

Bacterial Nutrition- Microbiology Test 4A

I. Basic Nutritional Requirements

A. carbon

1. forms backbone for synthesis of small molecules in the cell
2. energy source

B. nitrogen

1. found in nitrogen-containing compounds, such as proteins and coenzymes

C. phosphorus

1. found in nucleic acids, ATP, and a large number of phosphorylated compounds

D. sulfur

1. found in cysteine and methionine (amino acids) and coenzyme A

E. potassium

1. needed for enzymatic reactions, such as protein synthesis

F. magnesium

1. found in DNA-metabolizing enzymes
2. stabilizes DNA and ribosomes
 - a. 2 positive charges of Mg bind to the negative charges of the phosphates in DNA

G. iron

1. found in cytochromes- part of electron transport system

H. cobalt

1. found in the vitamin B-12

I. calcium

1. involved in enzymatic reactions and sporulation

J. zinc, copper...

1. trace minerals found in metalloenzymes- enzymes that have metals as part of their structure

II. Minimal Media

A. 5 basic requirements

1. KH_2PO_4 = monobasic potassium phosphate
2. K_2HPO_4 = dibasic potassium phosphate
 - a. 1 and 2 provide a source of potassium and phosphate
 - b. they also form a buffer solution to allow pH to be maintained at some desired point
3. sodium citrate
4. $(\text{NH}_4)_2\text{SO}_4$ = ammonium sulfate
 - a. serves as a source of nitrogen and sulfur
5. glucose

B. E. coli will grow with in this minimal media b/c can make vitamins, amino acids, etc. using glucose

III. Media for Fastidious Organisms

A. have many requirements

1. minimal media
2. large numbers of carbon sources (sugars)
3. vitamins
4. nucleosides
5. amino acids

B. need enriched media b/c these org are genetically deficient- can't make products using glucose

Shayna Goodman

IV. Rich Media

A. defined

1. put in carbon sources, amino acids, bases, vitamins, etc. and know what's in it
2. advantage is if have unknown org and want to know what it needs to grow, you can vary sources from the medium and see what org needs to grow- have control over medium

B. soup

1. don't need to know what's in medium, just that it has a lot of nutrients
2. can grow large numbers of bacteria this way- don't care how, just need bac
3. 2 ways to get this type of soup
 - a. meat digest
 1. use trypsin (a protease) to digest the meat
 2. add the meat digest to a minimal salts medium to get a rich medium
 - b. meat or yeast extract
 1. boil meat or yeast and extract stable small molecules- vitamins, amino acids, etc.
 2. take the liquid with the molecules and add it to a minimal salts medium

V. Exoenzymes

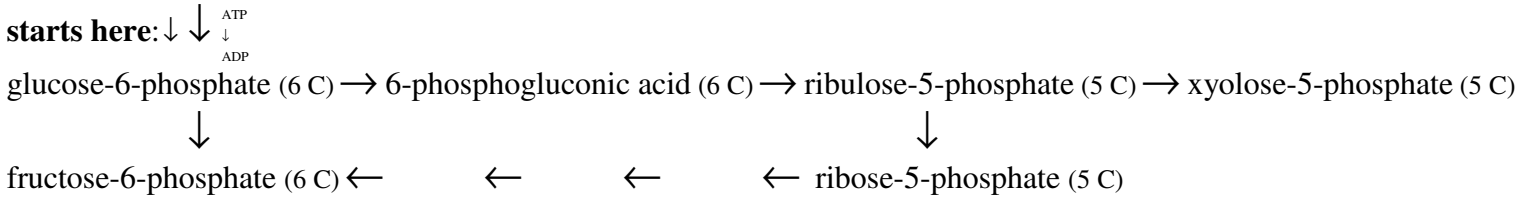
- A. proteins that are made inside the cell and extend outward linearly signal peptide first
- B. they break down large molecules outside the cell into small molecules
- C. the cell can then take in the molecules via facilitated diffusion, active transport, or group translocation
- D. ex: of exoenzymes
 1. polysaccharidases- break polysaccharides into sugars
 - a. amylase breaks down amylose
 - b. cellulase breaks down cellulose
 - c. pectinase breaks down pectine
 2. mucopolysaccharidases- break mucopolysaccharides into sugars
 - a. hyaluronidase breaks down hyaluronic acid
 - b. chitinase breaks down chitin
 3. nucleases- break nucleid acids into bases, nucleotides, and sugars
 4. lipases- break lipids into fatty acids
 5. phosholipases- break phospholipids into glycerol and fatty acids
 6. proteases- break proteins into amino acids
- E. exoenzymes are virulence factors
 1. they break down patient's nucleic acids, proteins, and phospholipids

VI. Metabolism

- A. it is the sum total of all reactions taking place inside a bac cell
- B. 2 types:
 1. breakdown (catabolism)
 2. synthesis (anabolism)
- C. each step in a metabolic pathway is catalyzed by an enzyme
 1. the product of each step is used as a substrate for the next step

IX. Pentose Cycle=Hexose Monophosphate Shunt

A. glucose (6 C)

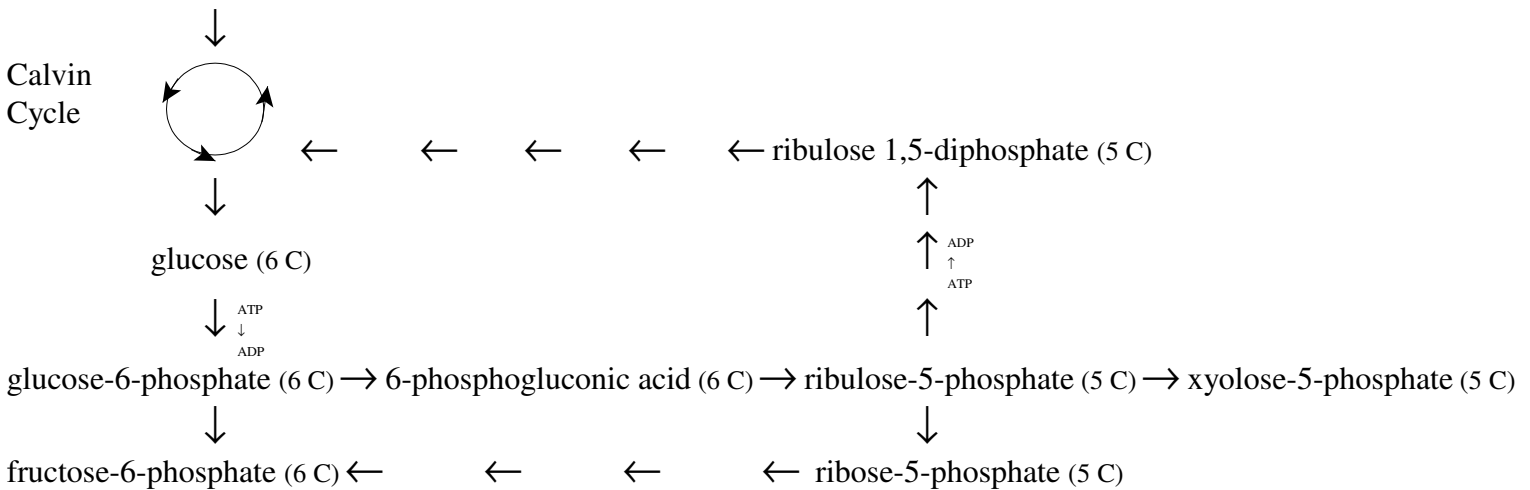


B. 2 imp't things about the pentose cycle

1. it's the source of 5 carbon sugars for DNA and RNA
 - a. ribose-5-phosphate becomes ribose and deoxyribose
2. it's the source of NADPH
 - a. NAD (nicotine adenine dinucleotide) is a shovel molecule
 - b. it picks up protons and deposits them elsewhere
 - c. it provides reducing power- putting protons on other molecules reduces the molecules
 - d. this is imp't for biosynthesis reactions

X. Calvin Cycle

A. carbon dioxide



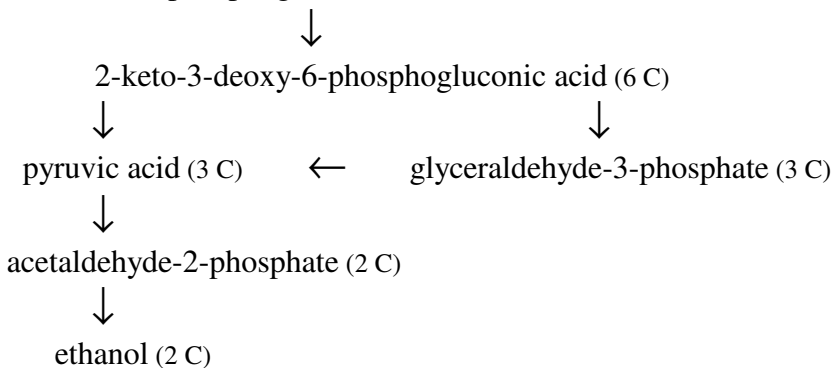
B. this cycle is a series of cyclic reactions that is essentially like photosynthesis

1. only photosynthetic bac undergo Calvin cycle

C. this cycle makes products used for glycolysis

XI. Entner-Doudoroff Pathway

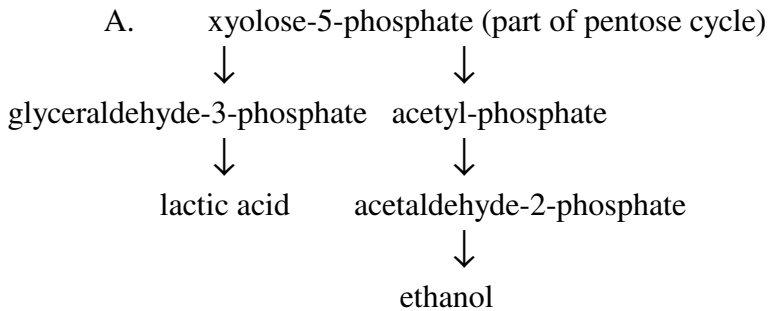
A. 6-phosphogluconic acid (6 C)



B. this pathway does not produce acid (ethanol is neutral)

1. growing bac usually produce acid (as part of glycolysis and Kreb's) which limits growth
2. this is imp't for diagnostic microbio
 - a. if org does not produce acid, it must be org that has this pathway
 - b. ex: pseudomonas uses this pathway and does not produce acid when it grows

XII. Heterolactic Pathway



XII. What can bac grow on as carbon source?

A. any molecule which can directly or indirectly fit into one of the intermediates of the central pathways (glycolysis, Krebs's, and pentose)

1. lactose- can be converted into galactose and glucose (glycolysis)
2. galactose- can be converted to glucose (glycolysis)
3. glucose (glycolysis)
4. fructose- can be converted to fructose-6-phosphate (glycolysis)
5. glycerol- can be converted to glycerol-phosphate and then to DHAP (glycolysis)
6. pyruvate- can be converted to pyruvic acid (glycolysis)
7. acetate- can be converted to acetyl coA (glycolysis)
8. citrate- can be converted to citric acid (Krebs's)
9. succinate- can be converted to succinic acid (Krebs's)
10. ribose- can be converted to ribose-5-phosphate (pentose)
 - a. in the cell, these molecules exist in acid form (ex: citric acid, pyruvic acid), but we add salt form to medium (ex: citrate, pyruvate)

XIII. Internal Sources of Nutrition

A. protein breakdown

1. bac break their own proteins into amino acids
2. amino acids are exposed to the enzyme deaminase which removes the amine groups
3. then they're exposed to decarboxylase which removes the carboxyl groups
4. the molecules that are left are just chains of carbons that can go through glycolysis and/or Krebs's cycle by serving as carbon source directly or indirectly

B. lipid breakdown

1. bac break their own phospholipids into fatty acids and glycerol via phospholipases
 - a. glycerol can be converted into DHAP (glycolysis)
 - b. fatty acids can be converted into acetyl coA (glycolysis)

C. carbohydrate breakdown

1. bac break their glycogen into glucose (glycolysis)

XIV. Biosynthesis

A. need 3 things:

1. carbon skeletons from glycolysis, Krebs's cycle, and pentose cycle
2. reducing power from NADPH from pentose cycle
3. an energy source
 - a. ATP
 - b. acetyl-phosphate
 - c. acetyl coA
 - d. phosphoenol pyruvate

C. impt points:

1. from a single molecule of glucose, you can make the entire bac cell (cell mem and wall, proteins...)
2. there's flow- these reactions happen simultaneously
 - a. tremendous amount of biosynthesis taking place simultaneously
 - b. ex: E. coli doubles every 20 mins- all this happens

XV. Different Types of Pathways

- A. catabolic- breakdown
- B. anabolic- synthetic/buildup
- C. amphibolic- pathways that can be considered catabolic or anabolic depending on your point of view
 1. ex: glycolysis
 - a. catabolic from point of view of carbon breakdown
 - b. anabolic from point of view of biosynthesis

XVI. Anaerotic Reactions (replenishing)

- A. biosynthesis drains away 4 carbon intermediates of Krebs's cycle
- B. replenish them 2 ways:
 1. use PEP carboxylase
 - a. PEP + carbon dioxide → oxaloacetic acid
 1. bringing in new carbon dioxide yields more oxaloacetic acid to continue Krebs's
 2. glyoxylate bypass
 - a. has 2 steps:
 1. isocitric acid (6 C) → succinic acid (4 C) + glyoxylic acid (2 C)
 2. glyoxylic acid (2 C) + acetyl coA (2 C) → malic acid (4 C)

b. diagram looks like this:

