Biology 1200

2021

Organic molecules – nucleotides

Nucleic Acids

1

Organic Molecules: Nucleotides

- 3 principle components
  - nitrogenous base
    - single or double carbon-nitrogen ring
  - sugar (monosaccharide)
  - one or more phosphate groups
- ATP contains
  - adenine
  - ribose
  - 3 phosphate groups
- ATP is the universal energy carrying molecule

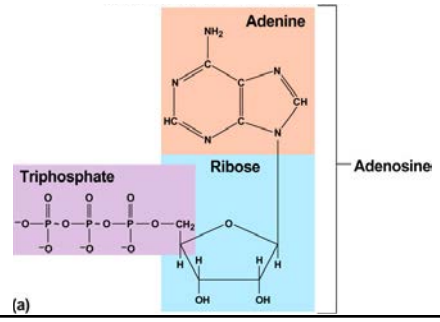
2

ATP

- High energy bonds
  - second and third phosphate groups are attached by high energy covalent bonds
    - phosphate groups are negatively charged and naturally repel each other
- ATPases hydrolyze the 3rd high energy phosphate bond of ATP producing ADP + P_i + energy
- Kinases (phosphokinases)
  - enzymes that phosphorylate (add the P_i released from ATP to) other enzymes or molecules to activate them

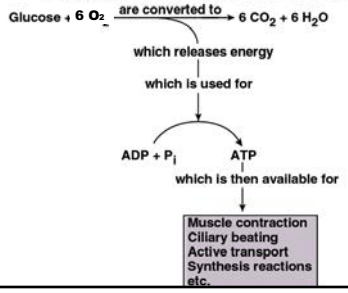
3

ATP



4

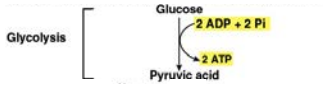
Production and Uses of ATP



5

ATP Production - Glycolysis

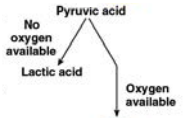
- Glycolysis
  - splits one 6 carbon glucose into two 3 carbon pyruvic acid molecules
  - yield 2 net ATP's



6

ATP Production - Anaerobic Fermentation

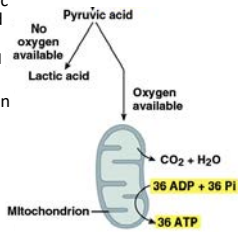
- If no oxygen is available pyruvic acid is converted to lactic acid (build up causes muscle soreness)
- Some ATP produced
- Allows glycolysis to start over (regenerates NAD^+)



7

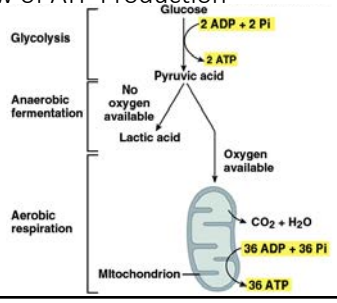
ATP Production - Aerobic Respiration

- If oxygen is available pyruvic acid is efficiently consumed
  - yielding 36 more ATP molecules (from the original glucose)
- Aerobic respiration occurs in mitochondrion



8

Overview of ATP Production



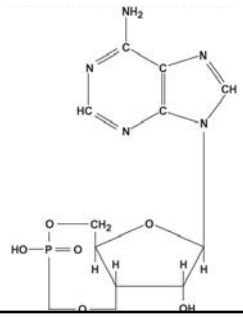
9

Other Nucleotides

- Guanosine triphosphate (GTP)
  - may donate a phosphate group (P_i) to other molecules or to ADP
- Cyclic adenosine monophosphate (cAMP)
  - formed after removal of both high energy P_i's
  - after chemical signal (first messenger) binds to cell surface, it triggers the conversion of ATP to cAMP (second messenger) to activate effects inside cell
- Nucleic acids are polymers of nucleotides

10

cAMP



11

Nucleic Acids

- DNA (deoxyribonucleic acid)
  - 100 million to 1 billion nucleotides long
  - contains the genetic code for
    - cell division, sexual reproduction, the instructions for protein synthesis
- RNA (ribonucleic acid)
  - 3 forms of RNA range from 70 to 10,000 nucleotides long
  - carries out instructions given by DNA
  - synthesizes the proteins coded for by DNA

12

The Instructions for Life Nucleic Acids

- Proteins which control or make a vast majority of our body are made from codes written on genes. Genes are parts of DNA that contain nucleotides in a particular order.
- There are two types of nucleic acids: **ribonucleic acid (RNA)** and **deoxyribonucleic acid (DNA)**.
- DNA gives direction for its own replication.
- DNA also directs RNA synthesis and, through RNA, controls protein synthesis.
- Organisms inherit DNA from their parents.
  - Each DNA molecule is extremely long and typically consists of hundreds to thousands of genes.
  - When a cell reproduces itself by mitosis or division, its DNA is copied and passed to the next generation of cells.

13

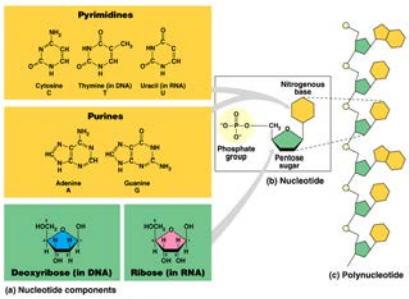
Nucleic Acids

- Nucleic acids are many **nucleotides joined together.**
- Each nucleotide consists of three parts: a nitrogen base, a pentose, 5 carbon, sugar, and a phosphate group

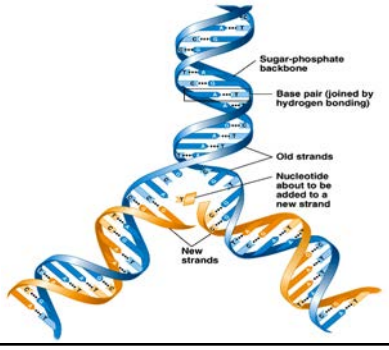
Purines and pyrimidines are the 2 types of nucleotides.

- Pyrimidines have a single six-membered ring.
- The three different pyrimidines, cytosine (C), thymine (T), and uracil (U)—part of RNA
- Purine have a six-membered ring joined to a five-membered ring. So have 2 rings not 1
- The two purines are adenine (A) and guanine (G).

14



15



16