3
Metabolisme Karbohidrat

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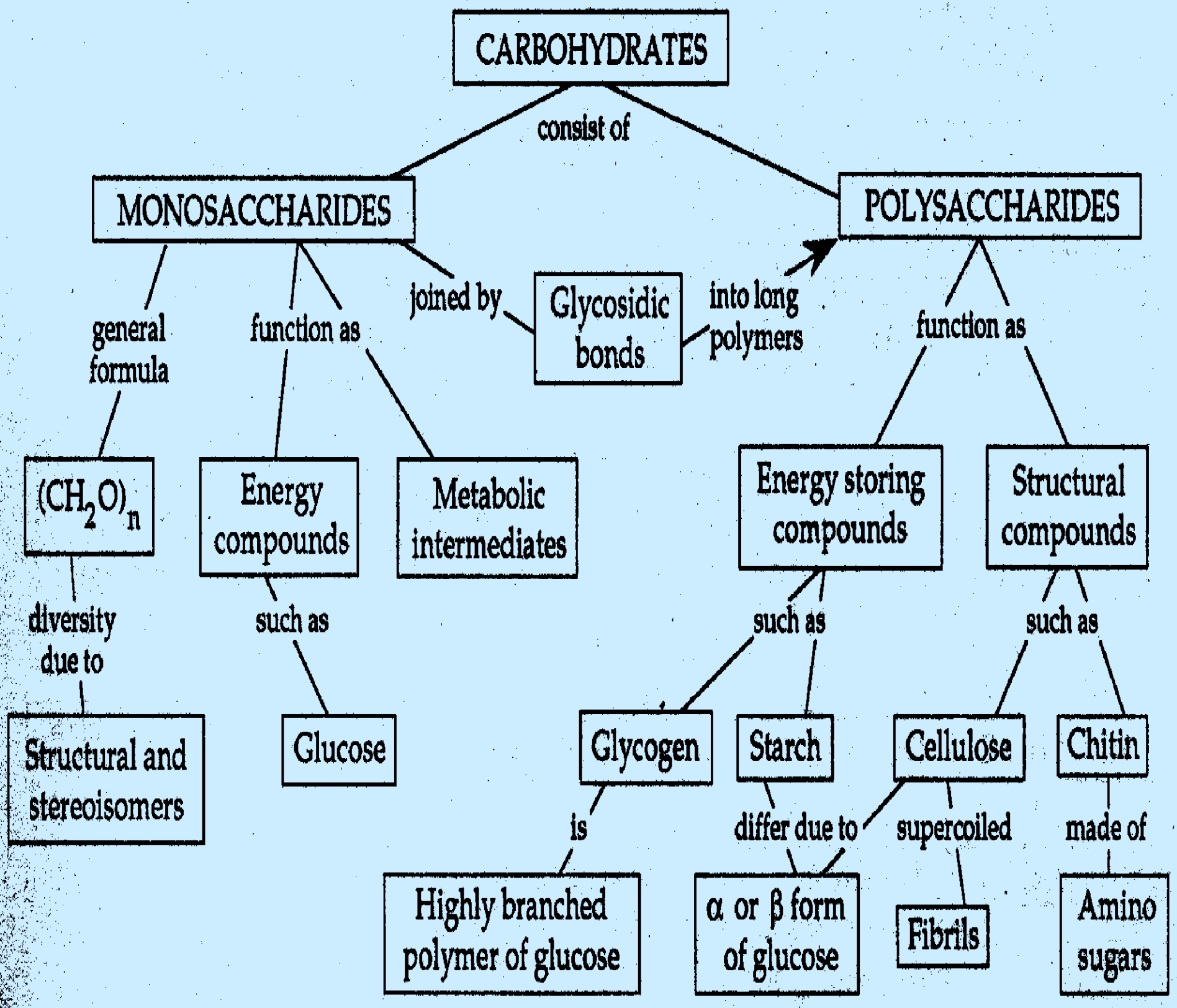
Biomolekul

- 4 macam senyawa organik esensial bagi proses hidup semua makhluk hidup:
  1. Karbohidrat,
  2. Lemak
  3. Protein, dan
  4. Asam Nukleat (DNA, RNA).
- Senyawa senyawa ini tersusun dr:
  - Carbon,
  - Hydrogen, and
  - Oxygen

1. KARBOHIDRAT

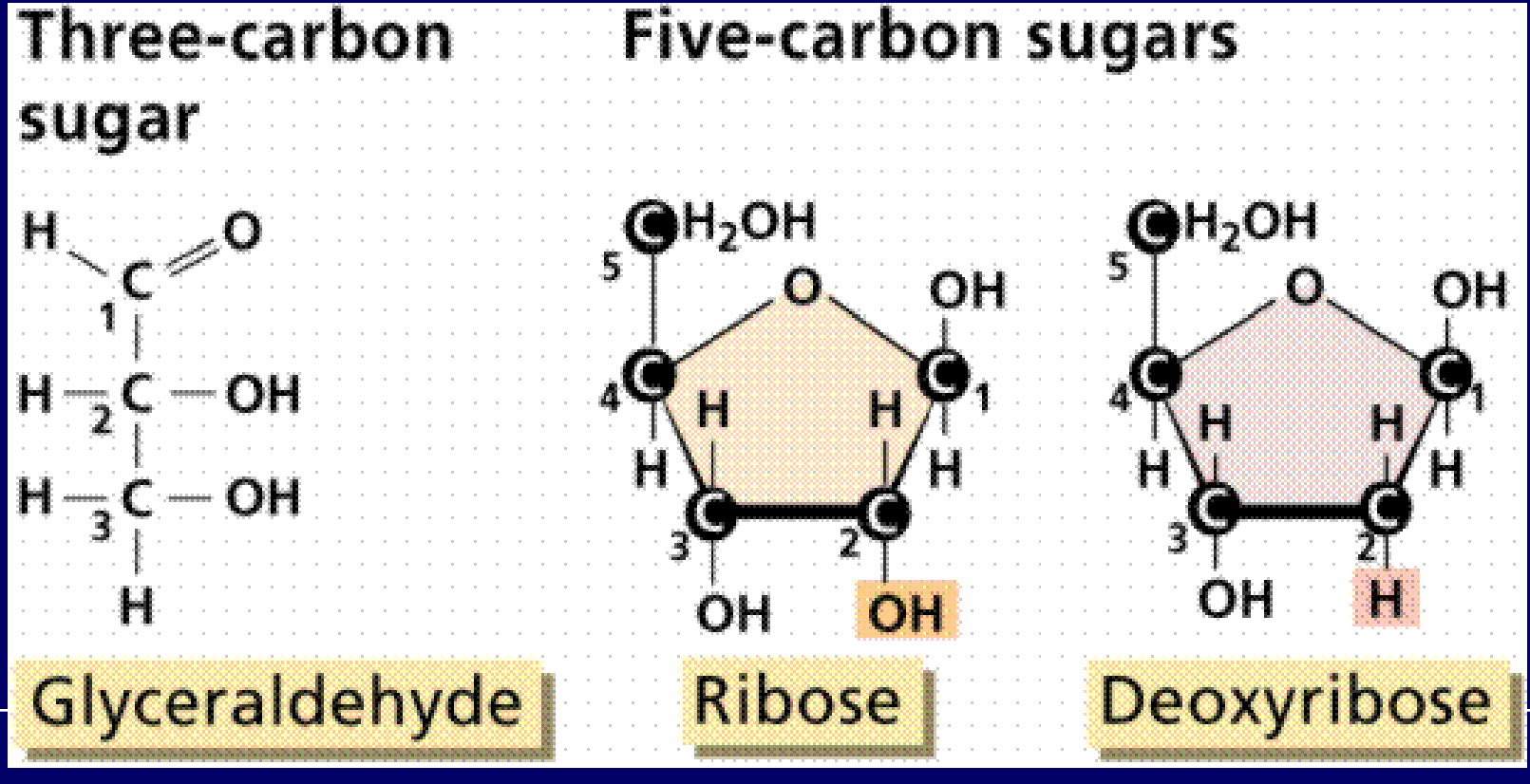

CARBOHYDRATES
consist of
MONOSACCHARIDES
POLYSACCHARIDES
general formula
function as
joined by
Glycosidic bonds
into long polymers
function as
$(CH_2O)_n$
Energy compounds
Metabolic intermediates
Energy storing compounds
Structural compounds
diversity due to
such as
such as
such as
Structural and stereoisomers
Glucose
Glycogen
Starch
Cellulose
Chitin
is
differ due to
supercoiled
made of
Highly branched polymer of glucose
α or β form of glucose
Fibrils
Amino sugars

- **Sumber energi: Sel-sel tubuh manusia memperoleh sebagian besar energinya dari karbohidrat.**
- **Tersusun dr C, H dan O dalam perbandingan sekitar 2 atom hidrogen dengan 1 atom oksigen. Jumlah atom karbon bervariasi.**

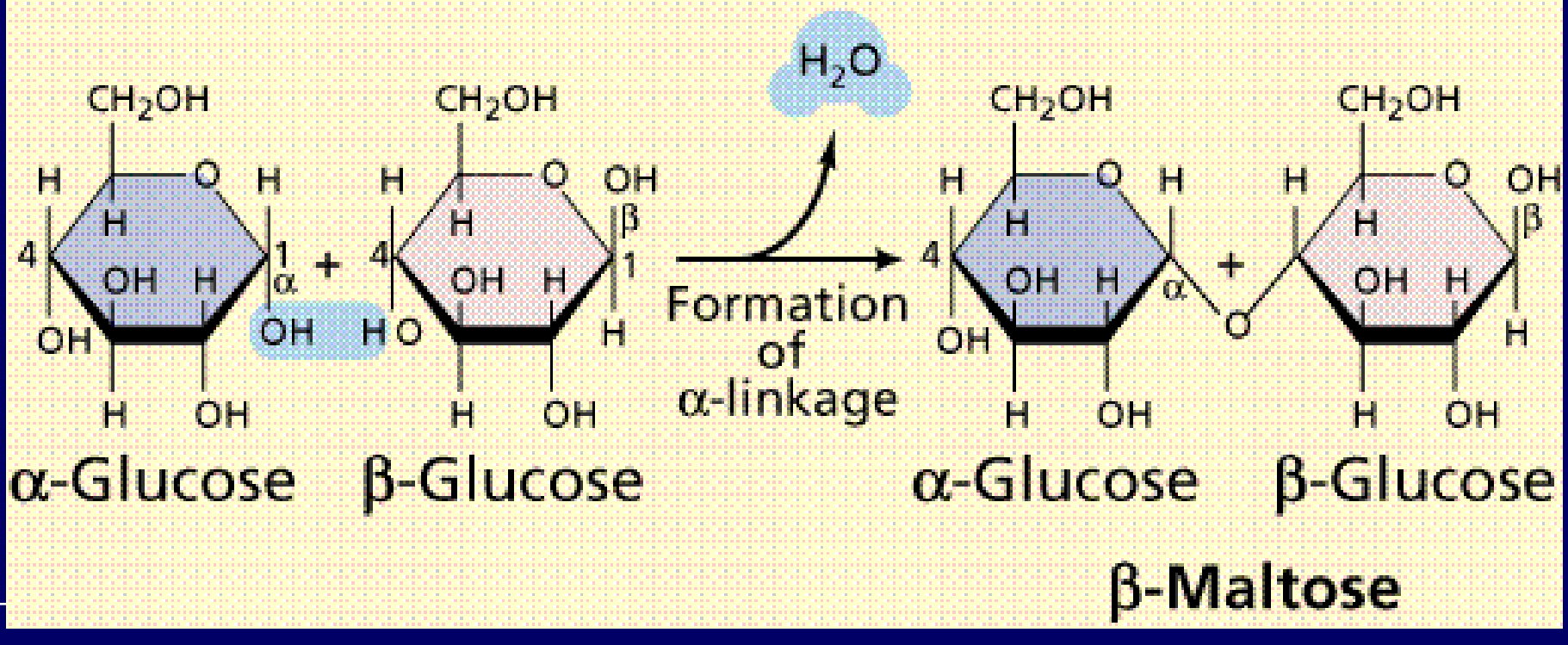
- Dikelompokkan:
  - Monosakarida,
  - Disakarida, dan
  - Trisakarida
- MONOSACCHARIDES (SINGLE SUGARS/ Simple Sugar) Misalnya: GLUCOSE, GALACTOSE, AND FRUCTOSE
- Glucose, Fructose, and Galactose have the same Molecular Formula, $C_6 H_{12} O_6$, but their Differing Structures determine the different Properties.

The chain (left) and ring (center and right) method of representing carbohydrates.

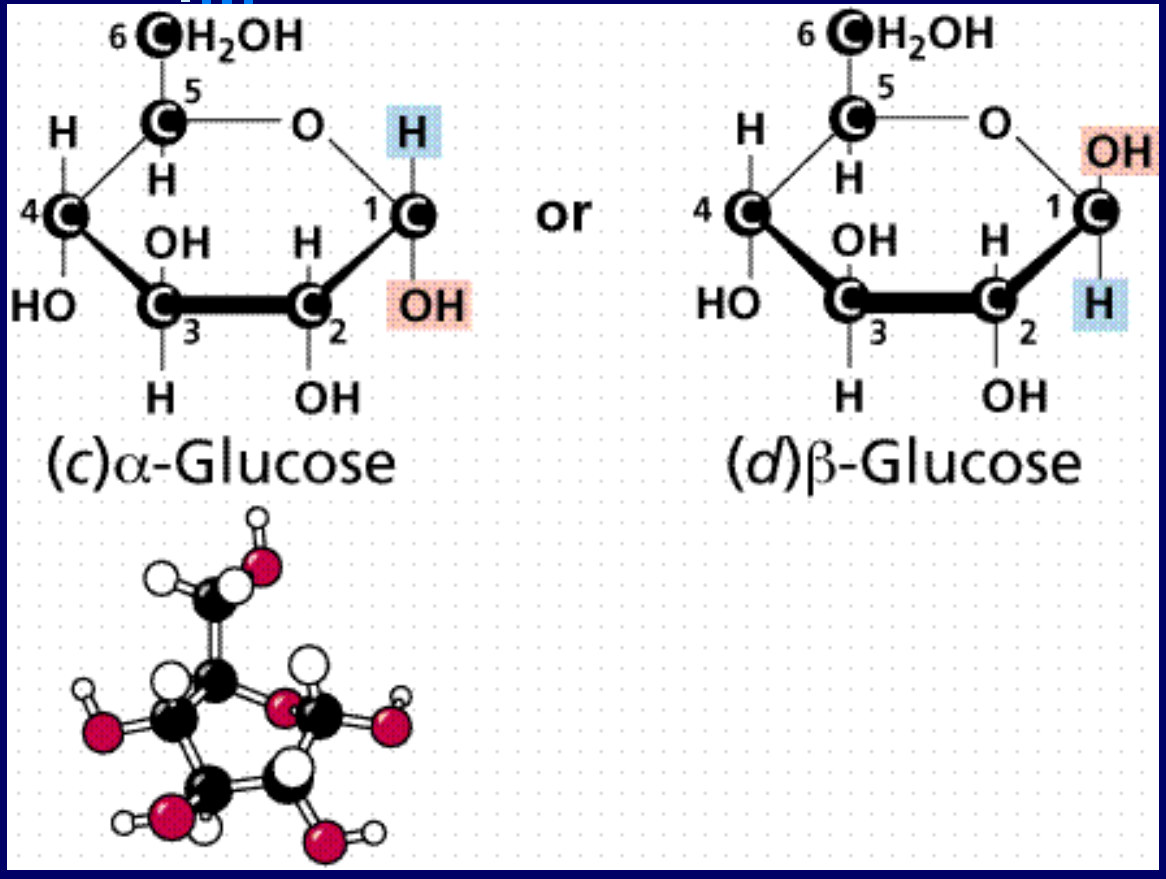
Monosaccharides are single (mono=one) sugars. Important monosaccharides include ribose ($C_5H_{10}O_5$), glucose ($C_6H_{12}O_6$), and fructose (same formula but different structure than glucose).

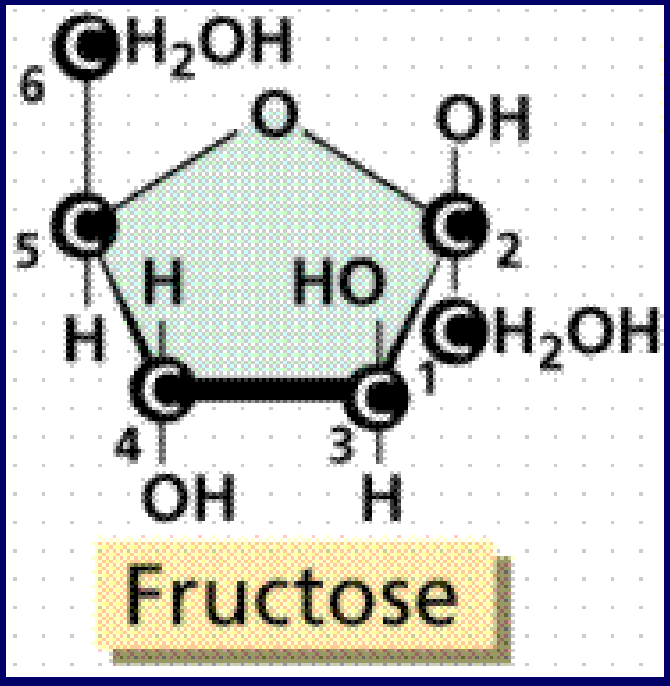


- DISACCHARIDES, OR DOUBLE SUGARS, CONSIST OF TWO SINGLE SUGARS (Monosaccharides) LINKED TOGETHER.
- Disaccharides are formed when two monosaccharides are chemically bonded together. Sucrose, a common plant disaccharide is composed of the monosaccharides glucose and fructose. Lactose, milk sugar, is a disaccharide composed of glucose and the monosaccharide galactose..

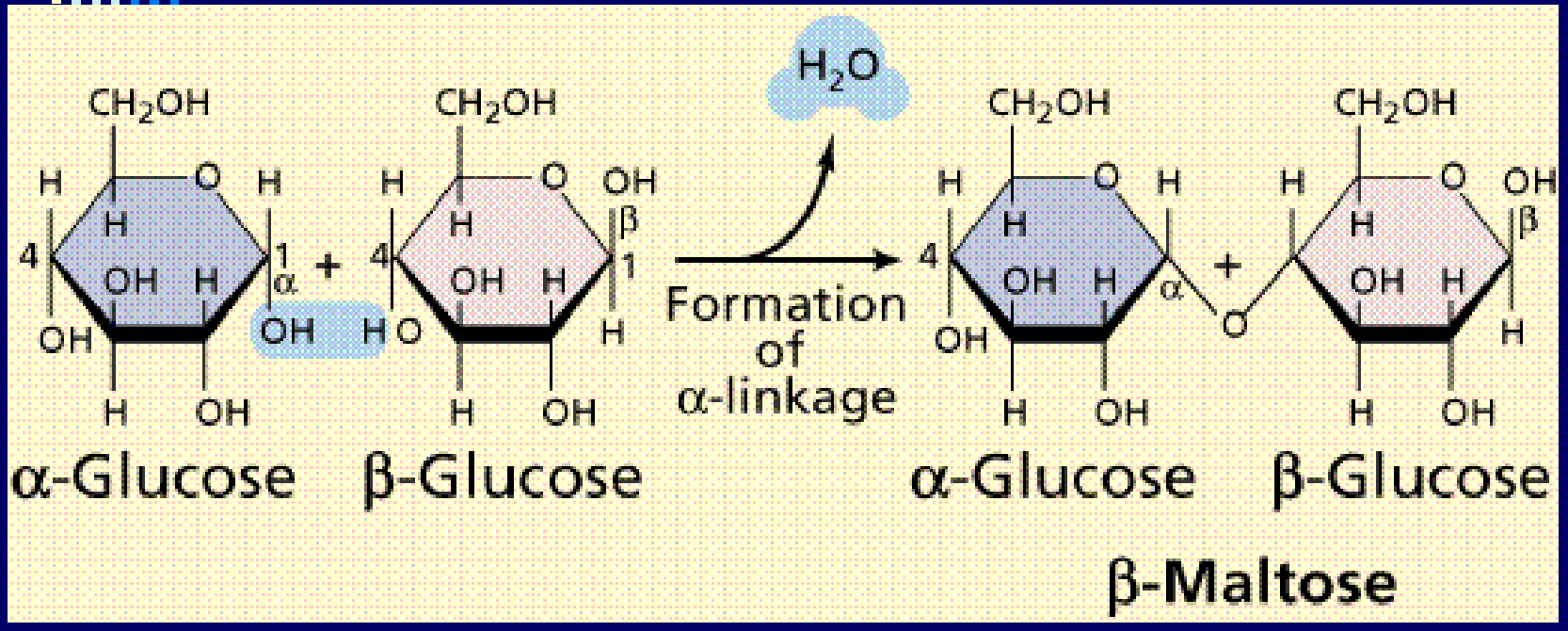


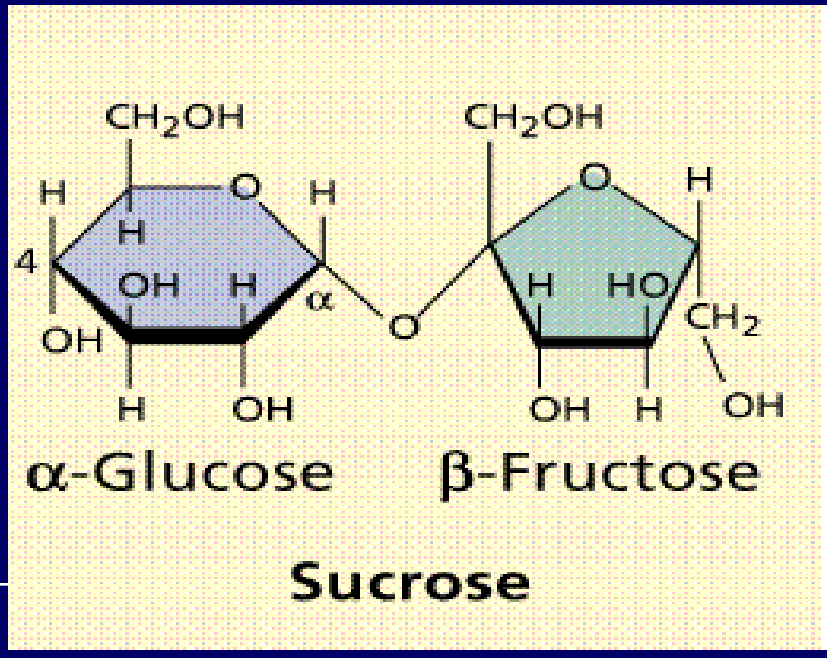
Models of glucose and fructose.

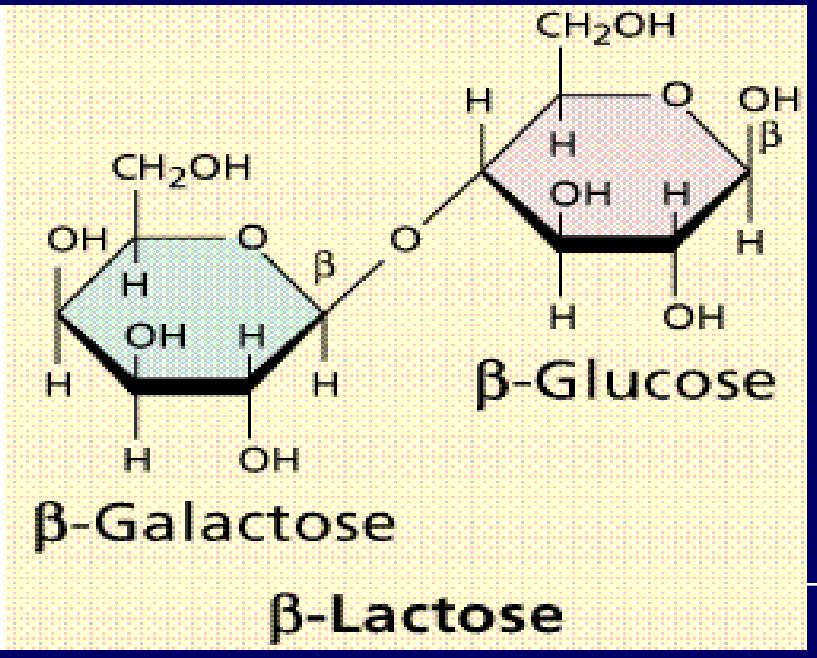




Formation of a disaccharide (top) by condensation and structure of two common disaccharides.

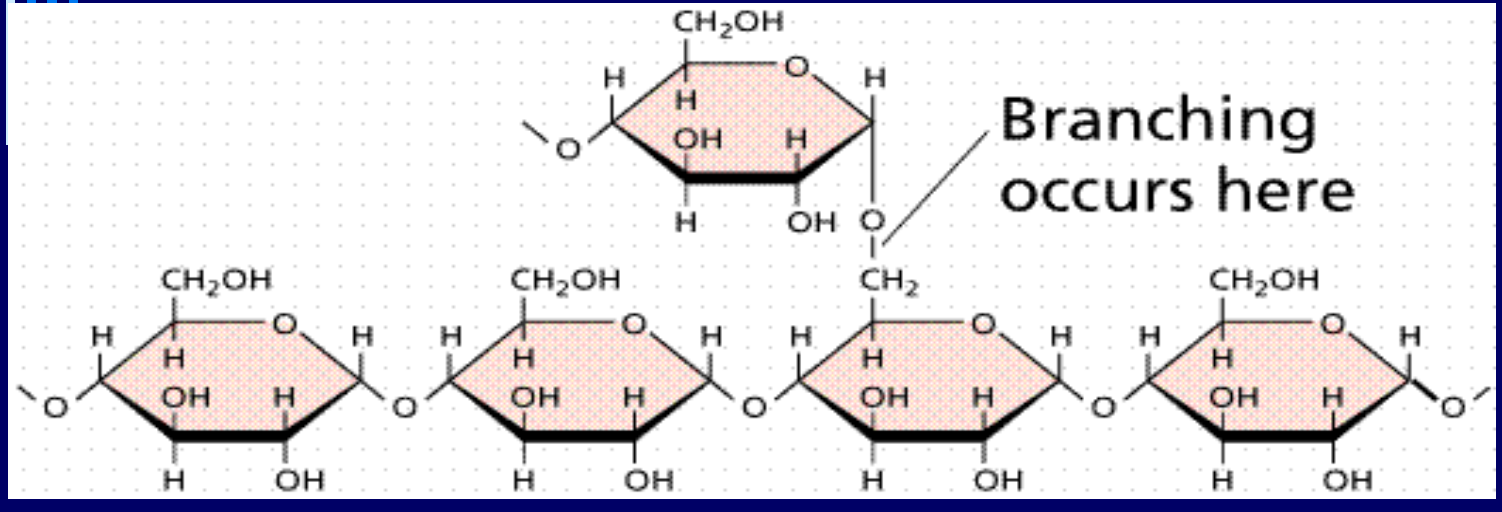


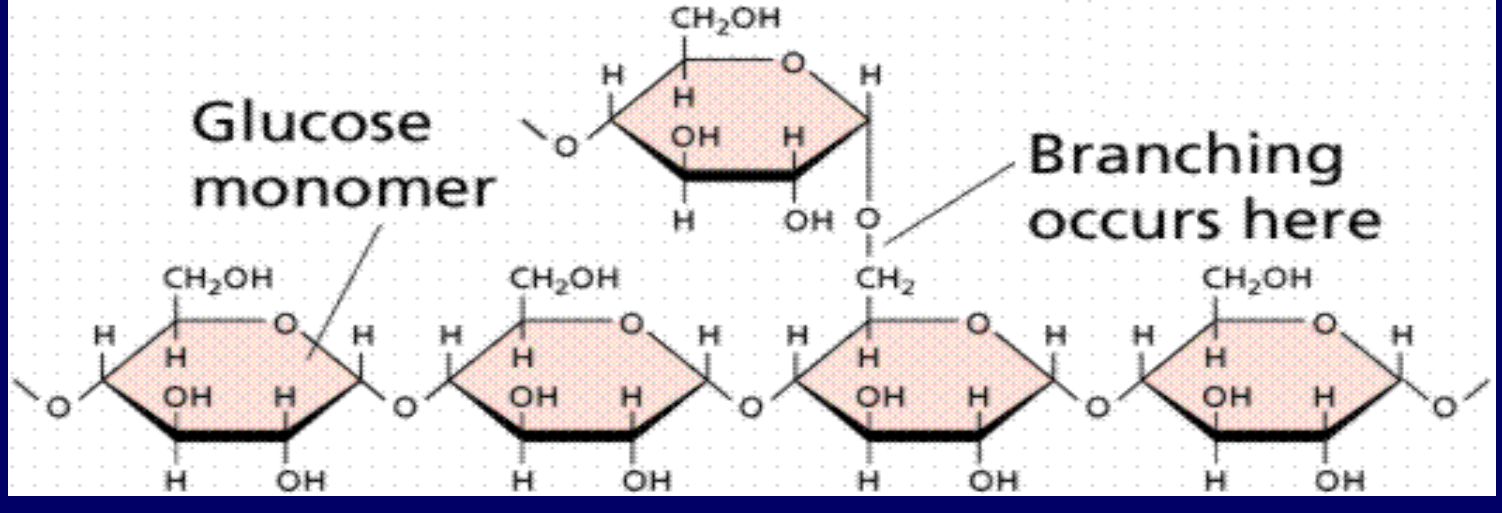


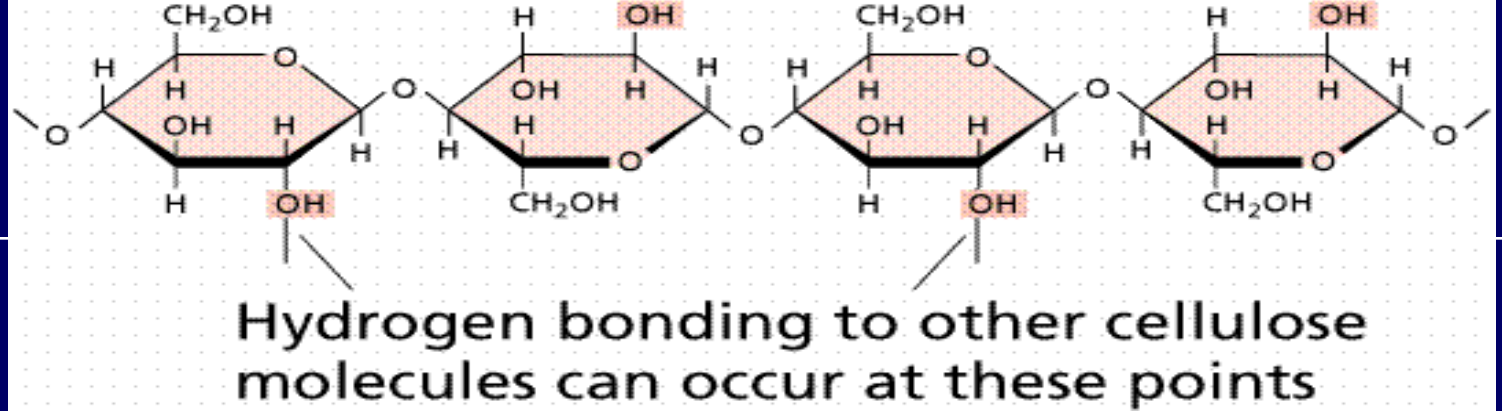


- POLYSACCHARIDE IS A CARBOHYDRATE MADE OF LONG CHAINS OF SUGARS ("Many Sugars", Three or More Monosaccharides).
- Cellulose is a polysaccharide found in plant cell walls. Cellulose forms the fibrous part of the plant cell wall. In terms of human diets, cellulose is indigestible, and thus forms an important, easily obtained part of dietary fiber. As compared to starch and glycogen, which are each made up of mixtures of a and b glucoses, cellulose (and the animal structural polysaccharide chitin) are made up of only b glucoses.
- The three-dimensional structure of the structural polysaccharides is thus constrained into straight microfibrils by the uniform nature of the glucoses, which resist the actions of enzymes (such as amylase) that breakdown storage polysaccharides (such a starch).

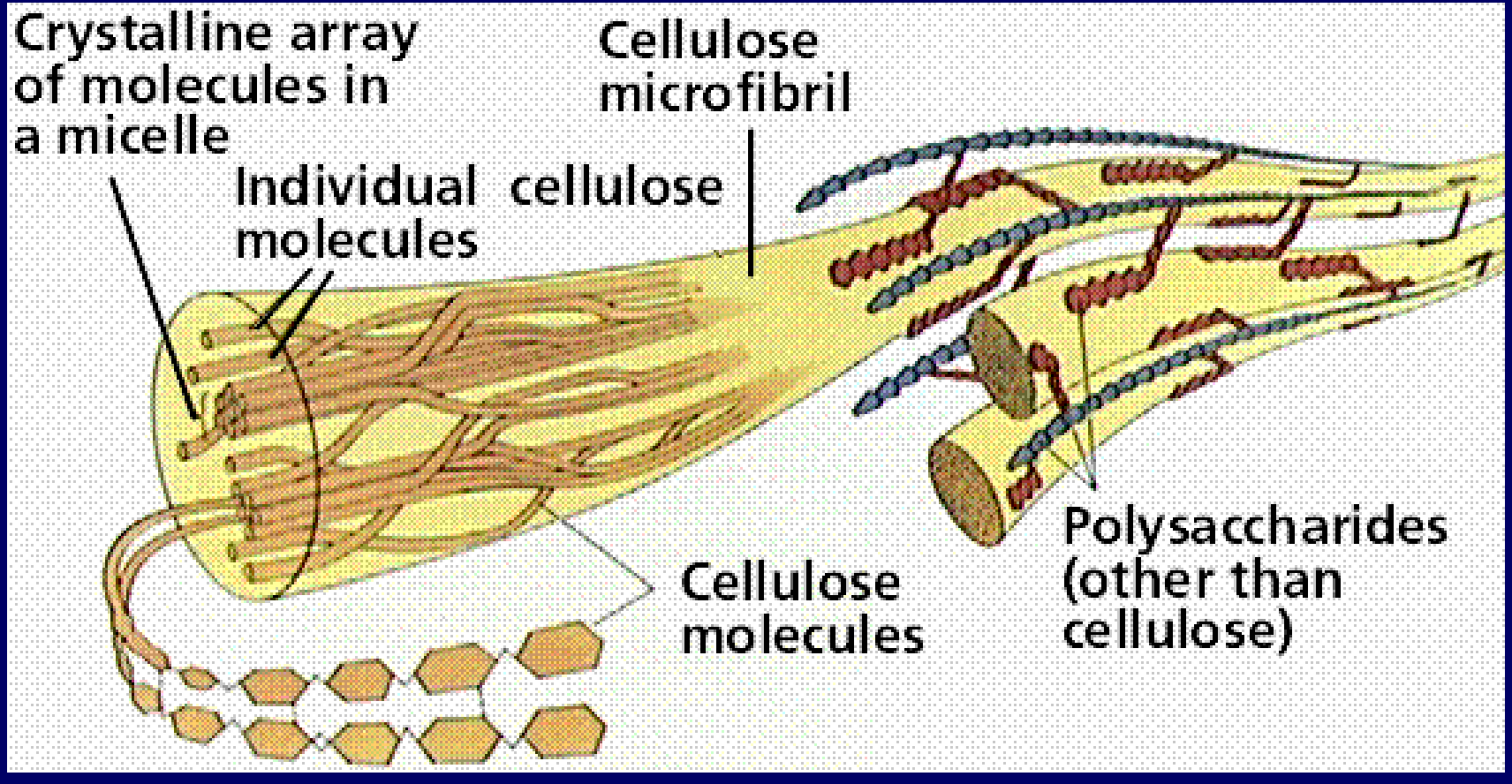
Images of starch (top), glycogen (middle), and cellulose (bottom).





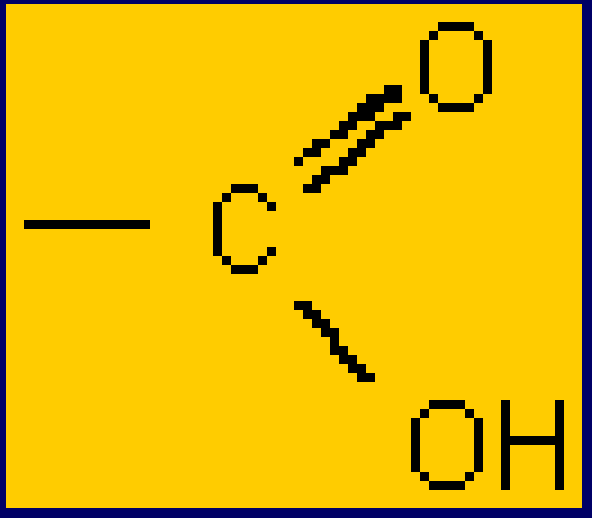


Structure of cellulose as it occurs in a plant cell wall.



Functional Groups (Gugus fungsi)

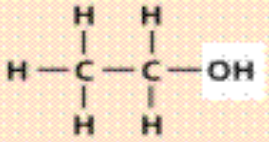
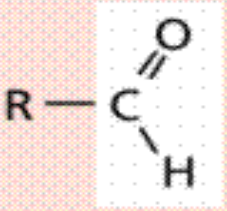
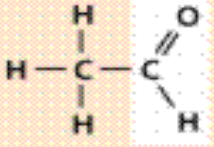
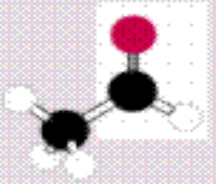
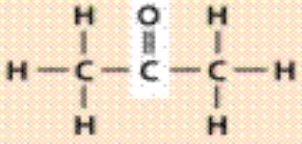
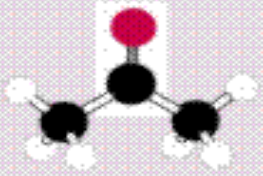
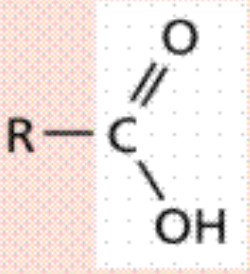
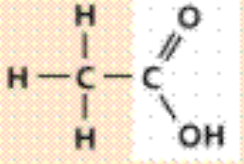
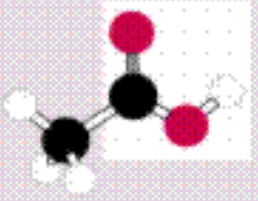
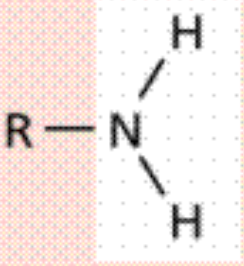
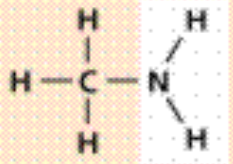
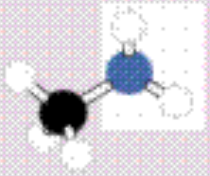
- Organic molecules may have functional groups attached. A functional group is a group of atoms of a particular arrangement that gives the entire molecule certain characteristics.
- Functional groups are named according to the composition of the group. For example, COOH is a carboxyl group.



FUNCTIONAL GROUPS

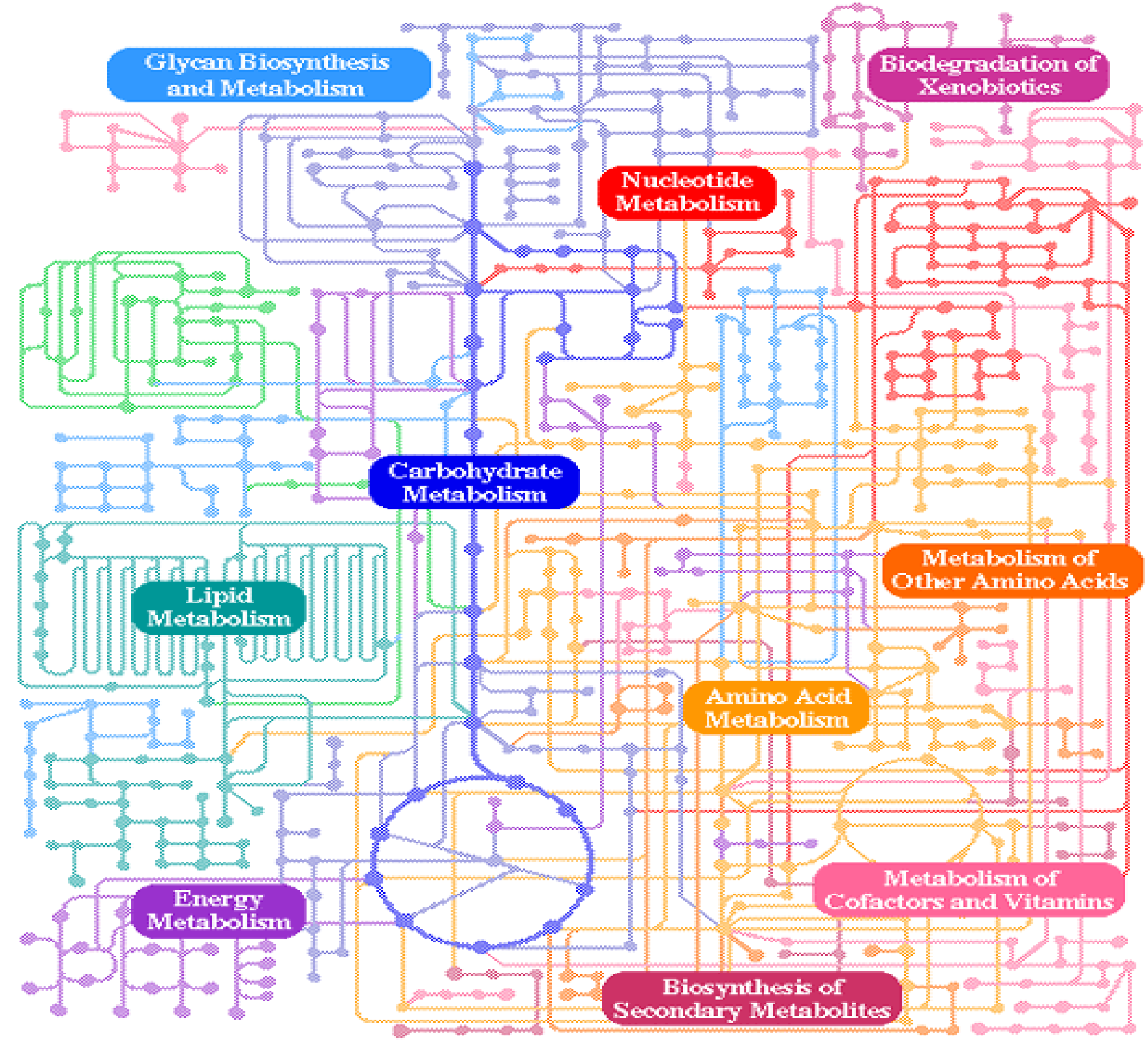
- 1. In MOST Organic Compounds, Cluster of Atoms, called **FUNCTIONAL GROUPS**, Influence the Properties of the molecule they Compose.
- 2. The **FUNCTIONAL GROUP** IS THE STRUCTURAL BUILDING BLOCK THAT DETERMINES THE CHARACTERISTICS OF THE COMPOUND.
- 3. One Functional Group important to living things is the **HYDROXYL GROUP**, represented by OH.
- 4. An **ALCOHOL** is an Organic Compound with a Hydroxyl Group attached to one of its Carbon Atoms.
- 5. The Hydroxyl Group makes Alcohol a Polar molecule that has Some Properties similar to Water, including the Ability to Form Hydrogen Bonds.

Functional groups in organic molecules.

Functional group	Class of compounds	Structural formula	Example	Ball-and-stick model
Hydroxyl –OH	Alcohols	R—OH	 Ethanol	
Carbonyl –CHO	Aldehydes		 Acetaldehyde	
Carbonyl 	Ketones		 Acetone	
Carboxyl –COOH	Carboxylic acids		 Acetic acid	
Amino $-NH_2$	Amines		 Methylamine	

Metabolisme

- – Seluruh reaksi kimia yang terjadi di dalam sel
- – enzim merupakan katalisator dalam reaksi ini.



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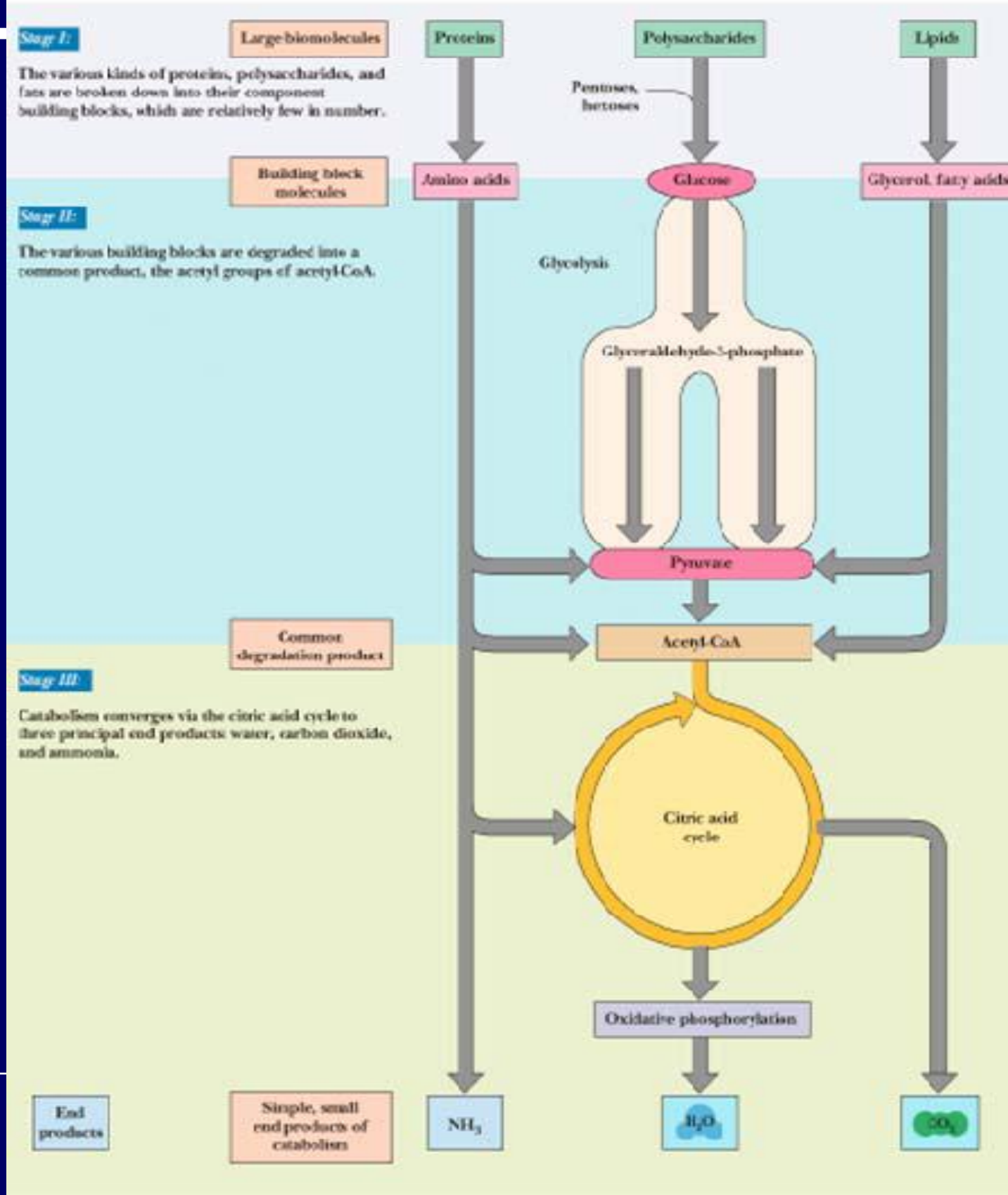
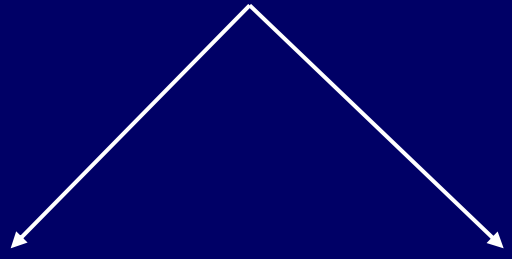
Metabolisme, disederhanakan



Metabolisme

METABOLISME

Segala proses reaksi kimia yg terjadi di dlm makhluk hidup

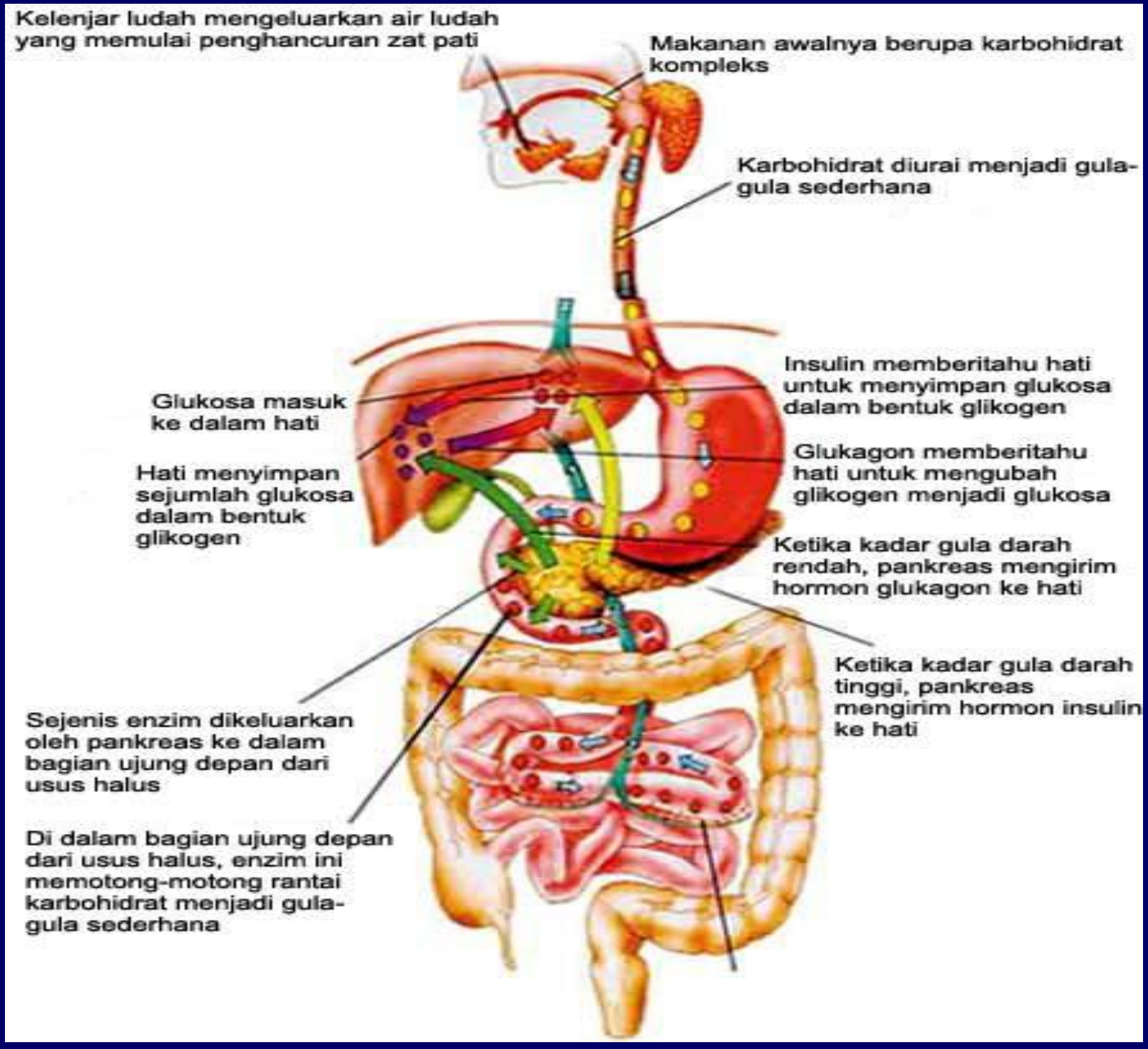


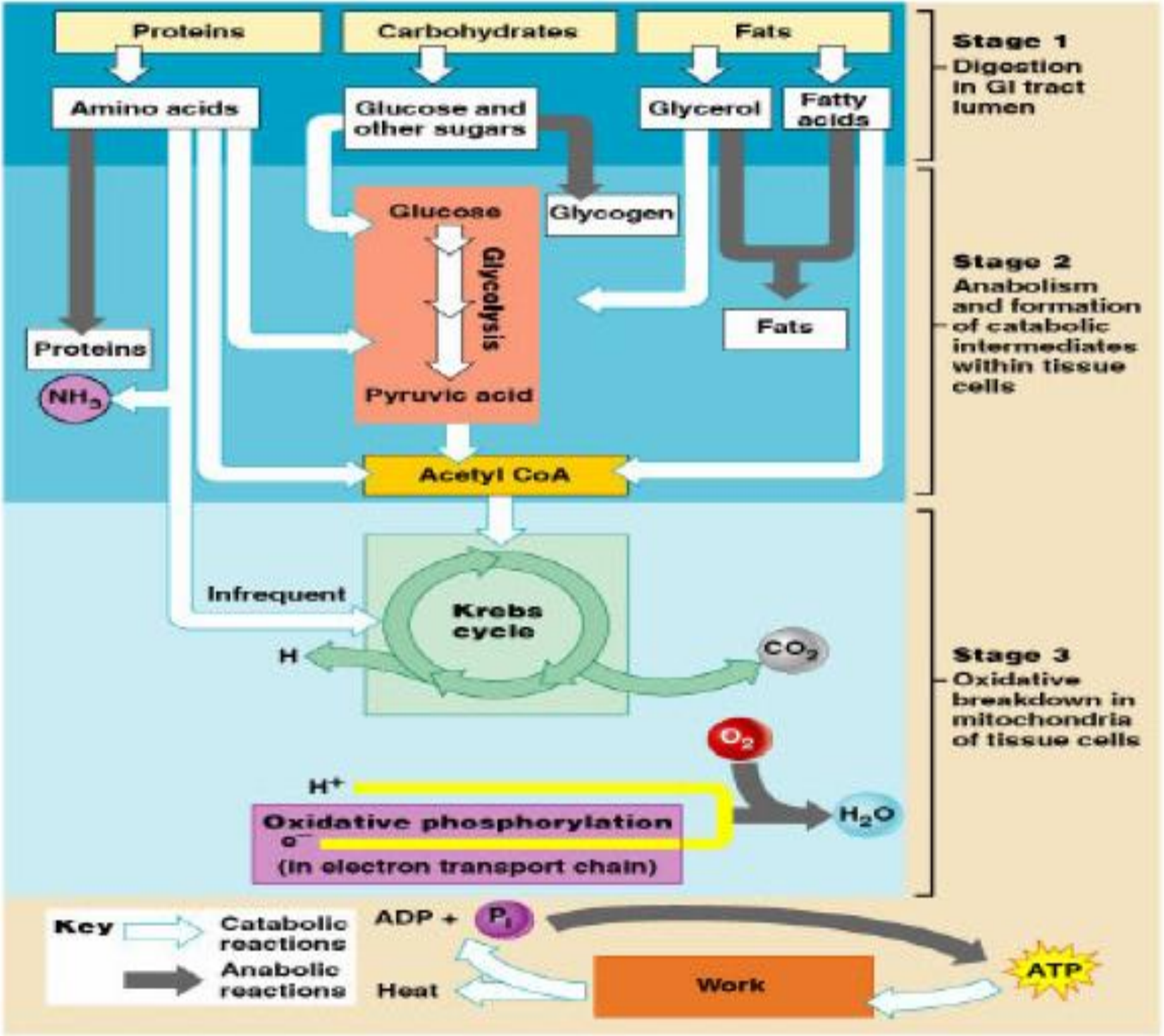
Anabolisme

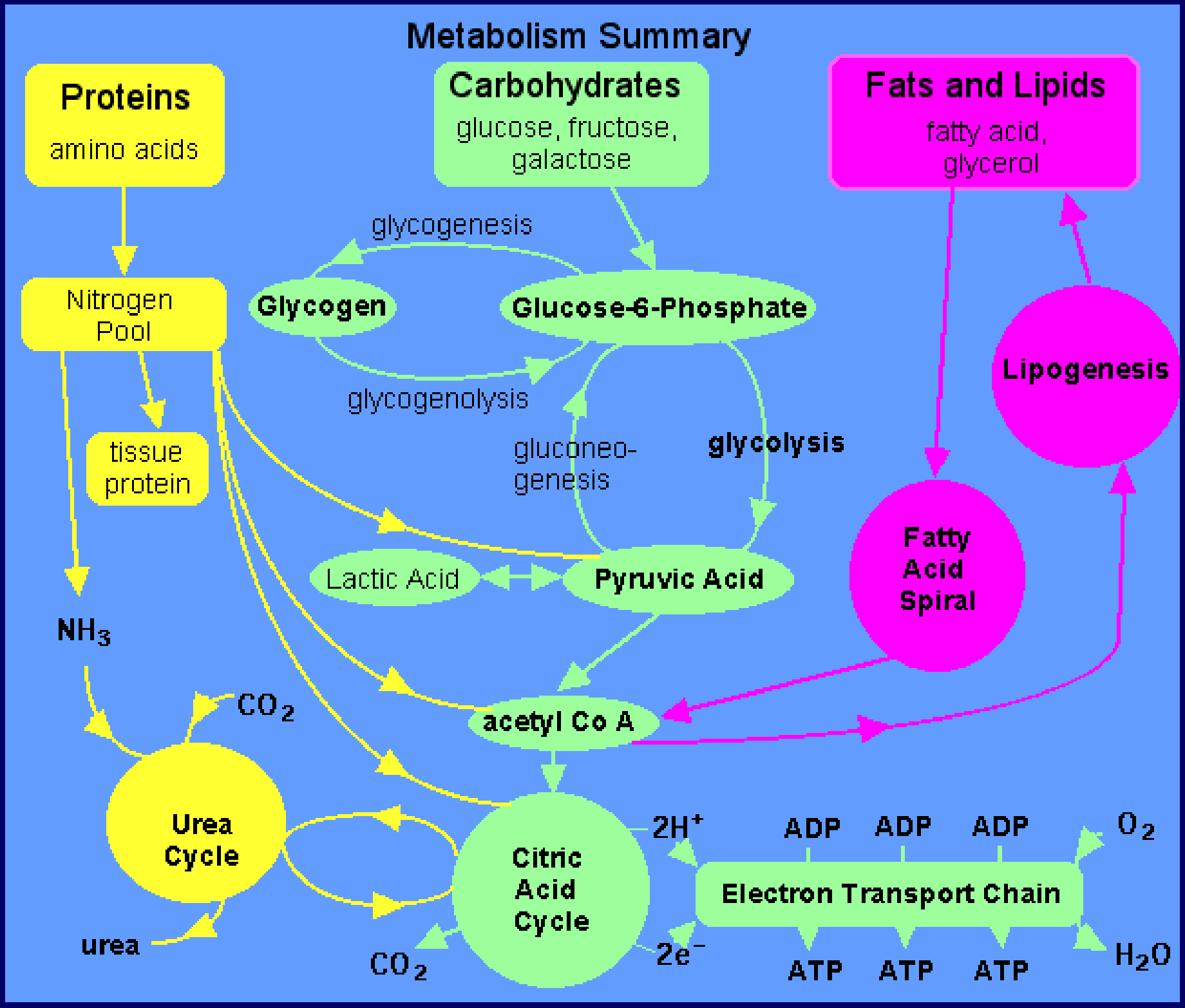
Katabolisme

Ringkasan Digesti KH, Protein, Lemak.

Karbohidrat		Protein		Lipida
Mulut: 1. Penc. Mekanis; 2. Penc. Enzimatis				
Polisakarida Oligosakarida disakarida		**Polipeptida Protein**		**lipida**
Lambung: 1. Enzim kel lambung (pepsin); 2. Asam lambung (HCl)				
Polisakarida Oligosakarida disakarida		Oligopeptida		Lipida trigliserida
Usus halus: 1. Cairan pankreas (Tripsin, Kimotripsin, amilase lipase, ribonuklease, deoksiribonuklease, kolesterol esterase); 2. Cairan empedu; 3. Enzim kelenjar usus halus (aminopeptidase, dipeptidase, sukrase, maltase, laktase, fosfatase, glukosidase), 4. Bakteri usus halus.				
Monoskarida: **- glukosa** **- fruktosa** **- galaktosa**		**Asam amino**		**- Gliserol** **- Asam lemak** **- Asam fosfat**
Penyerapan melalui dinding usus				
Aliran darah				
Hati: Metabolisme				**Jaringan otot: metabolisme**
		Ekskresi		

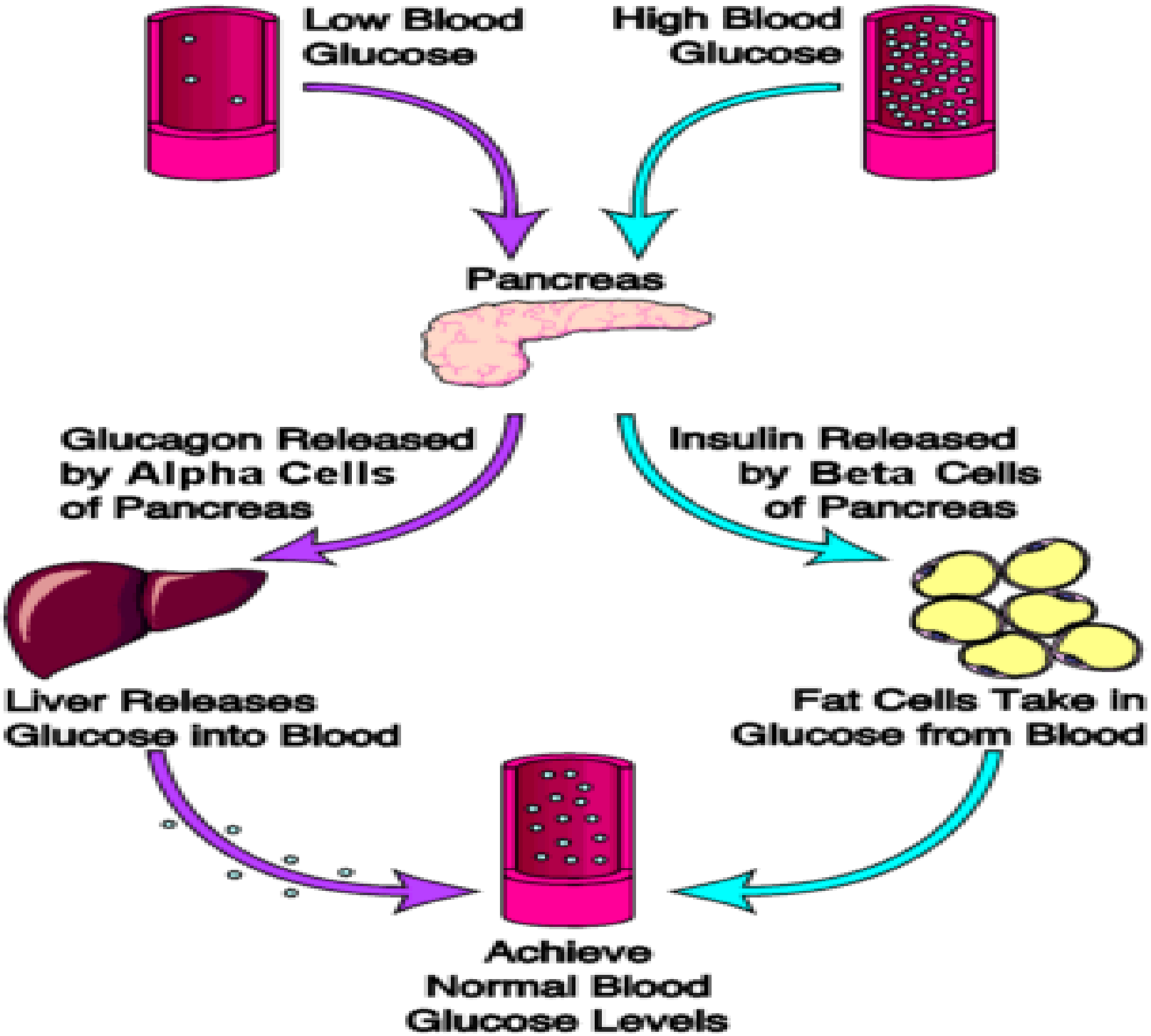

Kelenjar ludah mengeluarkan air ludah yang memulai penghancuran zat pati
Makanan awalnya berupa karbohidrat kompleks
Karbohidrat diurai menjadi gula-gula sederhana
Insulin memberitahu hati untuk menyimpan glukosa dalam bentuk glikogen
Glukosa masuk ke dalam hati
Glukagon memberitahu hati untuk mengubah glikogen menjadi glukosa
Hati menyimpan sejumlah glukosa dalam bentuk glikogen
Ketika kadar gula darah rendah, pankreas mengirim hormon glukagon ke hati
Ketika kadar gula darah tinggi, pankreas mengirim hormon insulin ke hati
Sejenis enzim dikeluarkan oleh pankreas ke dalam bagian ujung depan dari usus halus
Di dalam bagian ujung depan dari usus halus, enzim ini memotong-motong rantai karbohidrat menjadi gula-gula sederhana




Metabolism Summary
Proteins
amino acids
Carbohydrates
glucose, fructose, galactose
Fats and Lipids
fatty acid, glycerol
glycogenesis
Nitrogen Pool
Glycogen
Glucose-6-Phosphate
Lipogenesis
glycogenolysis
tissue protein
gluconeo-genesis
glycolysis
Fatty Acid Spiral
Lactic Acid
Pyruvic Acid
NH3
CO2
acetyl Co A
Urea Cycle
Citric Acid Cycle
2H+
ADP ADP ADP
O2
Electron Transport Chain
urea
CO2
2e−
ATP ATP ATP
H2O

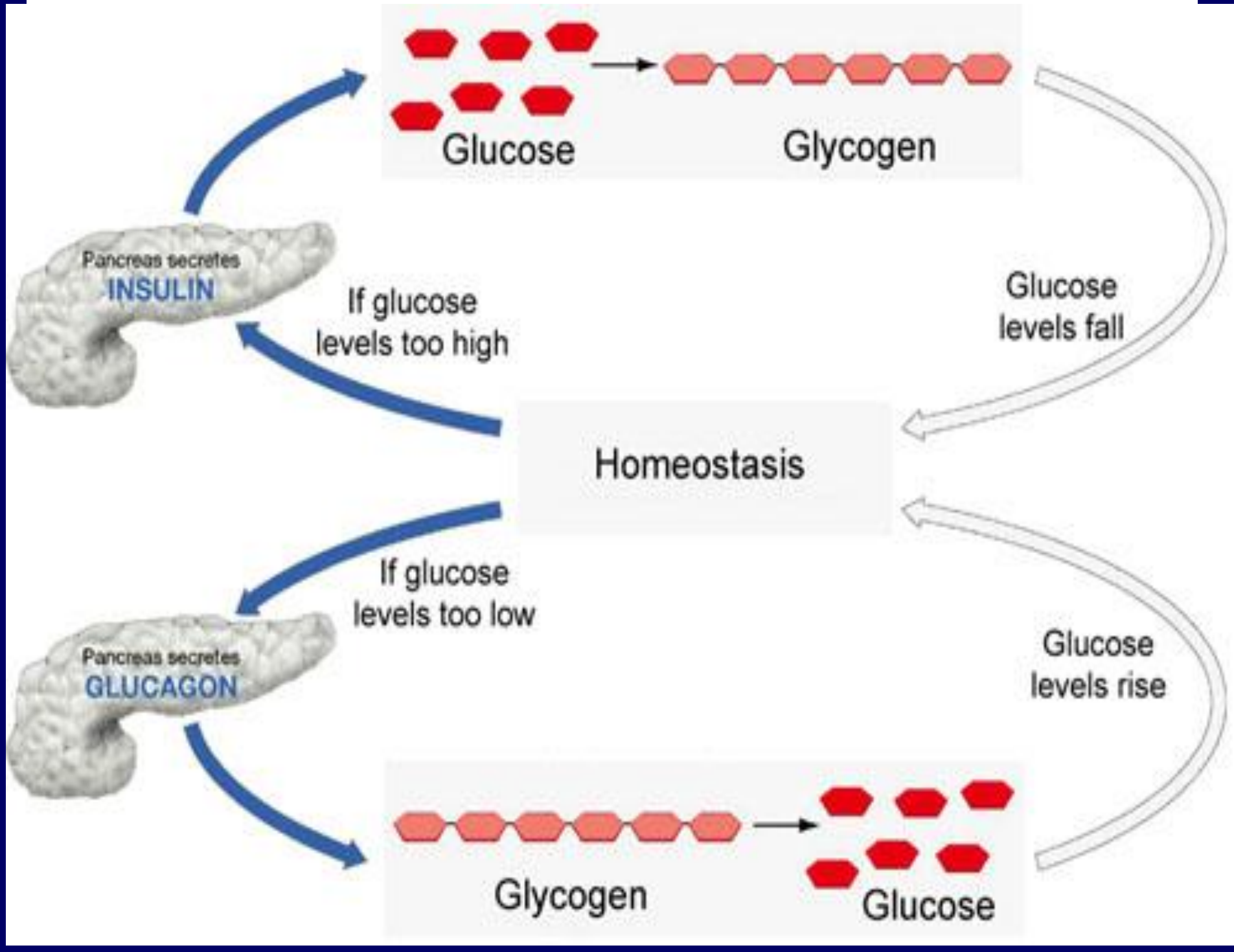
METABOLISME KARBOHIDRAT

- Penyerapan melalui ddg usus halus → monosakarida → hati => sintesis mjd glikogen, oksidasi mjd CO_2 dan H_2O atau dilepaskan utk dibawa aliran darah ke bag tubuh yg memerlukan.
- Hati dpt mengatur kadar glukosa darah krn pengaruh insulin dr pankreas.
- Glukosa darah naik → sintesis glikogen naik
- Glukosa darah rendah → glikogen diuraikan menjadi glukosa.
- Kadar glukosa darah?

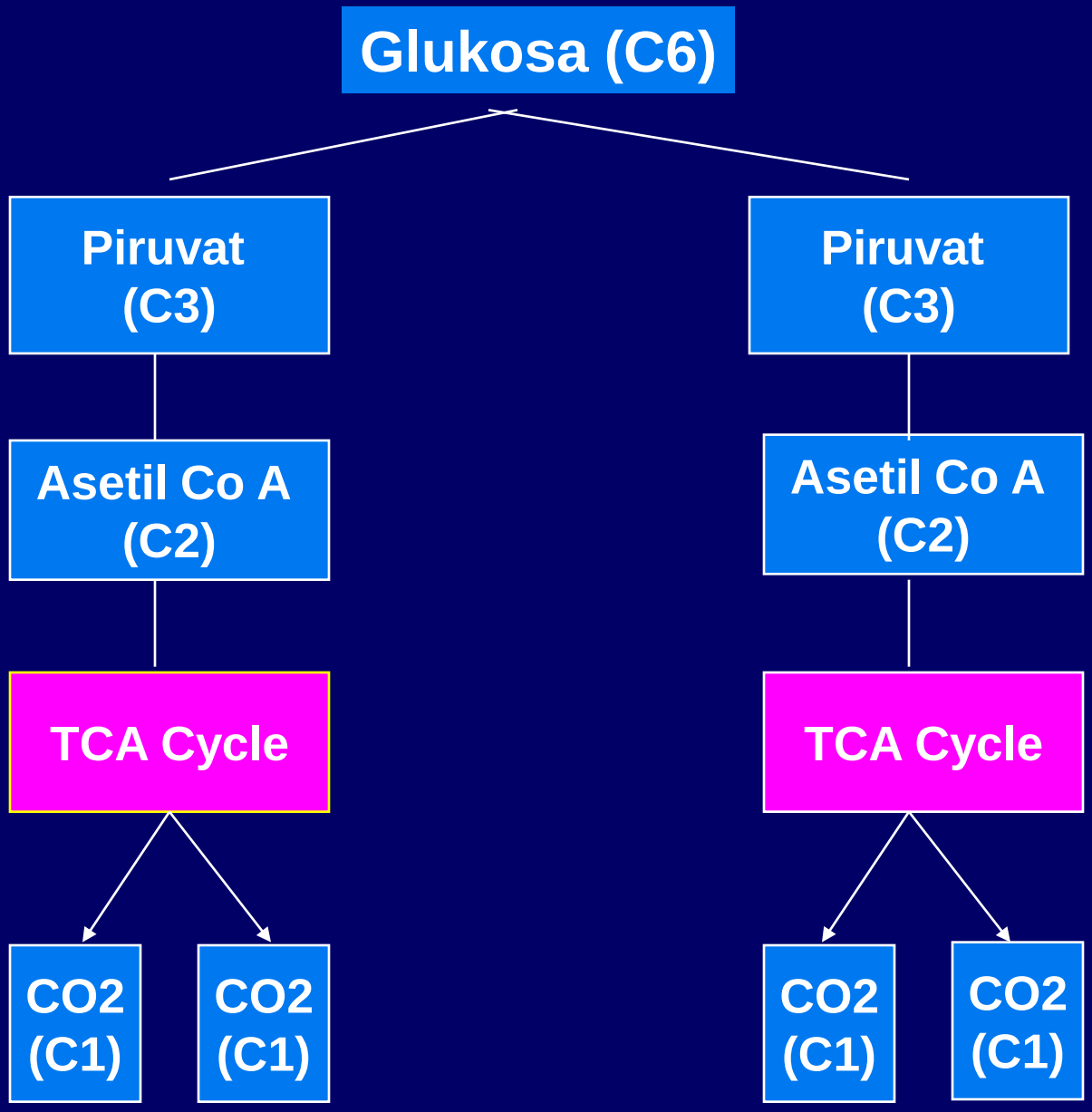

Low Blood Glucose
High Blood Glucose
Pancreas
Glucagon Released by Alpha Cells of Pancreas
Insulin Released by Beta Cells of Pancreas
Liver Releases Glucose into Blood
Fat Cells Take in Glucose from Blood
Achieve Normal Blood Glucose Levels

Mekanisme pengaturan Glukosa darah?

- **Cascade Mechanism (mekanisme bertahap.**
- **Terkait dengan pengaturan sintesis dan degradasi glikogen**
- **Enzim utam yg terlibat: glikogen sintase dan glikogen fosforilase.**
- **Kerjanya diatur oleh banyak enzim lainnya sec bertahap shg bs dalam keadaan aktif atau tidak aktif**
- **Mekanisme?**


Glucose
Glycogen
Pancreas secretes
INSULIN
If glucose
levels too high
Glucose
levels fall
Homeostasis
If glucose
levels too low
Pancreas secretes
GLUCAGON
Glucose
levels rise
Glycogen
Glucose

KATABOLISME CHO

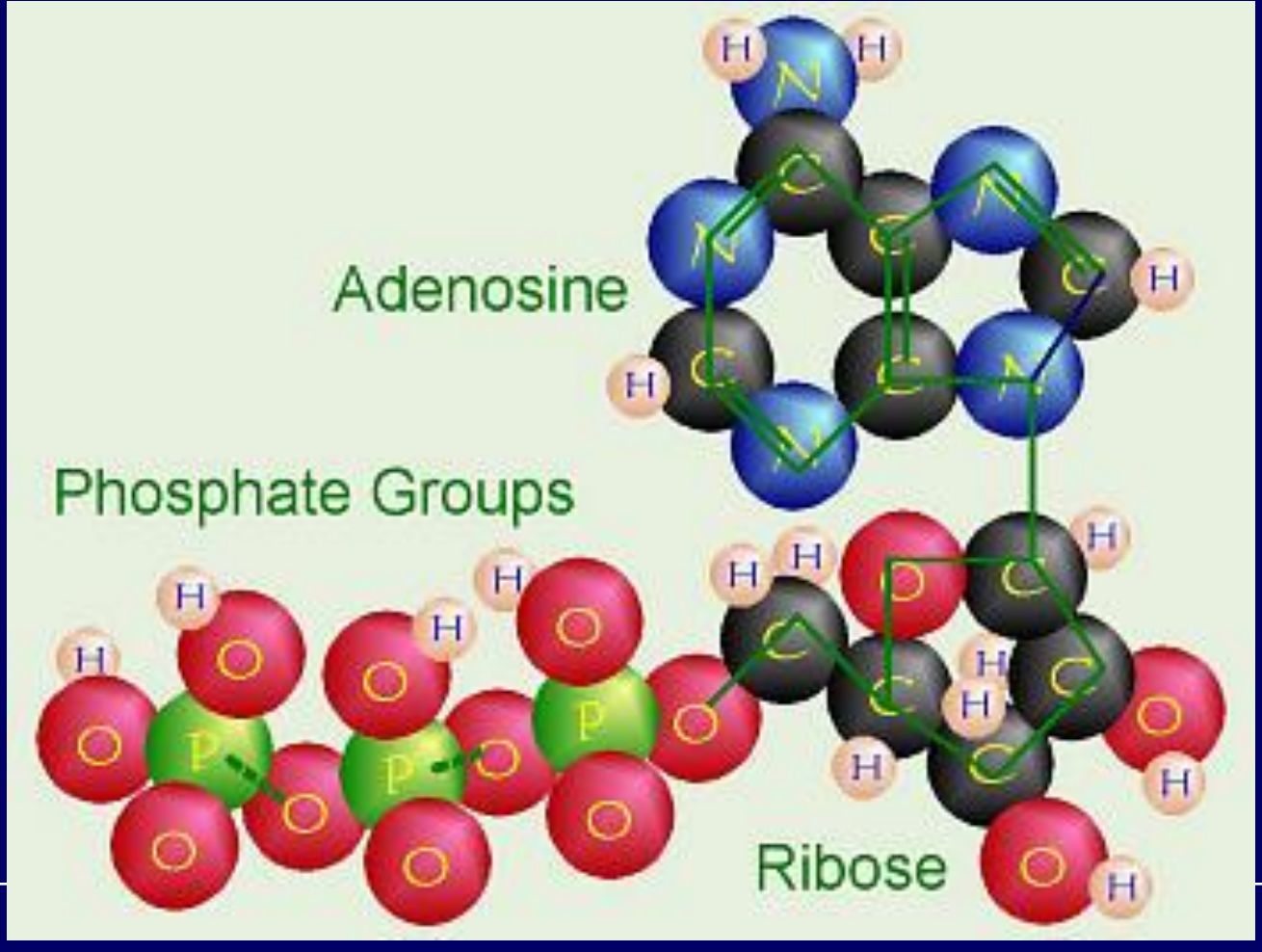


38ATPs

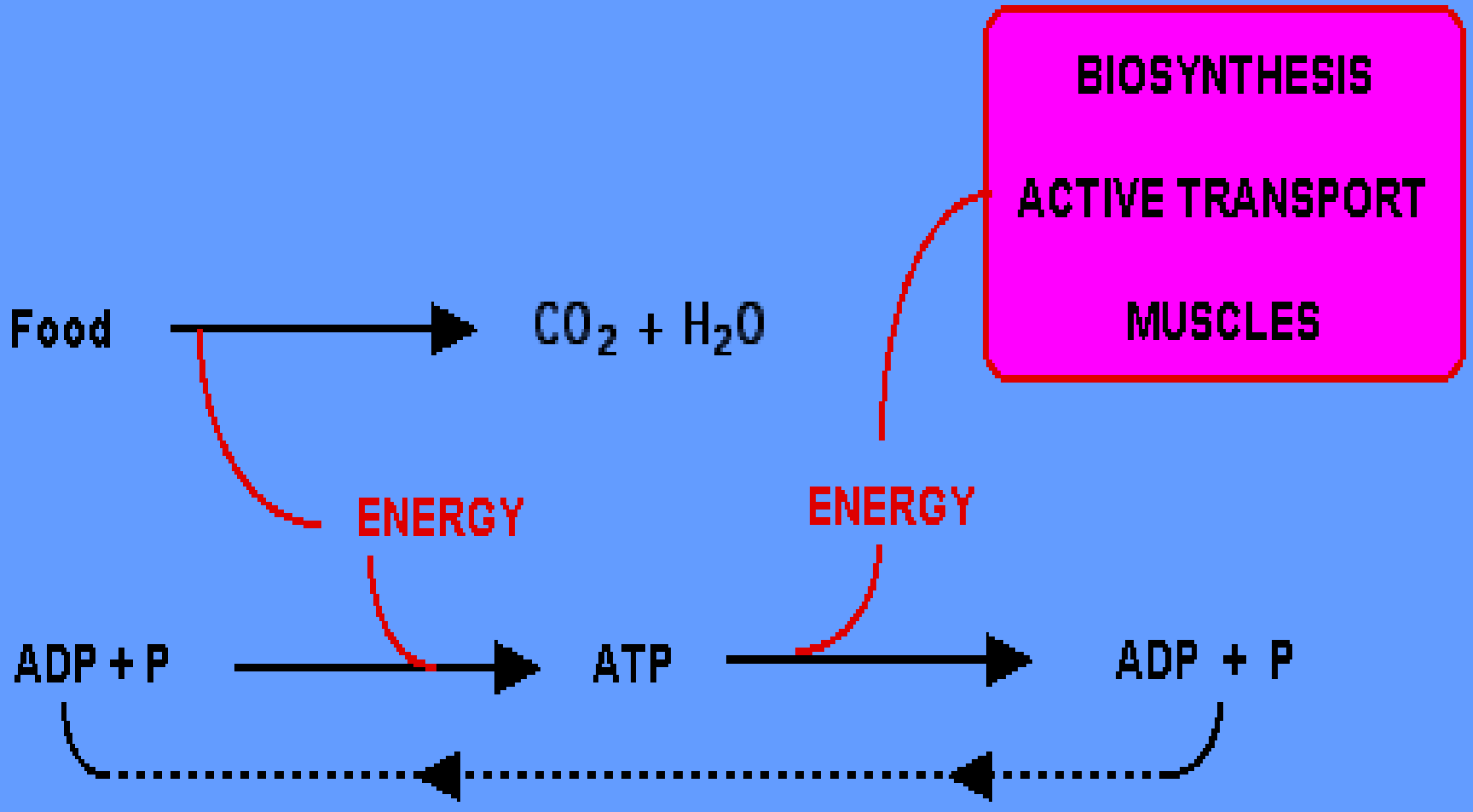
ENERGY CURRENCY - ATP

- Life Processes require a constant supply of ENERGY. This Energy is available to Cells in the form of Compounds that contain a Large amount of Energy in their overall Structure.
- The Most common Energy Compound used by Cells is ADENOSINE TRIPHOSPHATE OR ATP.

- **An ATP Molecule is made of a Sugar (RIBOSE, A FIVE-CARBON SUGAR), and Adenine Molecule, and a Chain of THREE Phosphates groups (TRIPHOSPHATE GROUP). When the Bonds between the outermost Two Phosphate Groups of ATP is broken, ATP becomes ADP (ADENOSINE DIPHOSPHATE). (DI = 2)**

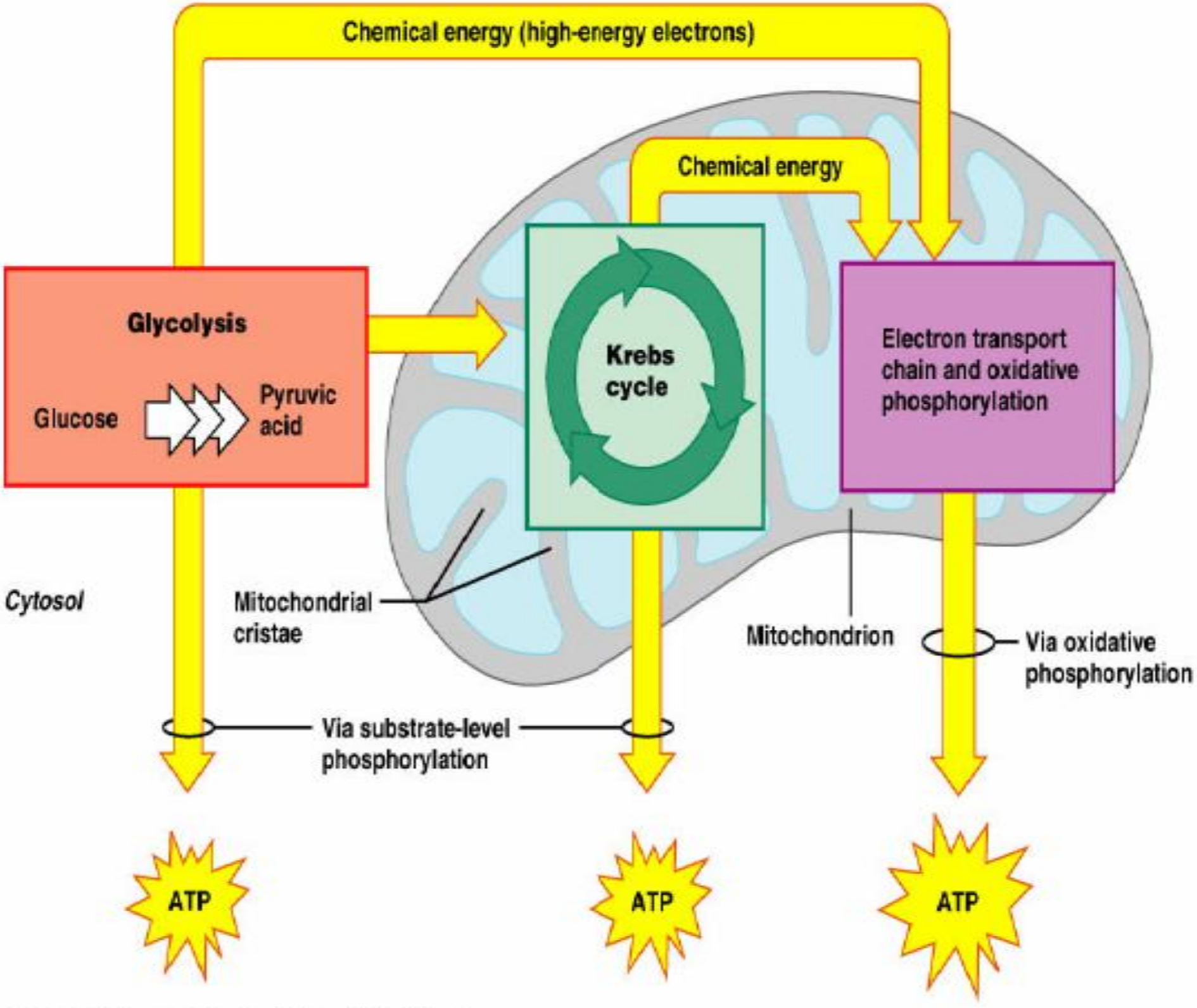


Energy Summary



Formation of ATP and energy release

- the chemical reaction for the formation of ATP as:
- a) ADP + Pi + energy ----> ATP
- b) Adenosine diphosphate + inorganic Phosphate + energy produces Adenosine Triphosphate
- The chemical formula for the expenditure/release of ATP energy :
- a) ATP ----> ADP + energy + Pi
- b) Adenosine Triphosphate produces Adenosine diphosphate + energy + inorganic Phosphate


Chemical energy (high-energy electrons)
Chemical energy
Glycolysis
Glucose
Pyruvic acid
Krebs cycle
Electron transport chain and oxidative phosphorylation
Cytosol
Mitochondrial cristae
Mitochondrion
Via oxidative phosphorylation
Via substrate-level phosphorylation
ATP
ATP
ATP