Clinical biochemistry

Clinical chemistry is the area of **chemistry** that is generally concerned with analysis of body fluids for **diagnostic** and therapeutic purposes (also known as chemical pathology, clinical biochemistry or medical biochemistry). The most common specimens tested in **clinical chemistry** are blood and urine. ... Components may include blood glucose, electrolytes, enzymes, hormones, lipids (fats), other metabolic substances, and proteins.

Metabolism is the process through which living systems obtain and use free energy to carry out functions. Metabolism requires highly coordinated cellular activity.

Metabolism performs 4 functions

1. Obtain energy for the cell.
2. Convert nutrients into macromolecules.
3. Assemble macromolecules into cellular structures.
4. Degrade macromolecules as required for biological function.

Metabolism consists of catabolism and anabolism.

Catabolism is the degradation pathways to salvage components and energy from biomolecules such as nucleotides, proteins, lipids and polysaccharides. The process generates energy.

Anabolism is the biosynthesis of biomolecules such as nucleotides, proteins, lipids and polysaccharides from simple precursor molecules. This process requires energy.

Biomolecules are composed predominantly of carbon, hydrogen, oxygen and nitrogen.

All living things require a source of energy, carbon, oxygen and nitrogen.

I. Energy and Carbon

Autotrophs – Self feeding

Autotrophs are prokaryotes that can produce all of their cellular components from simple molecules such as H_2O, CO_2, NH_3 and H_2S. These are self-sufficient cells that utilize CO_2 from the atmosphere as the carbon source.

Chemolithotrophs-obtain free energy via the oxidation of inorganic compounds such as NH3, H2S or Fe+2.

Photoautrophs – obtain free energy from light photons via photosynthesis.

Heterotrophs – Feeding on others.

Heterotrophs obtain energy by oxidation of organic compounds
(carbohydrates, lipids, or protein).
Heterotrophs obtain carbon from glucose, proteins and lipids. Ultimately Heterotrophs depend on autotrophs for these organic compounds.

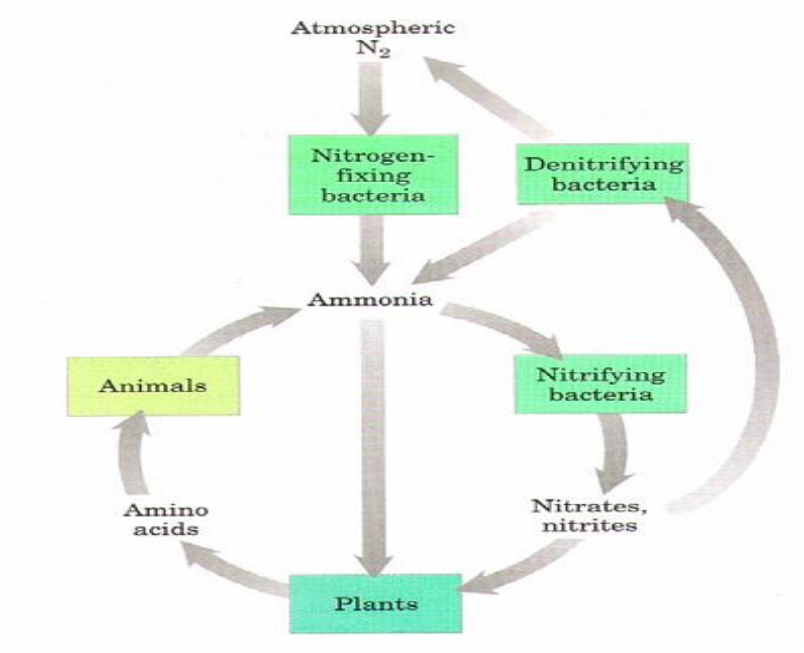
II. Oxygen

Living organisms can obtain oxygen from the atmosphere or from water.
Aerobes – live in the presence of oxygen. They use oxygen to oxidize organic nutrients.
Anaerobes – Live in the absence of oxygen. Catabolize nutrients without molecular oxygen.

III. Nitrogen

All living things require nitrogen. Most animals obtain nitrogen from amino acids. Plants are able to use ammonia or nitrates as nitrogen sources. Nitrogen N2 is the major gas component of our atmosphere (80%). It is relatively inert. The Earth's crust contains very little nitrogen. Only a few organisms can **fix** N2. All living organisms depend on these nitrogen fixing microorganisms such as cyanobacteria and blue-green algae. Many nitrogen fixing bacteria live in the soil. Some nitrogen fixing bacteria live symbiotically in the nodules of the roots of plants.

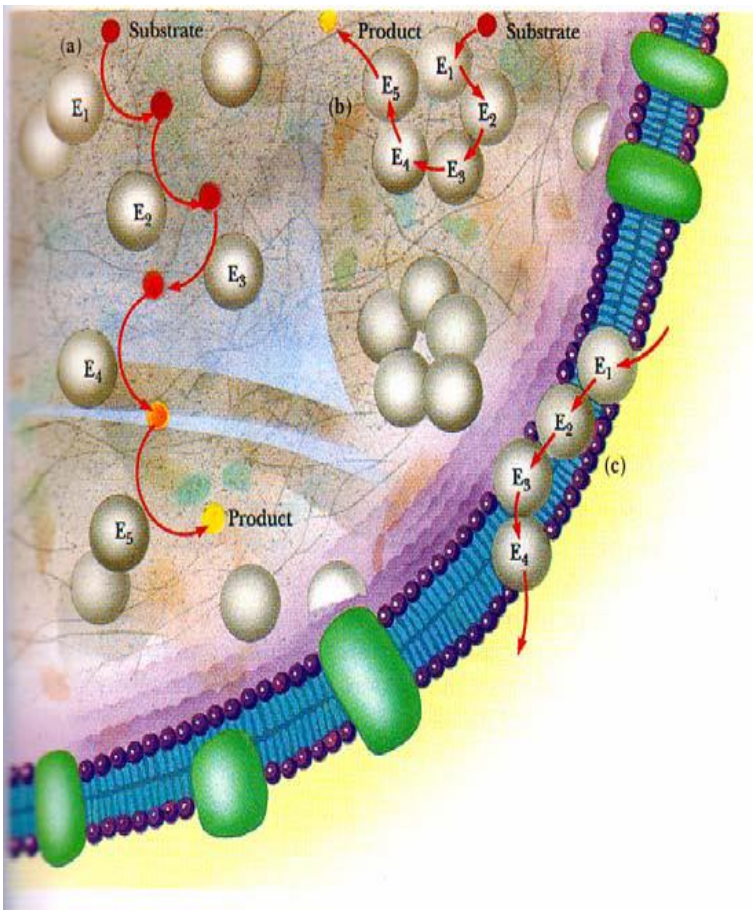
Nitrifying Bacteria – oxidize ammonia into nitrates.
Denitrifying Bacteria - reduce nitrates into ammonia.



Metabolic Pathways

Enzymes are the basic units of metabolism. The substrates of these enzymes are called metabolites. A metabolic pathway is a series of connected enzymatic reactions that produce a specific product. Metabolic pathways consist of sequential steps. There are more than 2,000 metabolic reactions, each catalyzed by a distinct enzyme.

The enzymes may be physically separate requiring the intermediate metabolites to diffuse from one active site to the next or enzymes may form a multienzyme complex where the intermediate metabolites are passed directly from one active site to the next. Some pathways reside within membranes. In this case the enzyme and the substrates diffuse in the two dimensions of the bilipid membrane.



The catabolic and anabolic pathways are related.

Catabolism

Complex metabolites are degraded into simpler products such as acetyl units linked to coenzyme A. The degradation process releases free energy. The free energy is conserved by the reduction of $NADP^+ \longrightarrow$ NADPH or by coupling exergonic reactions to ATP synthesis.

Anabolism

Complex biomolecules are synthesized from simple precursors. This process is endergonic. This process requires the free energy of ATP hydrolysis, ATP $\longrightarrow$ ADP^+ Pi or NADH oxidation, NADH $\longrightarrow$ NAD^+. The striking feature of anabolic pathways is that they begin with a few common metabolites as starting materials and diverge into a wide range of biomolecules.

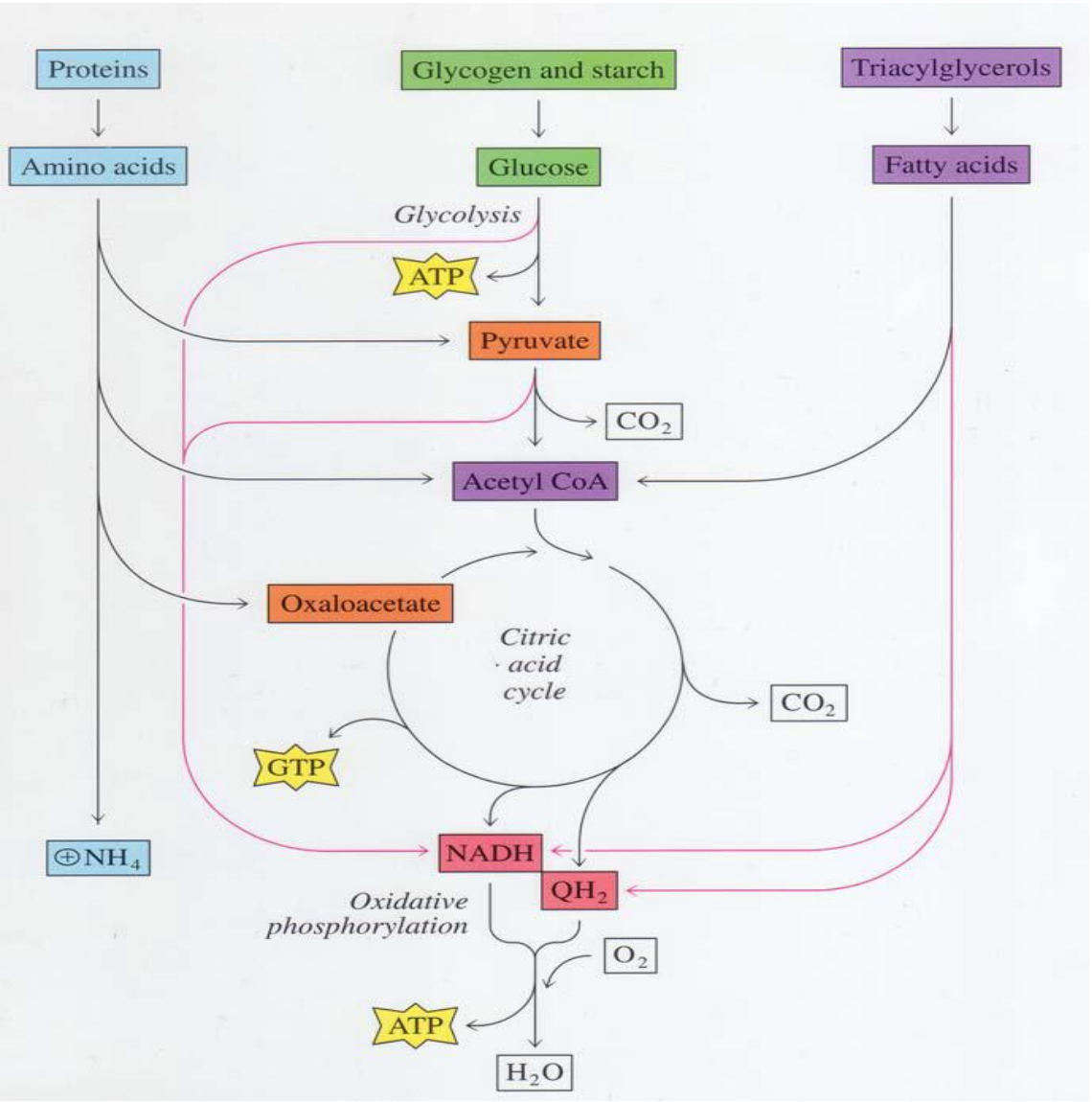
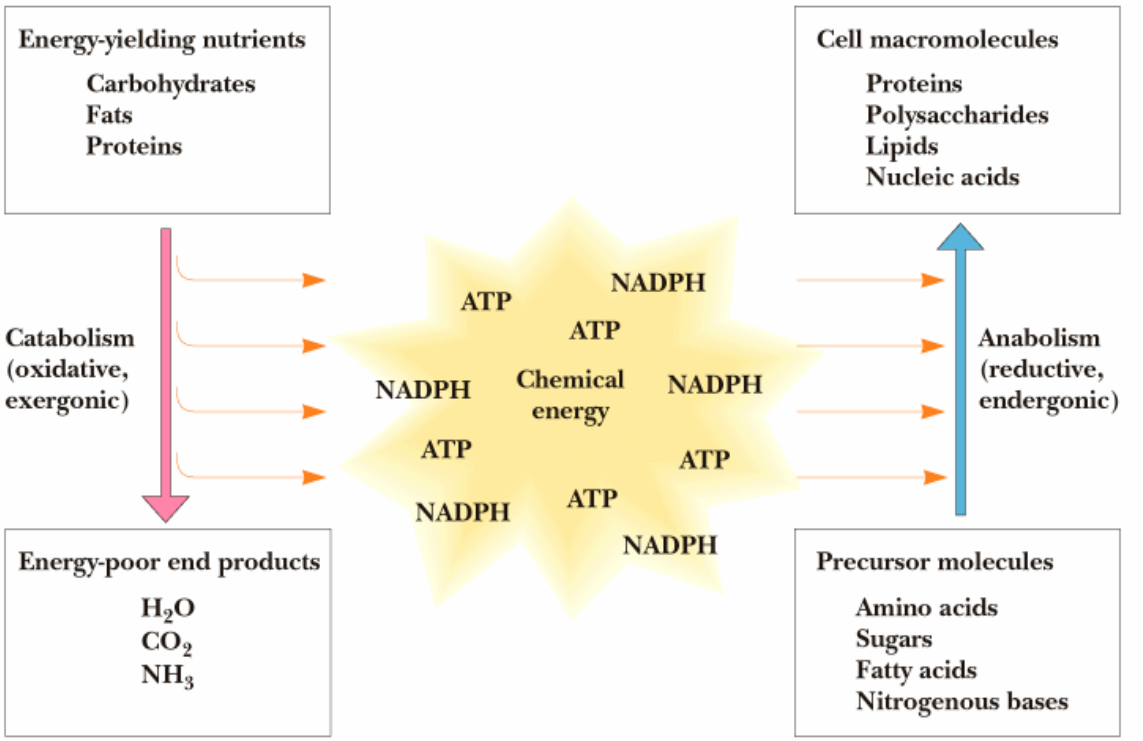

Proteins
Glycogen and starch
Triacylglycerols
Amino acids
Glucose
Fatty acids
Glycolysis
ATP
Pyruvate
CO_2
Acetyl CoA
Oxaloacetate
Citric acid cycle
CO_2
GTP
$\oplus NH_4$
NADH
QH_2
Oxidative phosphorylation
O_2
ATP
H_2O

Figure 18.4



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