form new proteins, other amino acids (ex. Transamination), or enter the Krebs cycle for energy generation.

- Lipids are broken down by lipases to glycerol and fatty acids. Glycerol can be converted to pyruvic acid via glycolysis and fatty acids enter the Krebs cycle following β-oxidation.

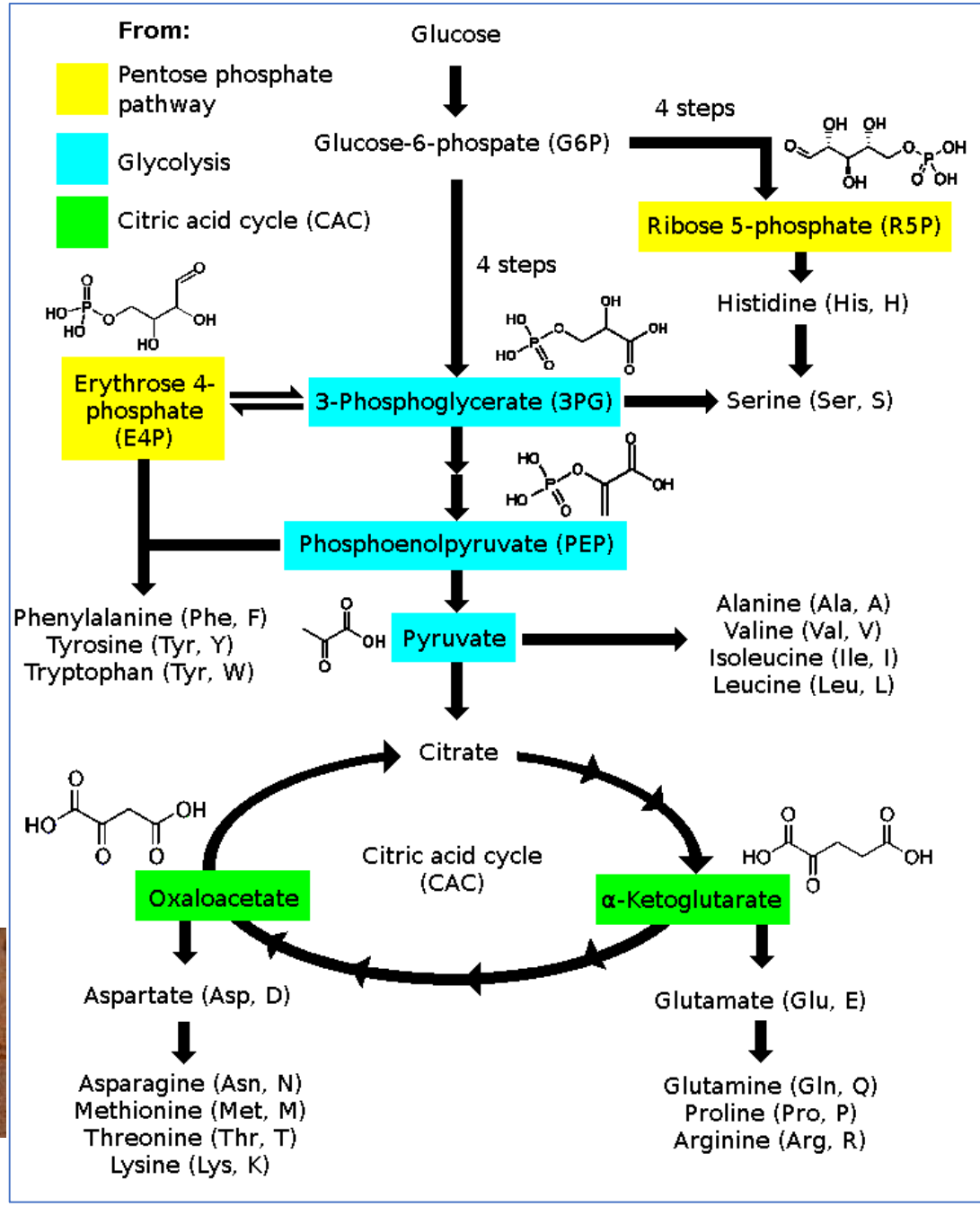




Amino acid (aa) synthesis

- Not all organisms can synthesize aa, some should be present in the media.
- The carbon backbones come from other metabolic pathways, while nitrogen comes from ammonia.
- Ammonia (NH_3) can come from Nitrogen (N_2) fixation. A process performed by Diazotrophs.

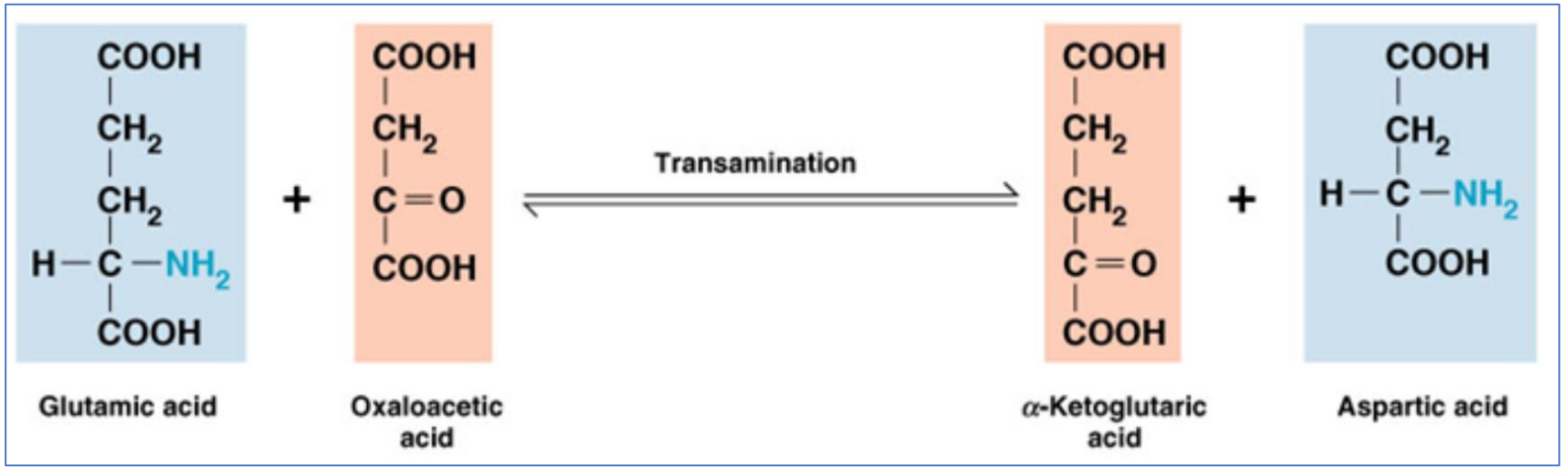
- Nitrogenases perform fixation in an energy costly reaction.



Amino acid (aa) synthesis

- Other nitrogen containing organic sources (urea, nucleotides or amines not used in protein synthesis) can be acted upon by enzymes (deaminases, decarboxylases and aminotransferases) to release the ammonia and make it available for biosynthesis.

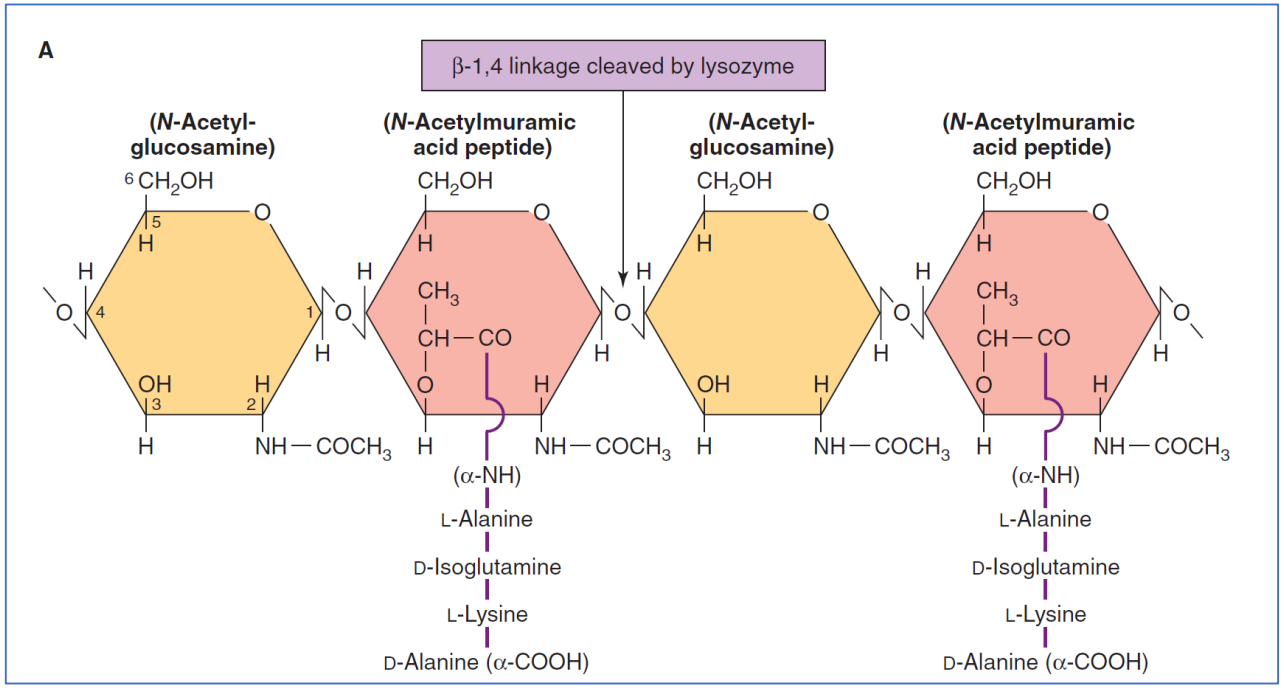
- Most amino acids are synthesized from α-ketoacids and later transaminated from another amino acid, usually Glutamic acid. The enzyme involved in this reaction is an aminotransferase

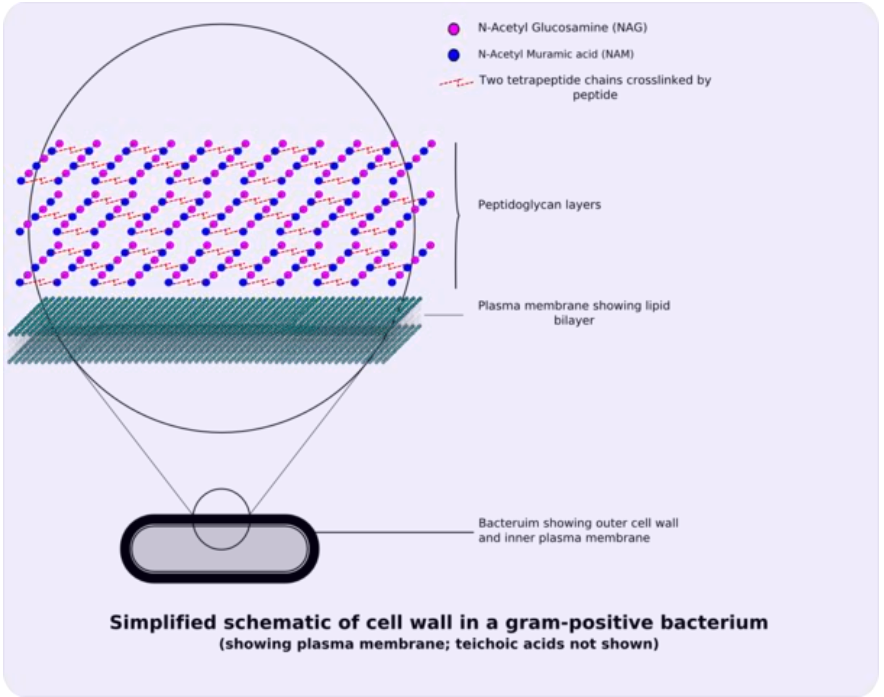


Cell wall synthesis/ Peptidoglycan

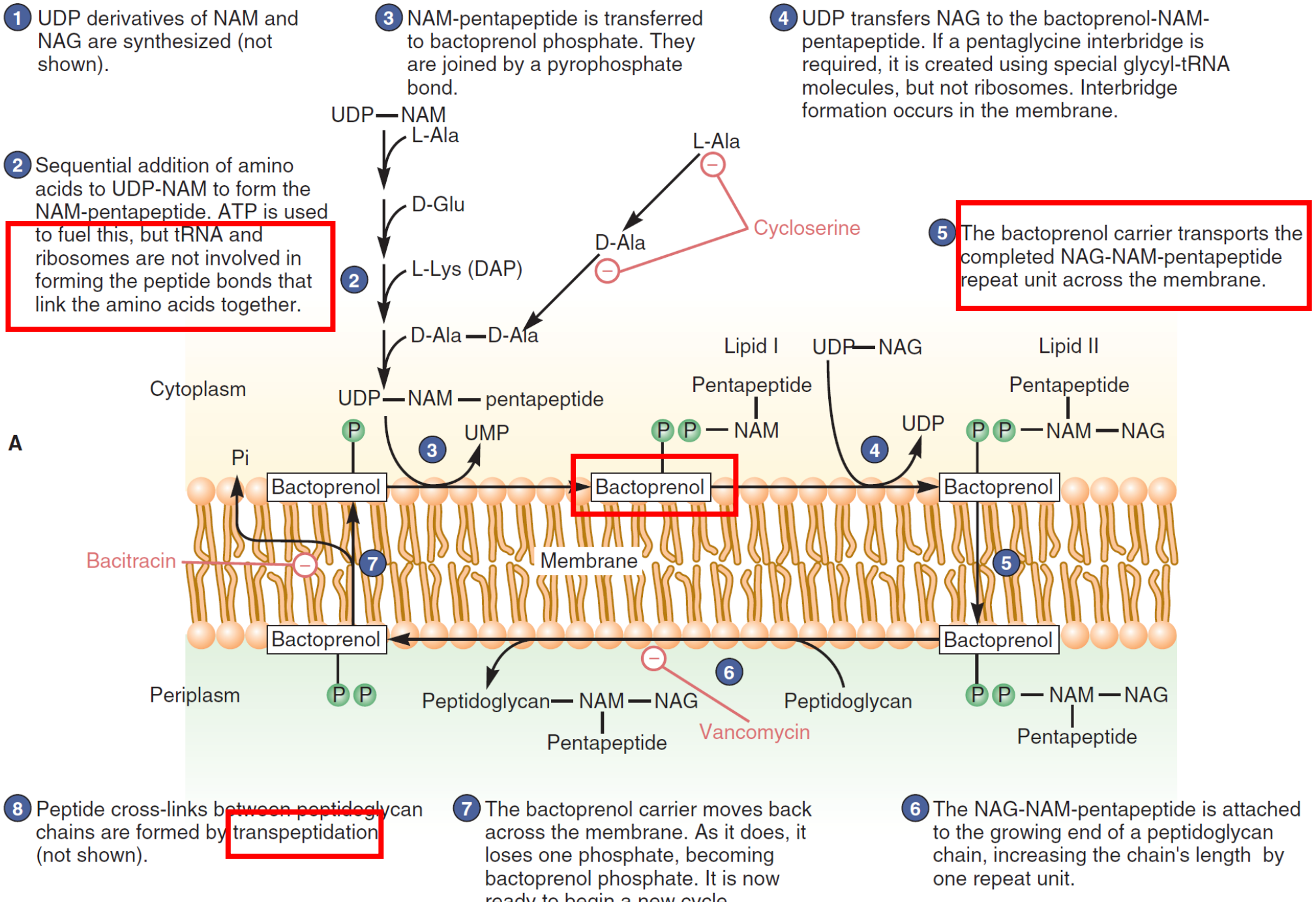
- Peptidoglycans: polysaccharide chains made of alternating N-acetylmuramic acid (NAM) and N-acetylglucosamine (NAG) residues. <u>Pentapeptide chains are attached to the NAM groups.</u>

- The PGN monomers are synthesized in the cytosol using glutamine, fructose 6-phosphate, acytel Co-A.





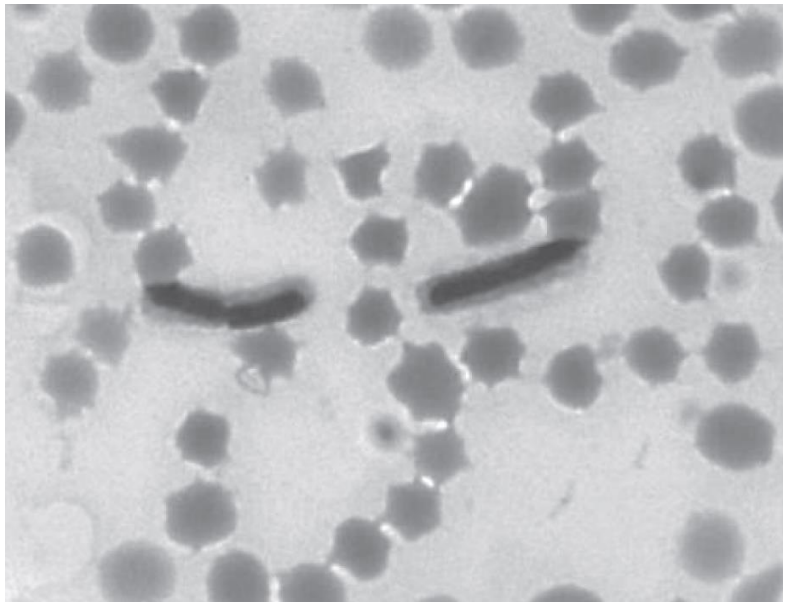
Transpeptidation is catalyzed by one of a set of enzymes called penicillin-binding proteins (PBPs). PBPs bind penicillin and other β-lactam antibiotics

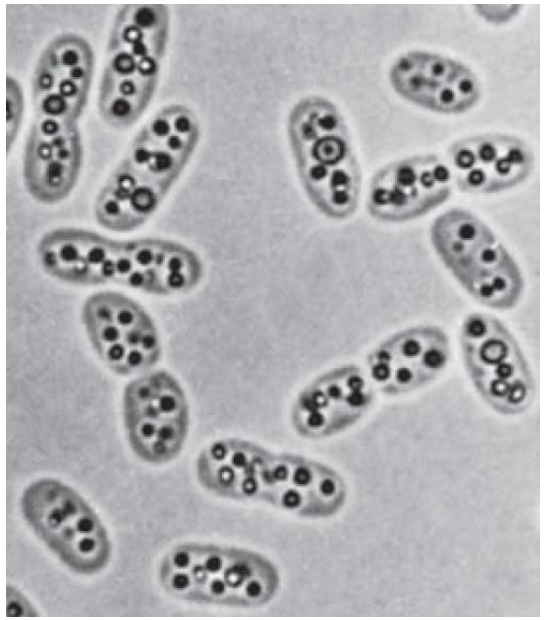


Capsule and granules synthesis

- Capsule formation depends on the presence of certain nutrients (glutamic acid, glucose, ribose) in the medium.

- Reserve granules can be used to store nutrients (ex. Glycogen, starch) when in excess, to be used when nutrients are depleted.





Further reading:

- Murray - Medical Microbiology 8th Edition
  Section 4: Bacteriology
  Chapter 13: Bacterial metabolisim and genetics

- Jawetz, Melnick & Adelberg's Medical Microbiology, 26th edition-
  Section 1: Fundamentals of Microbiology-
  Chapter 6:Microbial metabolism