Paper I- February 2010

1. Define enzymes. Classify enzymes with eg. Explain active site of enzymes.

Enzymes are classified and named according to their type of reaction catalyzed, followed by the suffix -*ase.* For example, dehydrogen*ases* remove hydrogen atoms, prote*ases* hydrolyze proteins, and isomer*ases* catalyze rearrangements in configuration. International union of biochemistry and molecular biology suggested the system of nomenclature of enzymes. It is complex but unambiguous and internationally accepted.

As per this system enzyme are represented as EC (enzyme class) number with 4 digits

First digit represent the class, second for the subclass, third for sub-sub class, and fourth represents specific enzyme in list

The enzymes are classified major classes

1. **Oxidoreductases –** these class of enzymes catalyze oxidations and reductions

   AH2 + B → A + BH2

   Eg: alcohol dehydrogenase, oxidases, reductases

2. **Transferases**– these class of enzymes catalyze transfer of moieties between substrate such as glycosyl, methyl, or phosphoryl groups

   A-R + B → A + B-R

   Eg: hexokinase, transaminase

3. **Hydrolases**– these class of enzymes catalyze *hydrolytic* cleavage of C—C, C—O, C—N, and other bonds by adding of water

   Eg: Acetyl choline + H2O → Choline + Acetate catalysed by Acethyl choline esterase

4. **Lyases –** These class of enzymes catalyze cleavage of C—C, C—O, C—N, and other bonds by *atom elimination,* leaving double bonds.

   Eg: Frucsotse-1,6bisphosphate → Glyceraldehyde -3-phosphate + DHAP by aldolase

5. **Isomerases –** these class of enzymes catalyze geometric or structural changes within a molecule

   Eg: Recemases, epimerase, cis-trans isomerases

6. **Ligases** -these class of enzymes catalyze the joining together of two molecules coupled to the hydrolysis of ATP)

   Eg: Acetyl CoA carboxylase **Acetyl CoA + CO2 + ATP** →Malonyl CoA + ADP +Pi

2. Describe the steps of HMP shunt. What is its significance? Add Regulation.[Feb 2005 SN]

Othername: Pentose phosphate shunt or Dickens- Horeckers pathway

Occurrence: Liver, adipose tissue, RBC, mammary glands, testes

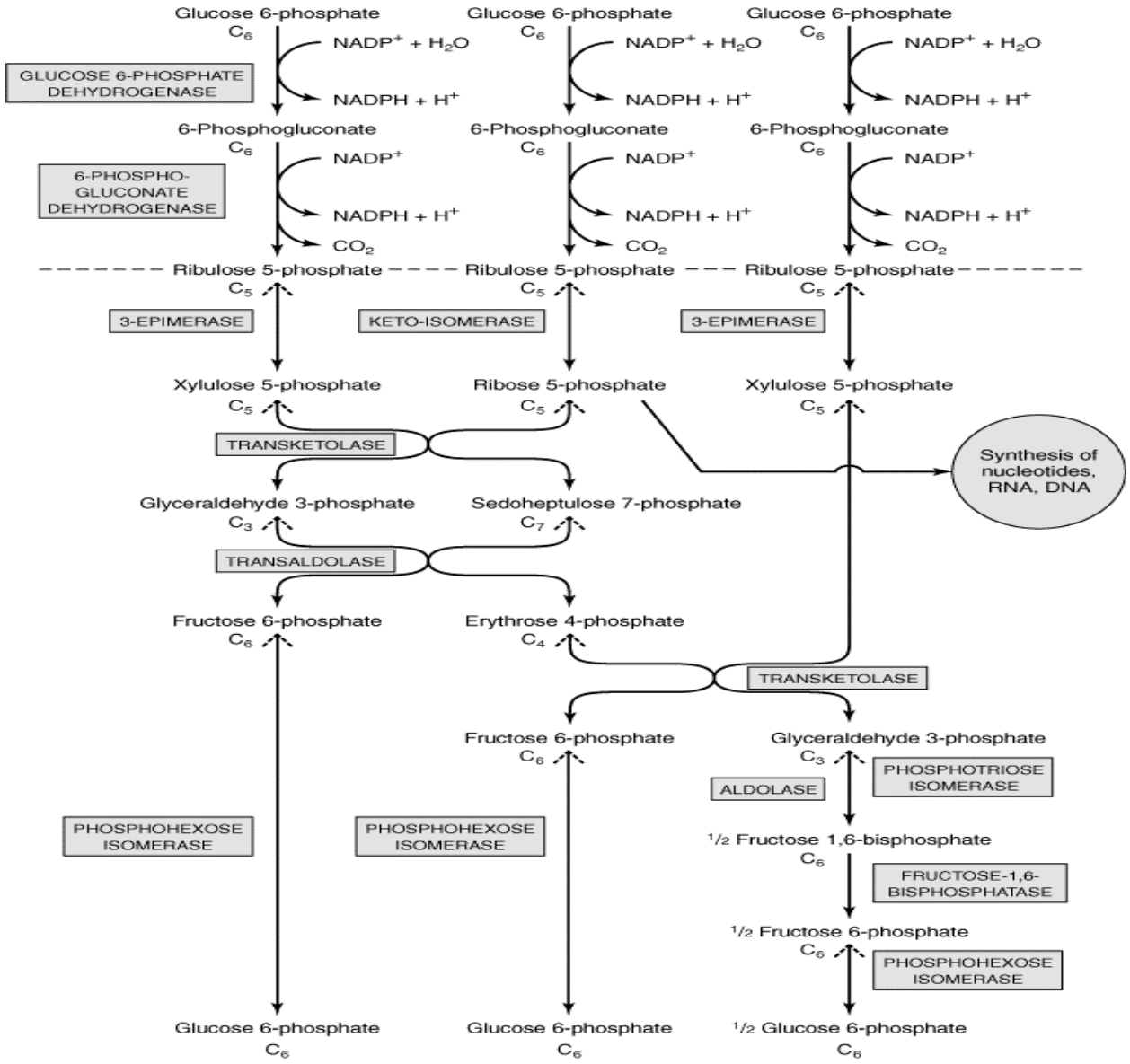


Fig HMP shunt

Significance:

- Produces NADPH which serves as hydrogen and electron donor in reductive biosynthesis
- Produces 5 carbon sugar (Ribose) which is a component of DNA, RNA, ATP, NAD, FAD, CoA SH

II Write short notes on (10*5= 50)

1. Nutritional importance of proteins.

1. **Essential amino acids**

   Isoleucine, leucine, threonine, lysine, methionine, phenylalanine, tryptophan, and valine. Histidine and arginine is semi essential. Growing children require in food.

2. **Nitrogen balance:**

   A normal healthy adult is said to be in Nitrogen balance means the dietary intake (I) equals the daily loss through urine (U) feaces (F) and skin (S).

   I=U+F+S.

   When excretion exceeds intake, it is negative Nitrogen balance

   When intake exceeds excretion, it is positive Nitrogen balance.

   Safe levels of protein intake is **0.75 g/Kg/day.**

   Factors affecting Nitrogen balance:

   1. Growth
   2. Hormones
   3. Pregnancy
   4. Convalescence
   5. Illness
   6. Protein deficiency.

3. **Nutritional Indices:**

   1. **Assessment of Nutritional value:**

      The protein is given to an animal and assess the weight gain.

      1 A. Biological Value (BV):

      It is the ratio between the amount of nitrogen retained and nitrogen absorbed during a specific interval.

$$= \frac{\text{Retained nitrogen}}{\text{Absorbed nitrogen}} * 100$$

4. **Limiting amino acids:**

   Certain proteins are deficient in one or more essential amino acids. If this particular protein is fed to a rat, it fails to grow. This amino acid is said to be the limiting amino acids. Limiting amino acid is that which limits the weight gain when a protein is supplied to an animal.

2. Describe folic acid.[Feb 2007 SN]

Source:

Yeast, green leafy vegetables.

RDA:

Adult: 200 microgram/day

Pregnancy: 400 microgram/day

Biochemical functions:

1. **Coenzyme function:**
   - ✓ Folic acid is 1st reduced to 7,8 dihydro folic acid and further reduced to 5,6,7,8 tetrahydro folic acid (THFA).
   - ✓ THFA is a carrier of one carbon groups.
   - ✓ One carbon groups play a vital role in donating carbon atoms for synthesis of different types of compounds

Different one carbon compounds

Group	Structure
Formimino	HN=CH-
Formyl	HCO
Methyl	-CH3
Methylene	-CH2-
Methenyl	-CH=

[N^5 and N^{10} atoms of THFA carry the 1-carbon groups]

Causes of folate deficiency:

1. Pregnancy
2. Defective absorption
3. Hemolytic anemia
4. Folate trap: When vit B12 is deficient, the following reaction cannot take place, leads to folate deficiency.

Deficiency manifestations:

1. 1.Reduced DNA synthesis
2. 2.Macrocytic anemia
3. Hyper-homocysteinemia
4. 4.Birth defects

3. Fluid mosaic model [Apr 2001 SN]

Cell membrane is also called as plasma membrane. It protects the intracellular organelles from outer environment and provides selective permeability for cell function.

The structure of cell membrane was described by singer and Nicolson and is accepted

Fluid mosaic model:

- The membrane is complex structure and is made up of lipids, proteins and carbohydrates etc
- The PL are arranged in bilayer with polar head groups oriented towards the exracellular side and cytoplasmic side with a hydrophobic core
- Other lipids and their compartmentalization
- Choline rich PL – external layer
- Ethanolamine and serine rich PL – inner layer
- Proteins present in membrane divided into three categories
- Peripheral – these proteins attached to polar heads of outer of plasma membrane lipids through ionic/polar bonds -
- Transmembrane – these proteins span the whole membrane – eg. Receptors
- Internal – these proteins are attached to tails of present in the inner plasma membrane – second messengers
- Dimensions: Single layer thichness – 25 A
- Total thickness – 50 – 80 A^{o}
- Properties of PM: free lateral moments are seen hence it is fluid in nature, semipermiability

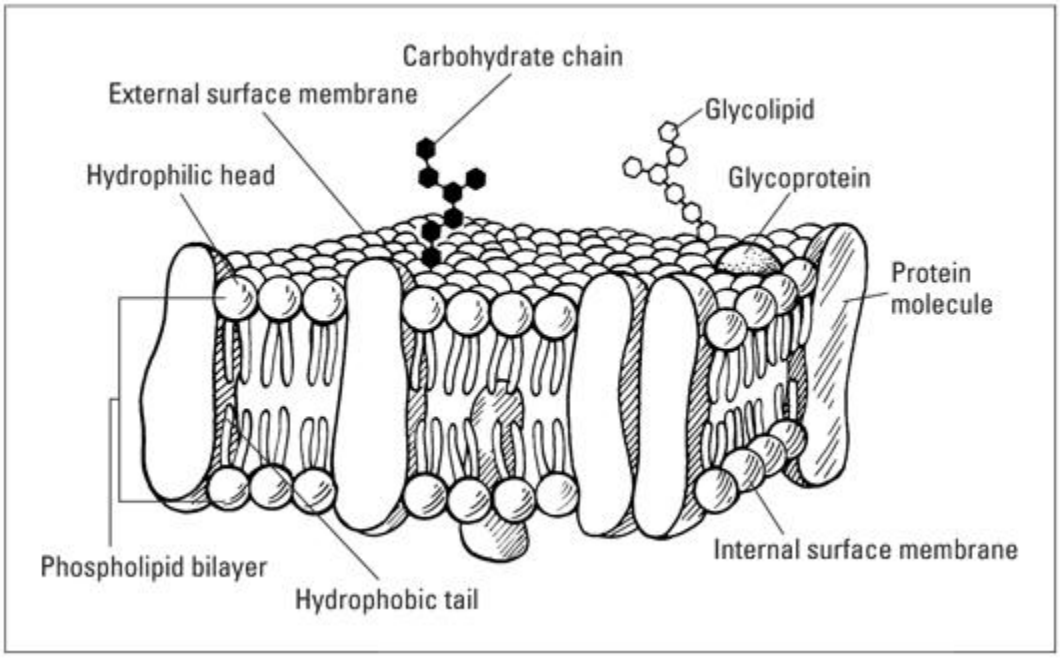


Fig Structure of cell membrane

4. Total parenteral nutrition

Other name: Intra venous hyperalimentation or total pareneral feeding.

- ✓ In patients who cannot or should not use their GI tract (unconscious, major surgery), total parenteral feeding has to be resorted.
- ✓ It contains Glucose and amino acids.
- ✓ About 10-30% glucose, 1- 1.5 g/kg protein, a fat emulsion containing 1-4 g fat/ kg body weight, along with multivitamins and trace element solution are commonly used.
- ✓ The solution should also contain adequate amounts of Na, K, Ca, Mg.
- ✓ The solution may be infused through one of the large vessels like subclavian vein to superior vena cava, where the blood flow is sufficient to dilute the hypertonic solution.

5. t RNA [Aug 2009 SN]

Other name: **Soluble RNA or Adaptor RNA**

- They transfer amino acids from cytoplasm to the ribosomal protein synthesizing machinery. Hence the name t RNA
- It is **clover leaf** in shape
- It contains unusual bases like pseudo uridine, dihydro Uracil, hypoxanthine. Moreover many bases are methylated.
- It contains 5 arms
    1) Acceptor arm: It carries amino acid
    2) Anticodon arm: It recognizes triplet nucleotide codon present in m RNA.
    3) D arm: It is having recognition site for enzymes which add amino acids.
    4) Pseudouridine arm: involved in binding t RNA to ribosomes.
    5) Variable arm.

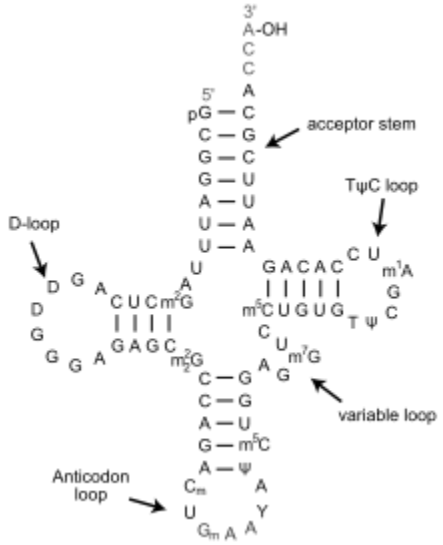
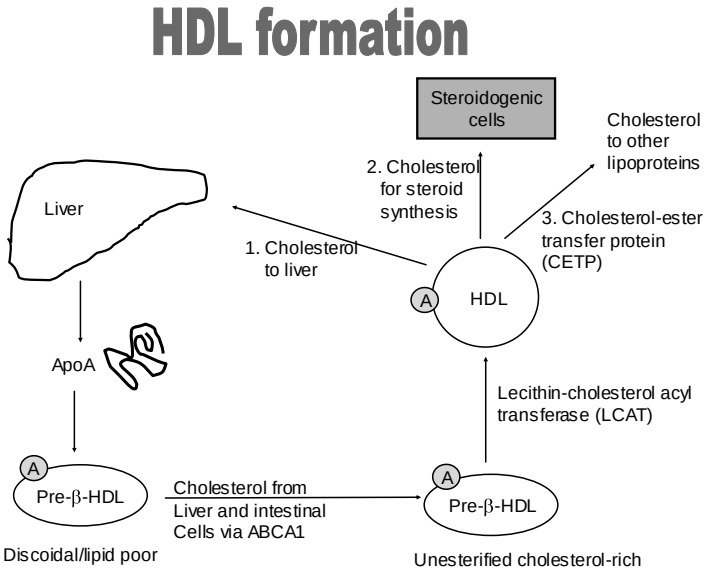


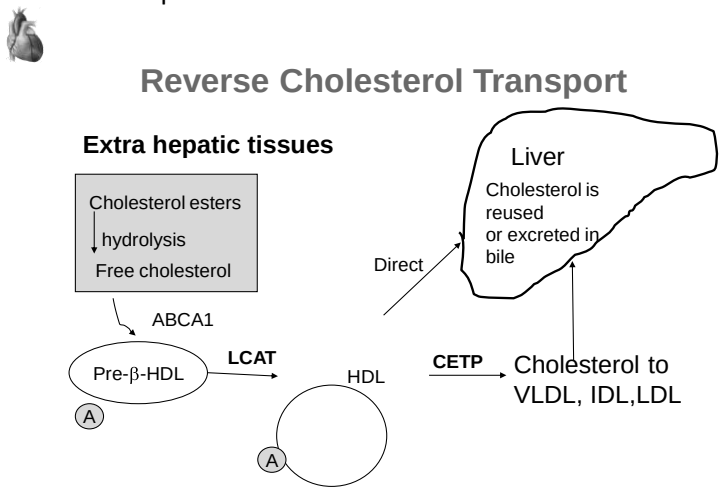
Fig t RNA

6. Explain the metabolism and functions of HDL.[Aug 2010 – 2 marks]

- Main transport form of cholesterol from peripheral tissues to liver.
- Anti-atherogenic known as good cholesterol
- Involved in reverse cholesterol transport.
- HDL sub fractions – HDL 1 (bad & contains only Apo E), HDL – 2
- Good and anti-atherogenic, HDL-3 contains Apo A-II and its role is controversial



- Act as a reservoir for apoproteins which can be donated or received from other lipoproteins.
- Also play a vital role in scavenging "used" cholesterol (reverse cholesterol transport):
- As an anti- oxidant it prevents the oxidation of LDL.



7. What are glycoproteins? Give 3 example and its importance

Glycoproteins (mucoproteins) occur in many different situations in fluids and tissues, including the cell membranes .They are proteins containing branched or unbranched oligosaccharide chains. The **sialic acids** are N- or O-acyl derivatives of neuraminic acid. **Neuraminic acid** is a nine-carbon sugar derived from mannosamine (an epimer of glucosamine) and pyruvate. Sialic acids are constituents of both **glycoproteins**
and **gangliosides.**

Table 13–5. Carbohydrates found in glycoproteins.

Hexoses	Mannose (Man) Galactose (Gal)
Acetyl hexosamines	*N*-Acetylglucosamine (GlcNAc) *N*-Acetylgalactosamine (GalNAc)
Pentoses	Arabinose (Ara) Xylose (Xyl)
Methyl pentose	L-Fucose (Fuc; see Figure 13–15)
Sialic acids	N-Acyl derivatives of neuraminic acid, eg, *N*-acetylneuraminic acid (NeuAc; see Figure 13–16), the predominant sialic acid.

8. Chemiosmotic theory [Apr 2001 SN, sep 2002, Feb 2006 SN]

The coupling of oxidation with phosphorylation is termed oxidative phosphorylation. Peter Mitchell in 1961 proposed this theory to explain oxidative phosphorylation.

- The ultimate transfer of electrons from the reducing equivalents NADH and $FADH_2$ to oxygen through iron and hemes, is the driving force for forming ATP in mitochondria.
- The electron transport is coupled to the oxidative phosphorylation of ATP via the protons pumped during ETS.
- The linkage of these two systems is explained by the chemiosmotic hypothesis.
- In this theory the differences in both pH and membrane potential created on opposite sides of the inner mitochondrial membrane drives the phosphorylation of ATP by the Fo/F1 subunits of ATP synthetase.

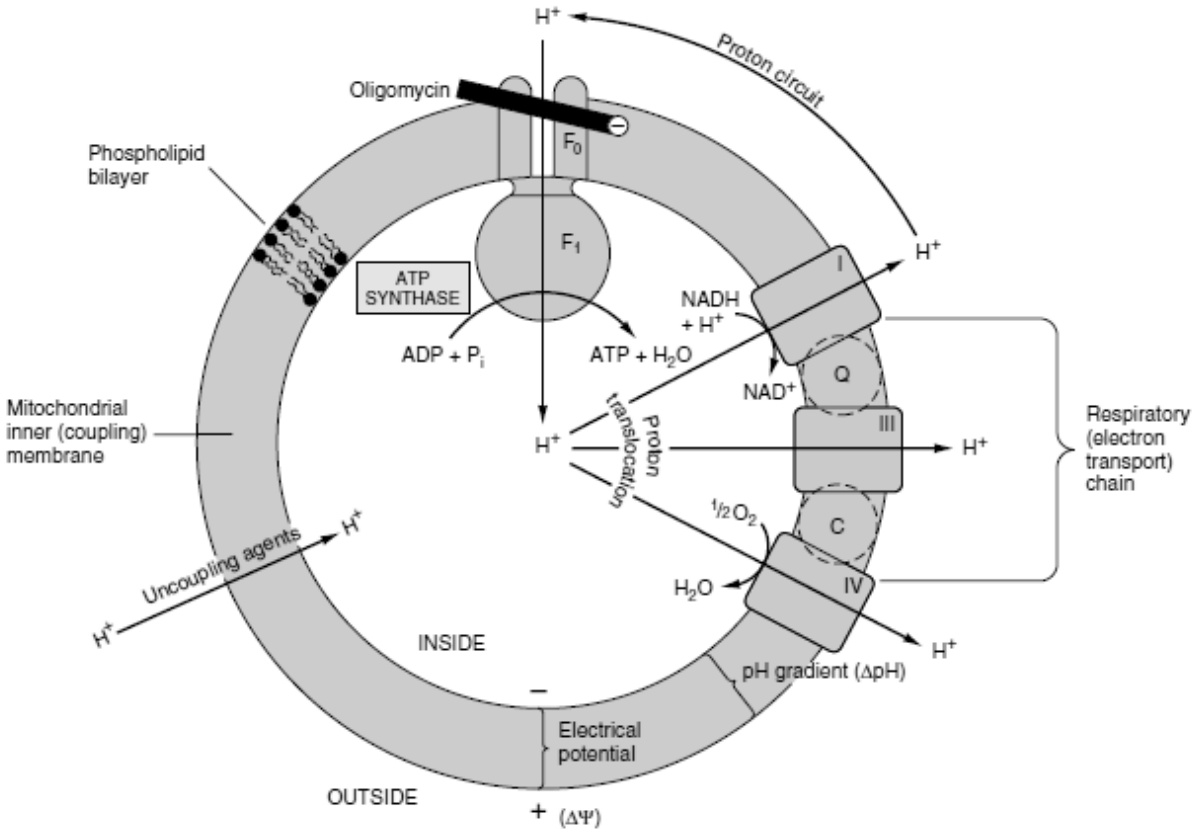


Fig chemiosmotic theory

9. Rapaport Leuberring shunt and its significance [Aug 2007 SN]

Other Name: Bisphospho glycerate shunt (BPG shunt)

In RBC, reaction catalyzed by 1,3 BPG kinase is bypassed(in glycolysis). In turn, bisphosho glycerate mutase converts 1,3 BPG to 2,3 BPG and converted to 3 phosphoglycerate by phosphatase enzyme.

Significance:

1. No release of energy

2. 2,3 BPG combines with Hb & reduces the affinity towards oxygen. So, tissues get more O_2.

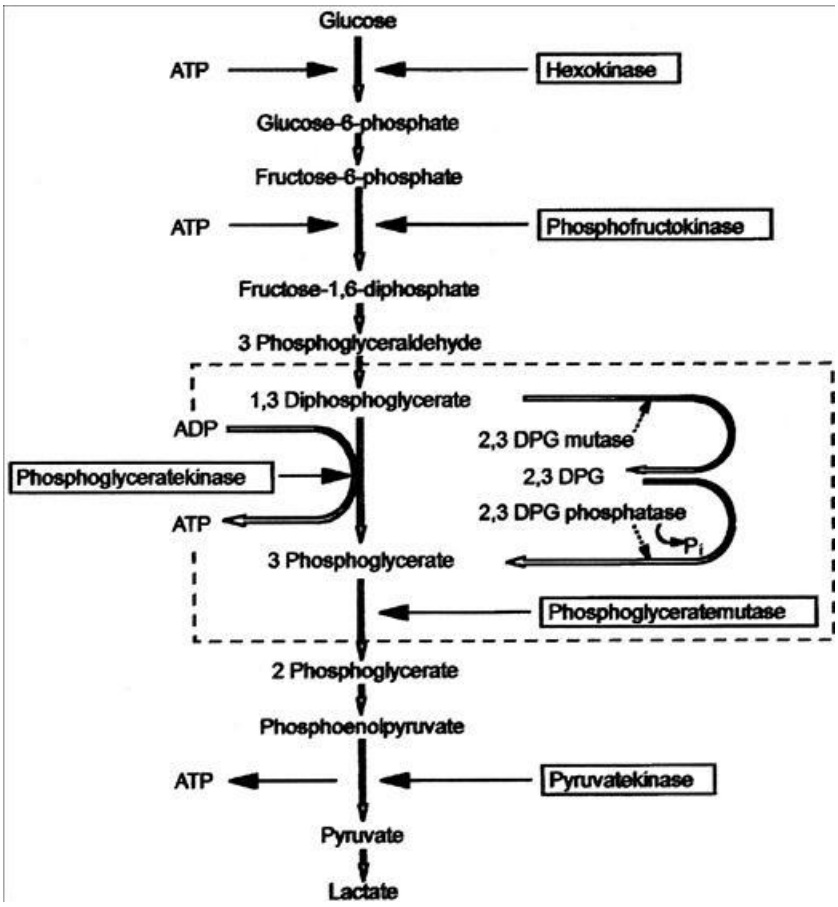


Fig BPG shunt

10. What are nucleotides? Name any three biologically important nucleotides and their importance.

SYNTHETIC NUCLEOTIDE ANALOGS ARE USED IN CHEMOTHERAPY

Synthetic analogs of purines, pyrimidines, nucleosides, and nucleotides altered in either the heterocyclic ring or the sugar moiety have numerous applications in clinical medicine. Their toxic effects reflect either inhibition of enzymes essential for nucleic acid synthesis or their incorporation into nucleic acids with resulting disruption of base-pairing. Oncologists employ 5-fluoro- or 5- iodouracil, 3-deoxyuridine, 6-thioguanine and 6-mercaptopurine, 5- or 6-azauridine, 5- or 6-azacytidine, and 8-azaguanine which are incorporated into DNA prior to cell division. The purine analog allopurinol, used in treatment of hyperuricemia and gout, inhibits purine biosynthesis and xanthine oxidase activity. Cytarabine is used in chemotherapy of cancer.

Finally, azathioprine, which is catabolized to 6-mercaptopurine, is employed during organ transplantation to suppress immunologic rejection.

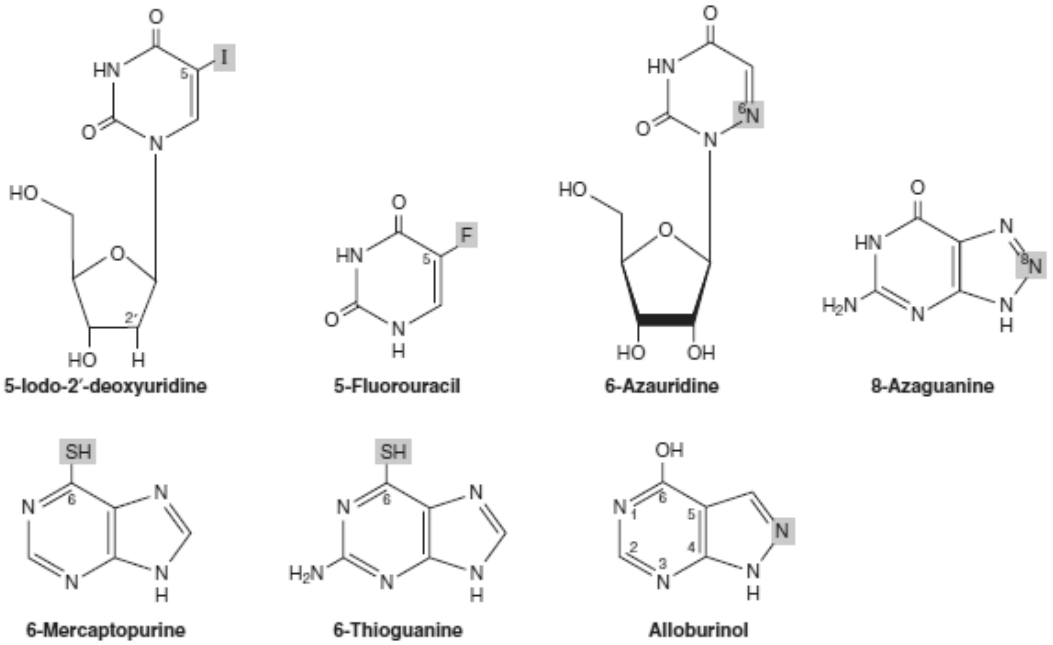


Figure 33–12. Selected synthetic pyrimidine and purine analogs.

Fig Synthetic nucleotides

III. SHORT ANSWERS (10*2=20)

1. Why sucrose is called a non reducing disaccharide?

The functional group of sucrose is used in the formation of 1- 4 linkage. Hence here is no functional group. Hence it is a non reducing sugar.

2. Name the essential fatty acids.[Aug 2007 SN]

The important PUFA are

1. Linoleic acid
2. Linolenic acid
3. Arachidonic acid

They are present in vegetable oils and fish oils.

Significance of PUFA:

1. Used for esterification & excretion of Cholesterol
2. They are **Essential Fatty Acids**.
3. It increases the fluidity of membranes
4. Eicosanoids (Prostagladin, prostacyclin & thromboxanes) are derived from Arachidonic acid.
5. Anti-atherogenic

4. **Name any 4 biologically important compounds from cholesterol.**

   Bile acids
   Progesterone
   Androgens
   Vit D
   Corticosteroids

4. What are phospholipids? Eg.

they contain esters of fatty acids with glycerol/spingosine, nitrogenous base, and phosphate group.

Properties and functions of phospholipids:

- They are amphipathic in nature.
- They are made up of fatty acids, alcohol, carbohydrate and phosphate.
- They are structural components of cell membrane.
- They are structural components of lipoproteins.
- They help in fat absorption in the form of micelle.

Eg lecithin

5. Name the essential amino acids.

Isoleucine, leucine, threonine, lysine, methionine, phenylalanine, tryptophan, and valine. Histidine and arginine is semi essential. Growing children require in food.

6. **Mention any two biological functions of albumin**

   It maintains the colloidal osmotic pressure.

   It is the main transport protein.

7. **Name the amino acids required for purine biosynthesis.**

   Glutamic acid and aspartic acid.

8. Sickle cell Haemoglobin[March 2002, sep 2002 SN]

Haemoglobin is a conjugated protein made up of a prosthetic group called heme and protein part globin. Globin is a complex tertiary structure composed of two alpha and two beta chains. The genes for these proteins are located in 16 and 11 respectively. Any mutation in these genes gives raise to abnormal structure of haemoglobin which shows altered haemoglobin function. There are plenty abnormal Hb is discovered yet.

- HbS: Sickle Cell Hb – The glutamic acid in the 6^{th} position of beta chain of Hb is changed to valine. This change of aminoacid causes sikling of RBC. The sickled RBC plugs in capillaries and may cause occlusion of major vessels and lead to infarction of organs.

9. Specific Dynamic Action

It is represented as thermogenic effect of food. The heat is produced after intake of food, which is due to energy expenditure for digestion and absorption of food form reserved energy

SDA can be considered as the activation of energy needed for a chemical reaction. This activation energy is to be supplied initially. This activation energy is varied to different food

Eg: for Carbohydrate – 5 %, For Proteins – 30 % and for Fat – 15 % etc.

If a person takes 250 g of carbohydrates, calculate SDA

Actual calories from 250 g CHO = 250 X 4 = 1000 Cal

SDA of CHO = 5%, i.e. about 100 cal is drawn from our reserve energy, thus net generation of energy from 250 g is 900 cal.

Hence an extra calorie should be provided to account for the loss of energy as SDA

10. Write principle of Biuret test:

Cupric ions chelate with peptide bonds of proteins in alkaline medium to produce a pink or violet colour. The intensity of colour is proportional to the number of peptide bonds.

It is widely used method for plasma protein estimations.

Disadvantage:

It is unsuitable for estimation of proteins in mg or microgram quantities.