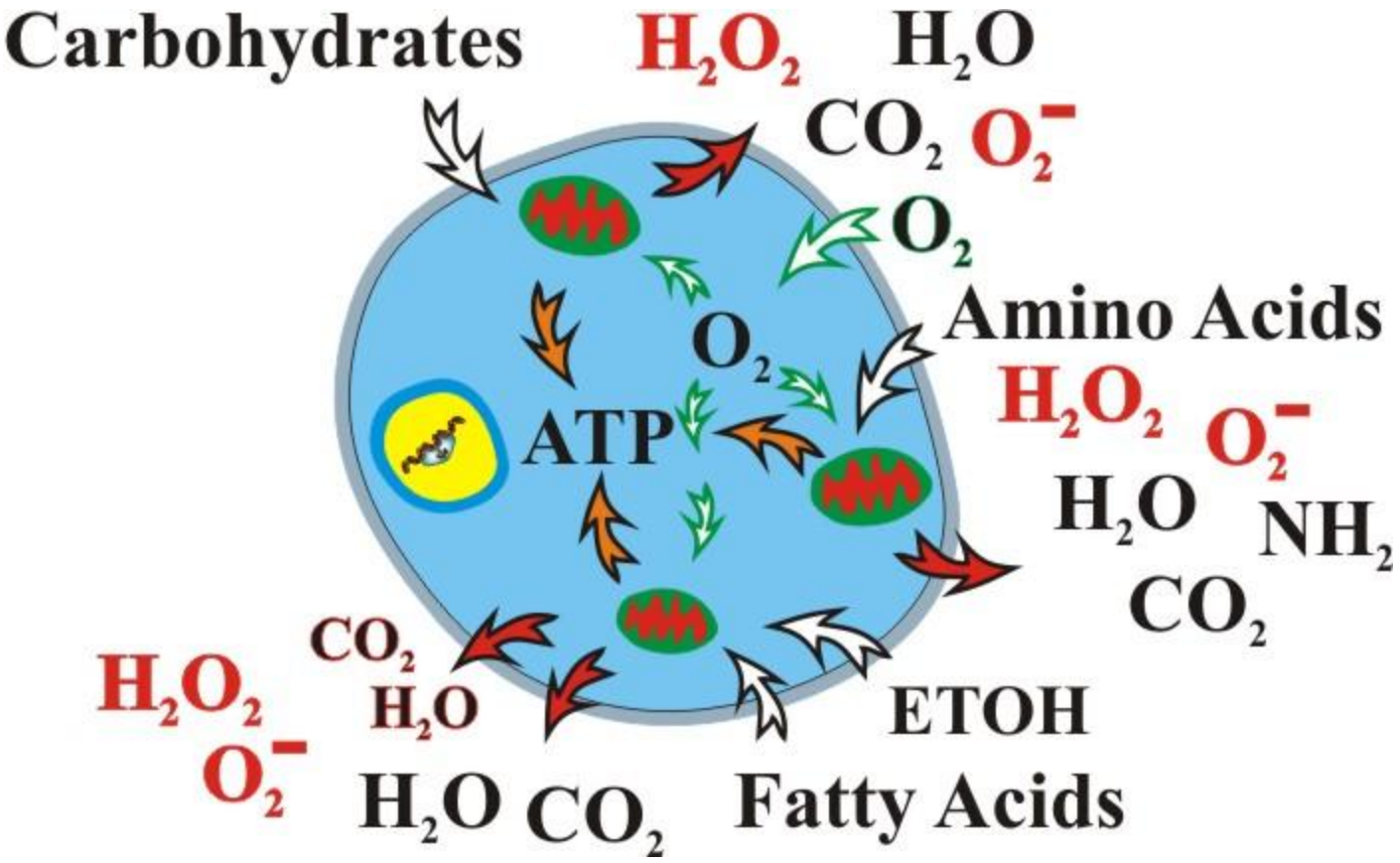
SEMEY STATE MEDICAL UNIVERSITY
Chair of biochemistry and chemistry disciplines

SIW

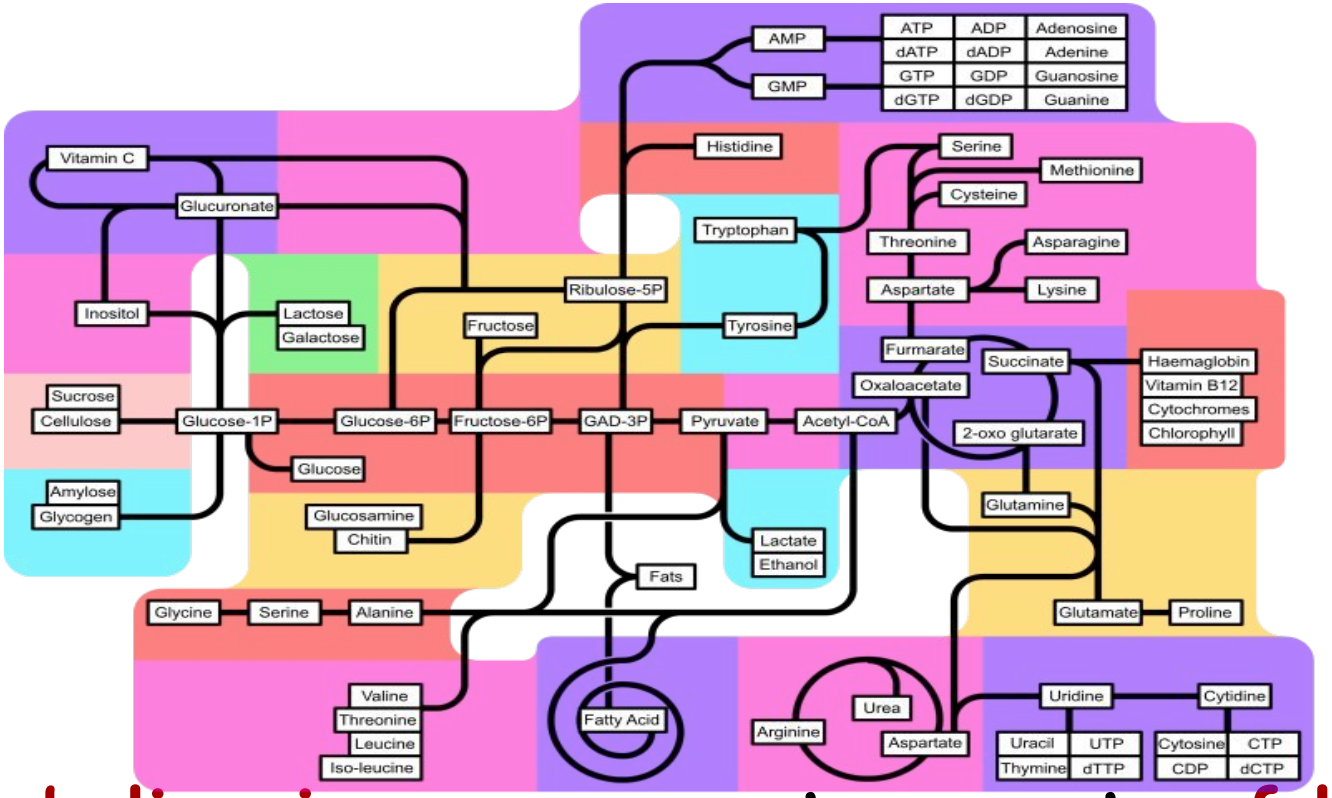
Prepared by: Zhumakanova T.M
Checked by: Irina Ivanovna
Course: 2 gr(207)
Faculty: Dentistry

Semey
2017

Introduction to Metabolism



- **Metabolism** is the sum of an organism's chemical reactions



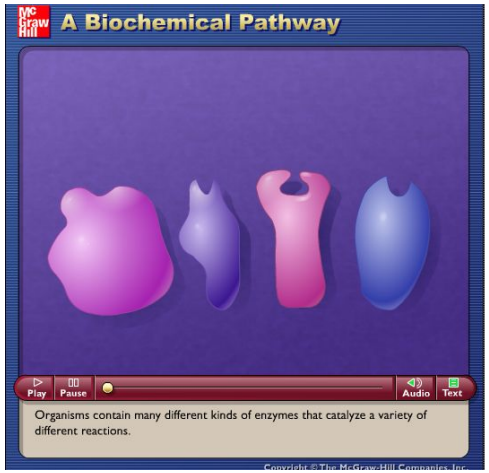
- **Metabolism** is an **emergent property** of life that arises from interactions between molecules within the cell

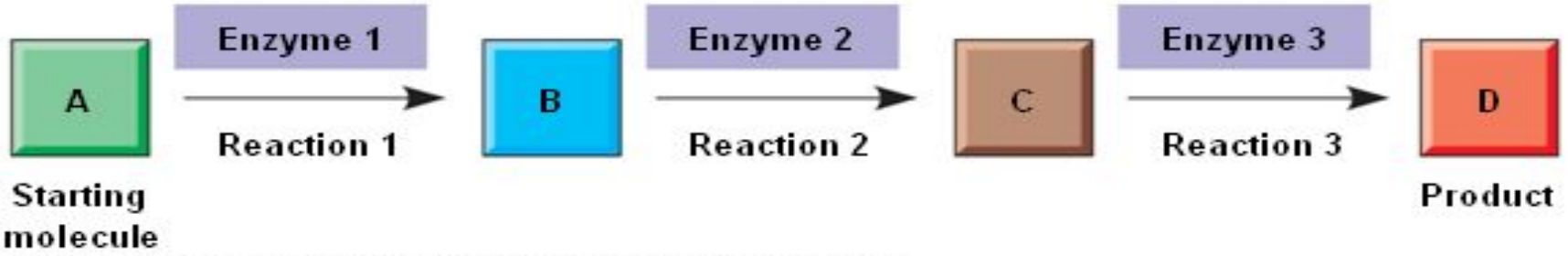
A metabolic pathway begins with a specific molecule and ends with a product

The product of one reaction is substrate of the next

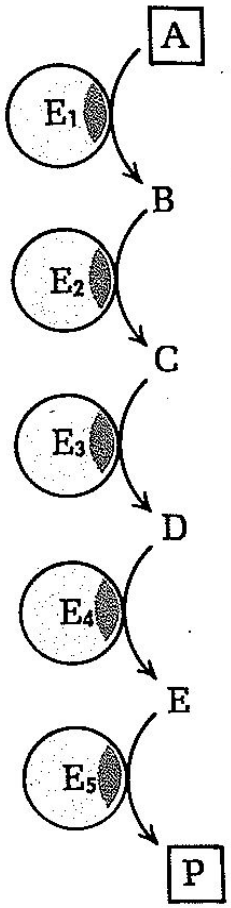
- Each step is catalyzed by a specific enzyme

BIOCHEMICAL PATHWAY VIDEO

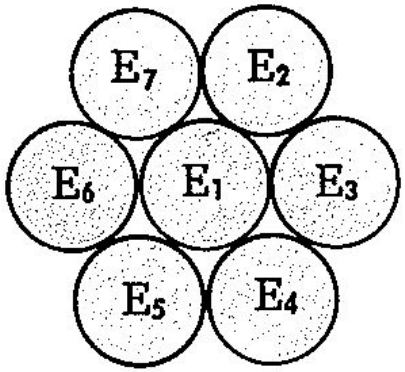




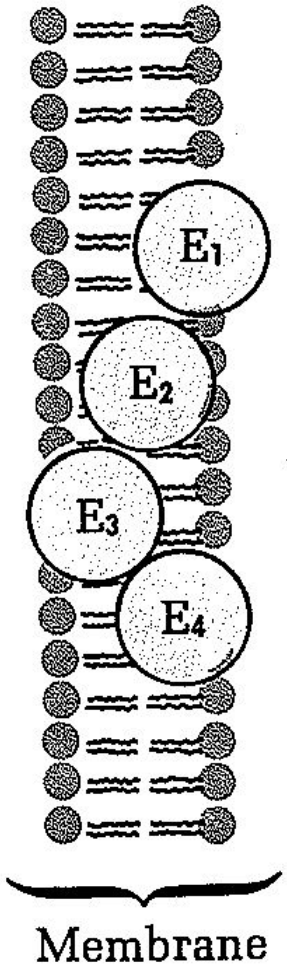
ENZYMES THAT WORK TOGETHER IN A PATHWAY CAN BE



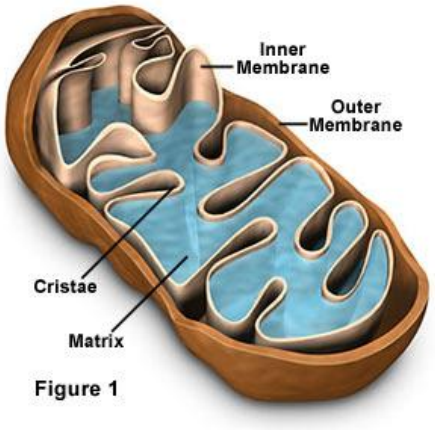
Soluble with free floating intermediates



Covalently bound in complex



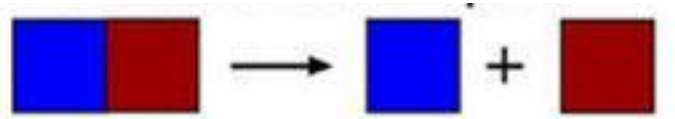
Attached to a membrane in sequence



Concentrated in specific location

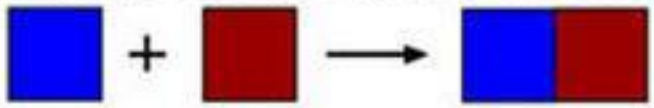
CATABOLIC PATHWAY (CATABOLISM)

Release of energy by the breakdown of complex molecules to simpler compounds
EX: digestive enzymes break down food

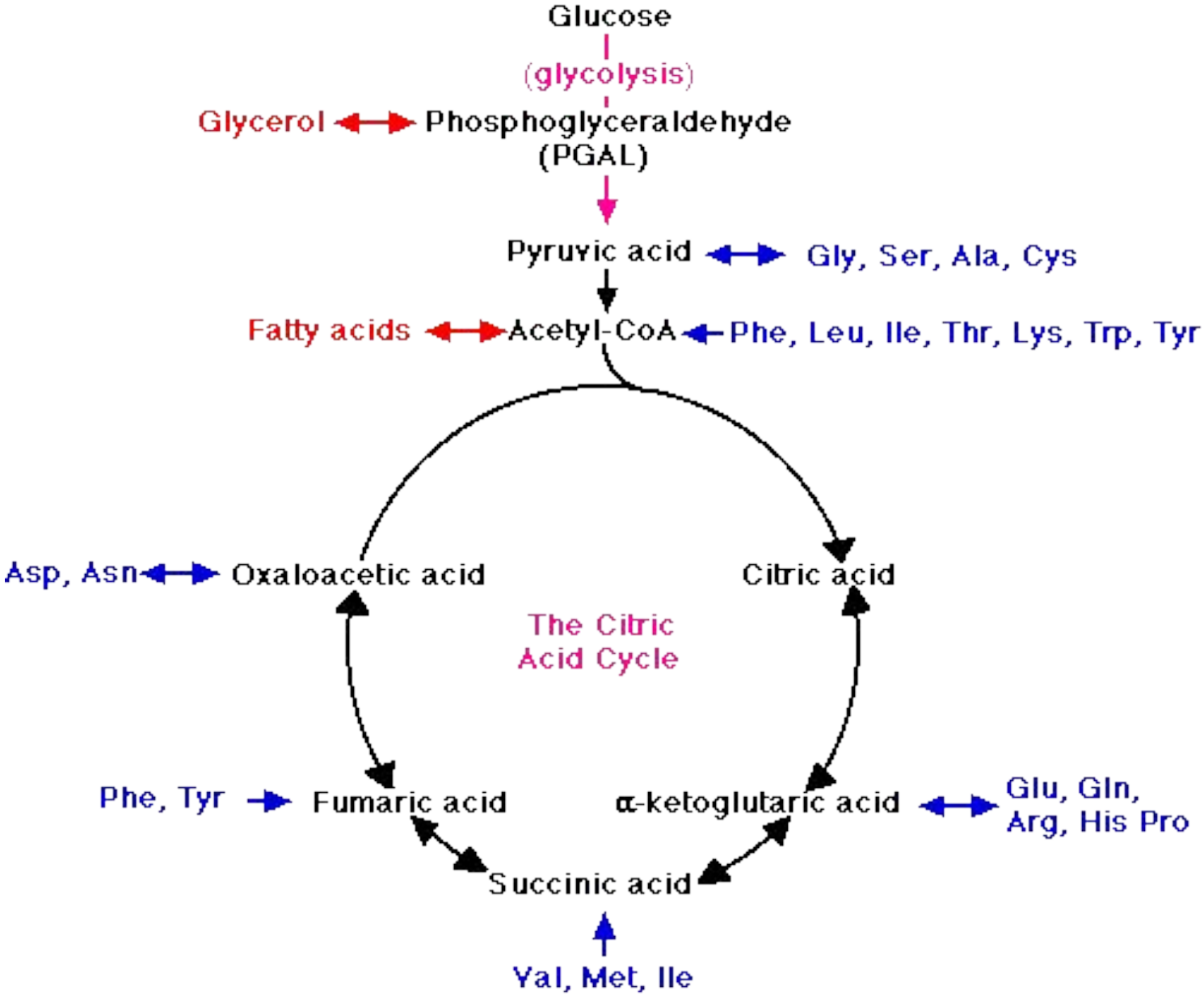


ANABOLIC PATHWAY (ANABOLISM)

consumes energy to build complicated molecules from simpler ones
EX: linking amino acids to form proteins

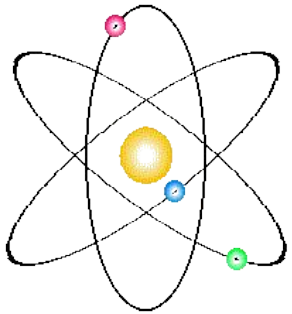


Krebs Cycle connects the catabolic and anabolic pathways



Forms of Energy

- ENERGY = capacity to cause change
- Energy exists in various forms
  (some of which can perform work)
- Energy can be converted from one form to another



KINETIC ENERGY –

energy associated with motion

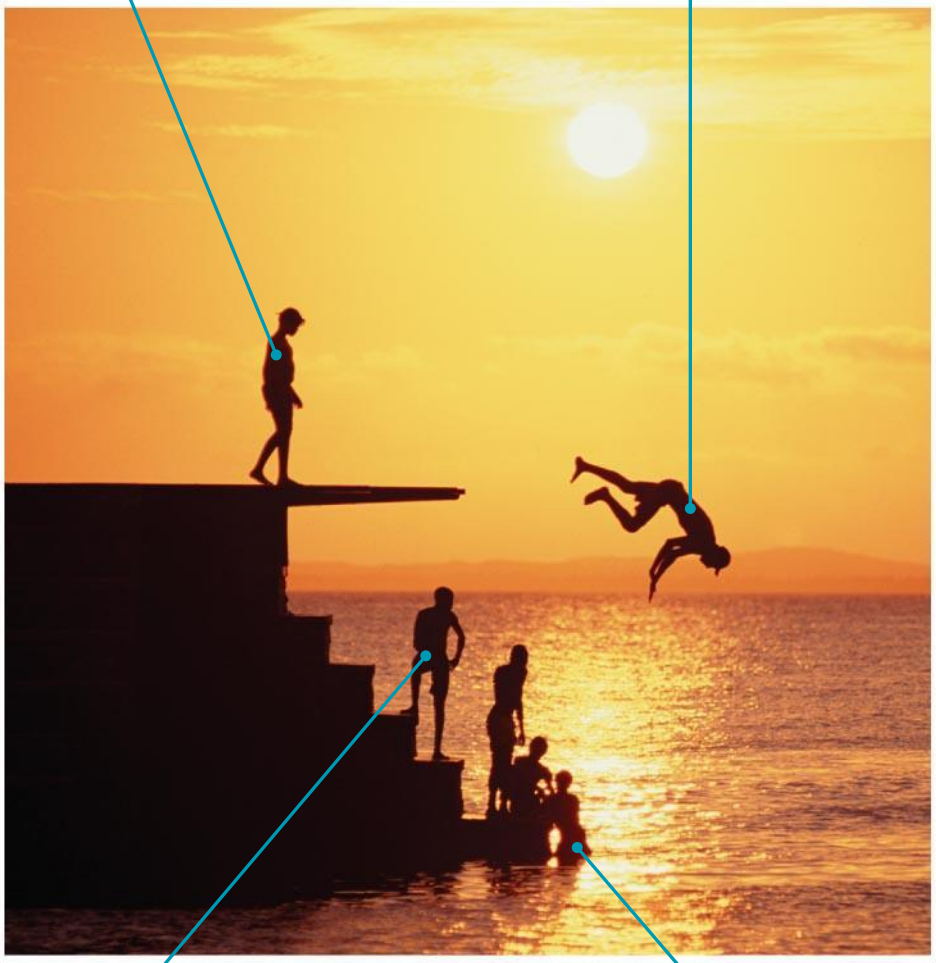
–HEAT (thermal energy) is kinetic energy associated with random movement of atoms or molecules

POTENTIAL ENERGY = energy that matter possesses because of its location or structure

–CHEMICAL energy is potential energy available for release in a chemical reaction

On the platform, the diver has more potential energy.

Diving converts potential energy to kinetic energy.



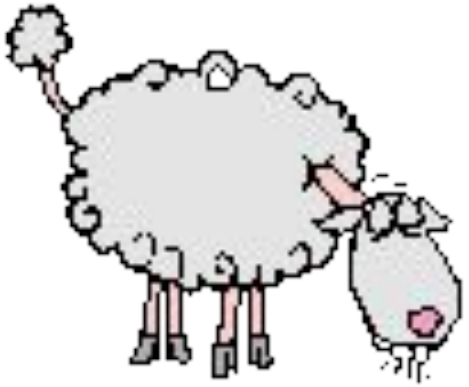
Climbing up converts kinetic energy of muscle movement to potential energy.

In the water, the diver has less potential energy.

THERMODYNAMICS

= the study of energy transformations

- CLOSED system (EX: liquid in a thermos)
  = isolated from its surroundings
- OPEN system
  energy + matter can be transferred between the system and its surroundings
- *Organisms are open systems*



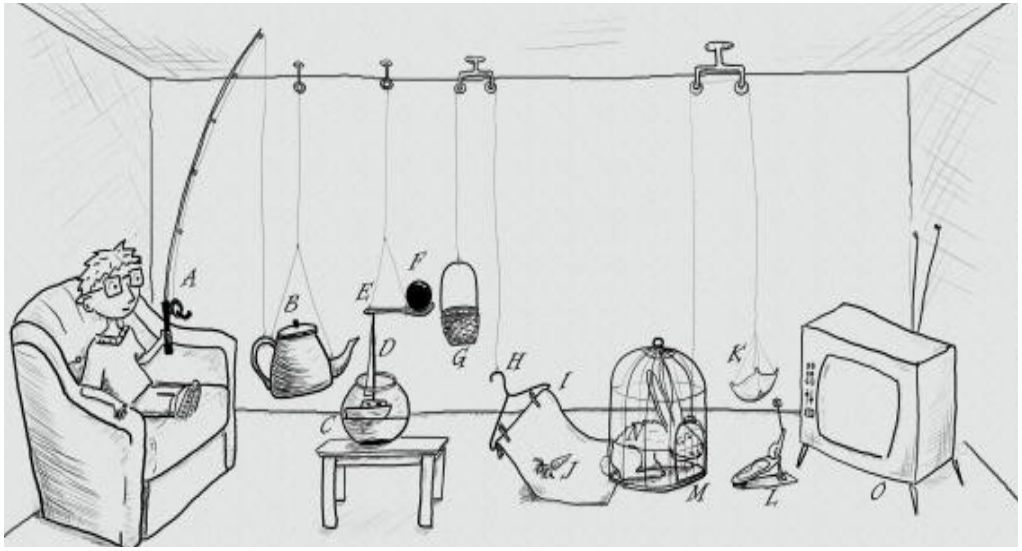
The First Law of Thermodynamics

= energy of the universe is constant

-Energy can be transferred and transformed

-Energy cannot be created or destroyed

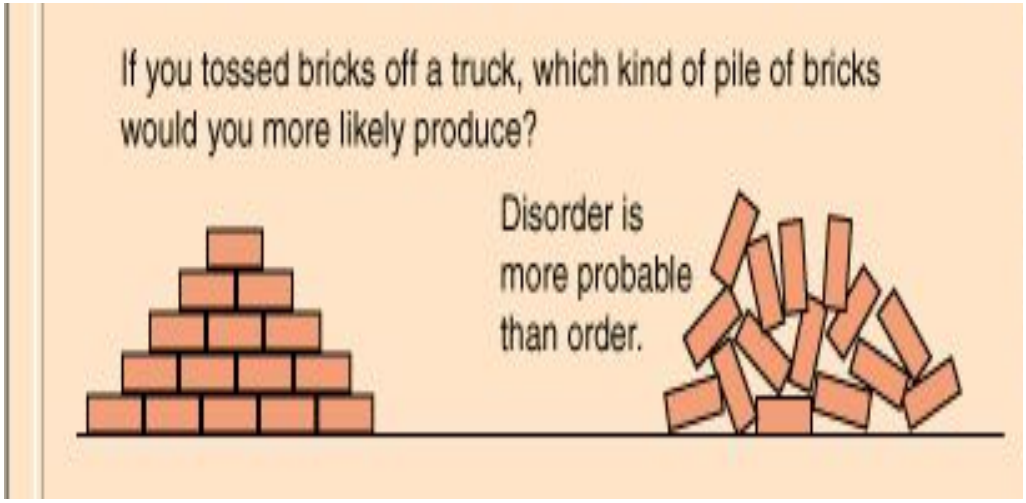
- The first law is also called the principle of CONSERVATION OF ENERGY



The Second Law of Thermodynamics

During every energy transfer or transformation

- entropy (disorder) of the universe INCREASES
- some energy is unusable, often lost as heat



First law of thermodynamics

Second law of thermodynamics

(a) (b)

ORGANISMS are energy TRANSFORMERS!

Spontaneous processes occur without energy input; they can happen quickly or slowly

For a process to occur without energy input, it must increase the entropy of the universe

Free-Energy Change (ΔG) can help tell which reactions will happen

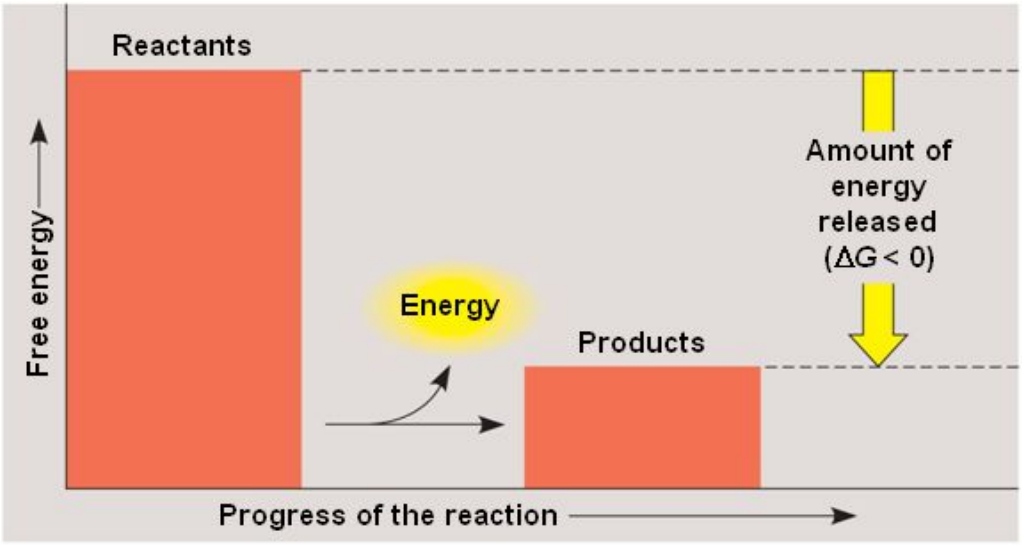
ΔG = change in free energy
ΔH = change in total energy (enthalpy) or change ΔS = entropy
T = temperature

$$\Delta G = \Delta H - T\Delta S$$

- Only processes with a negative ΔG are spontaneous
- Spontaneous processes can be harnessed to perform work

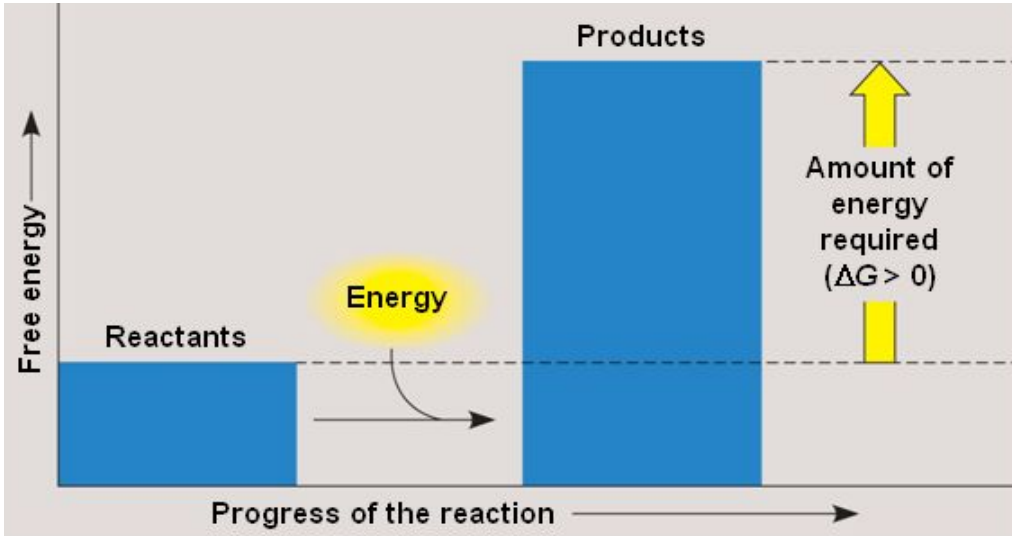
Exergonic and Endergonic Reactions in Metabolism

- EXERGONIC reactions (- ΔG)
- Release energy
- are spontaneous

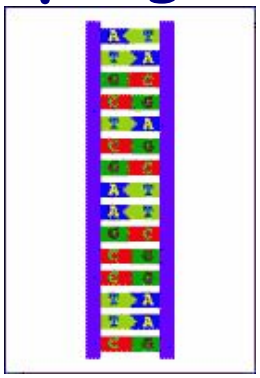


ENDERGONIC reactions (+ ΔG)

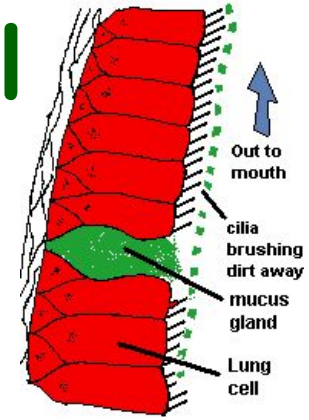
- Absorb energy from their surroundings
- are non-spontaneous

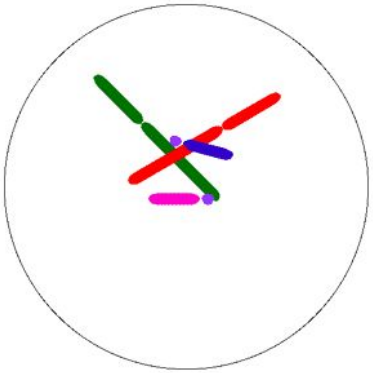


Concept 8.3: ATP powers cellular work by coupling exergonic reactions to endergonic reactions



- A cell does three main kinds of work:
  - Mechanical
  - Transport
  - Chemical



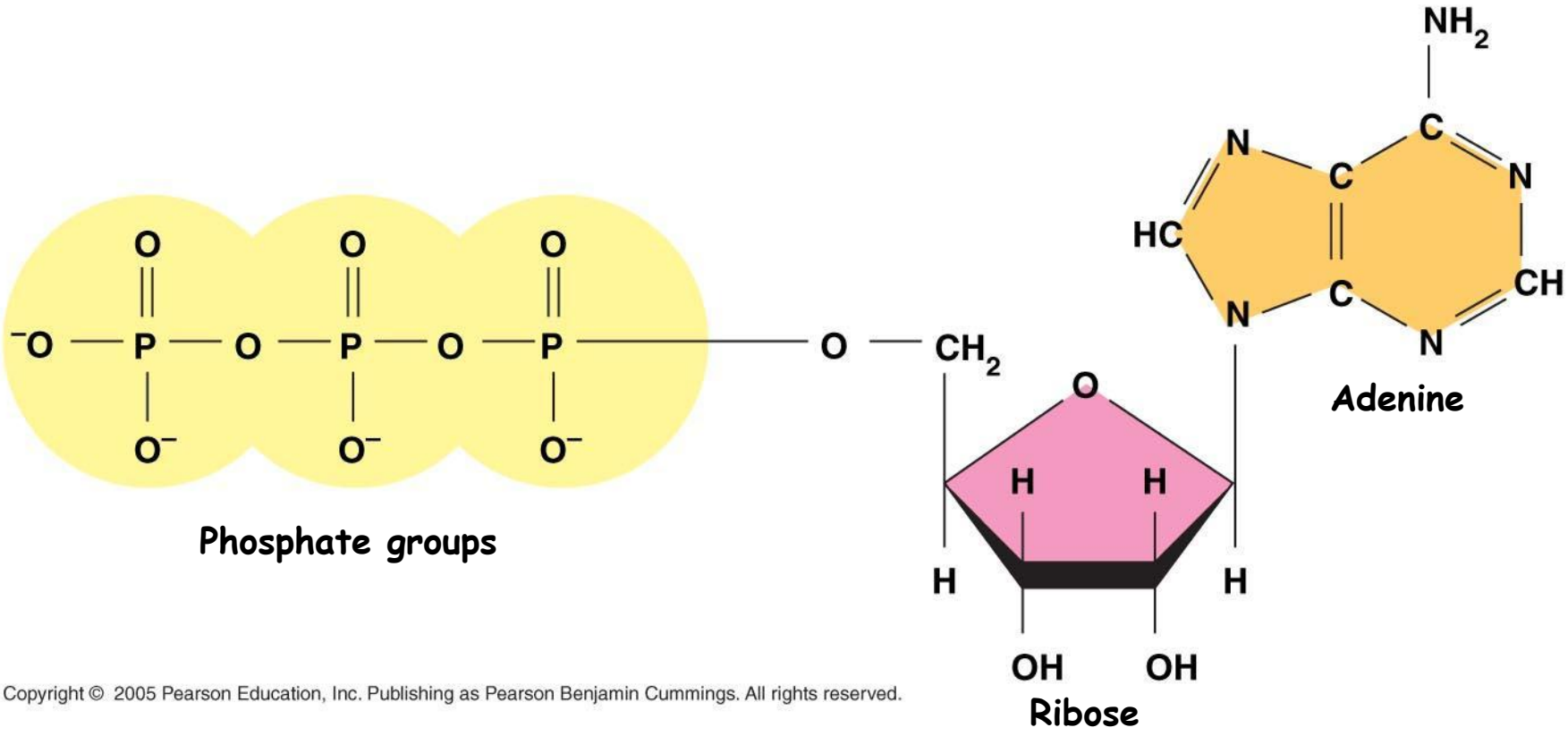


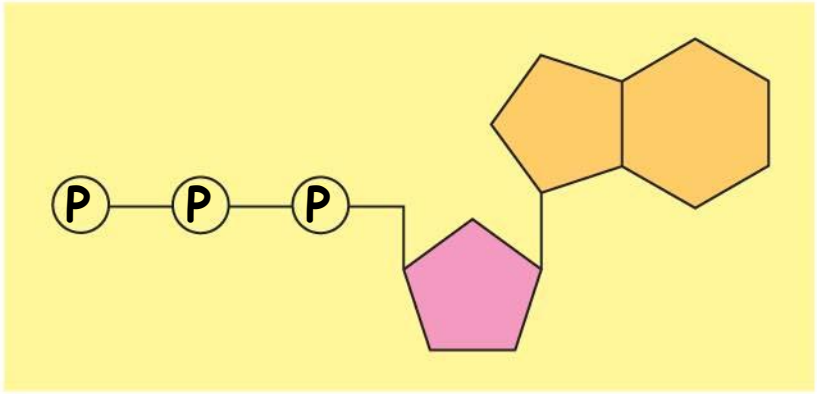
- In the cell, the energy from the exergonic reaction of ATP hydrolysis can be used to drive an endergonic reaction
- Overall, the coupled reactions are exergonic

ATP (adenosine triphosphate) is the cell's renewable and reusable energy shuttle

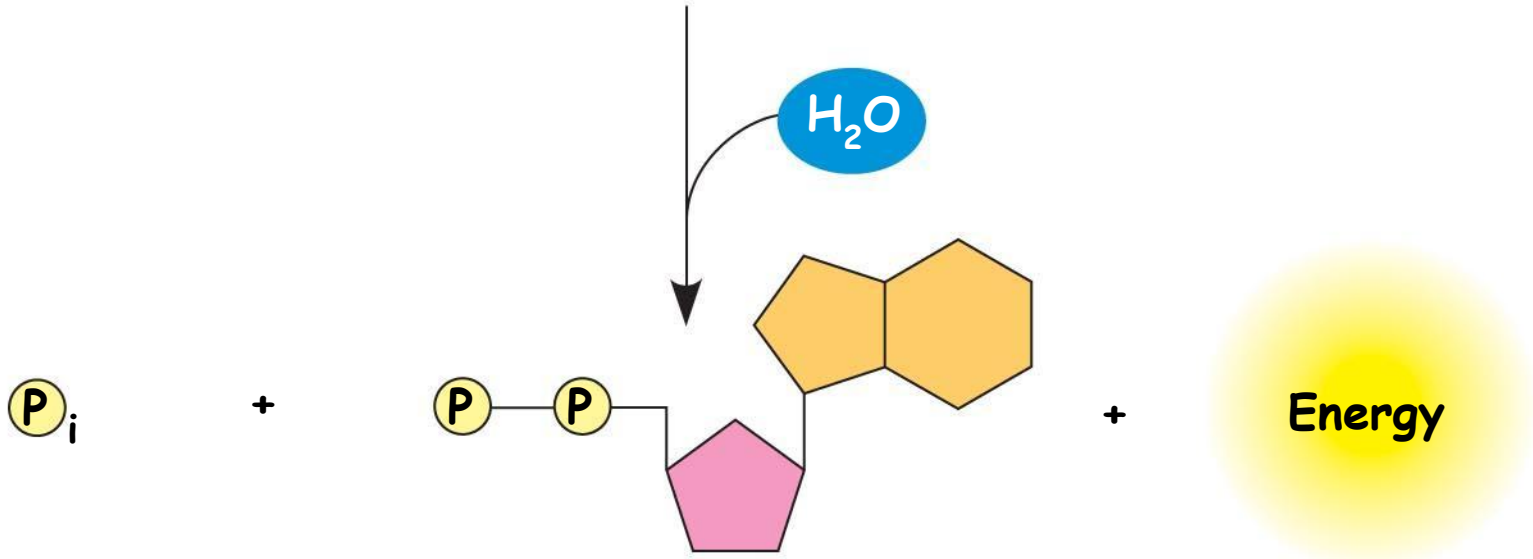
ATP provides energy for cellular functions

Energy to charge ATP comes from catabolic reactions

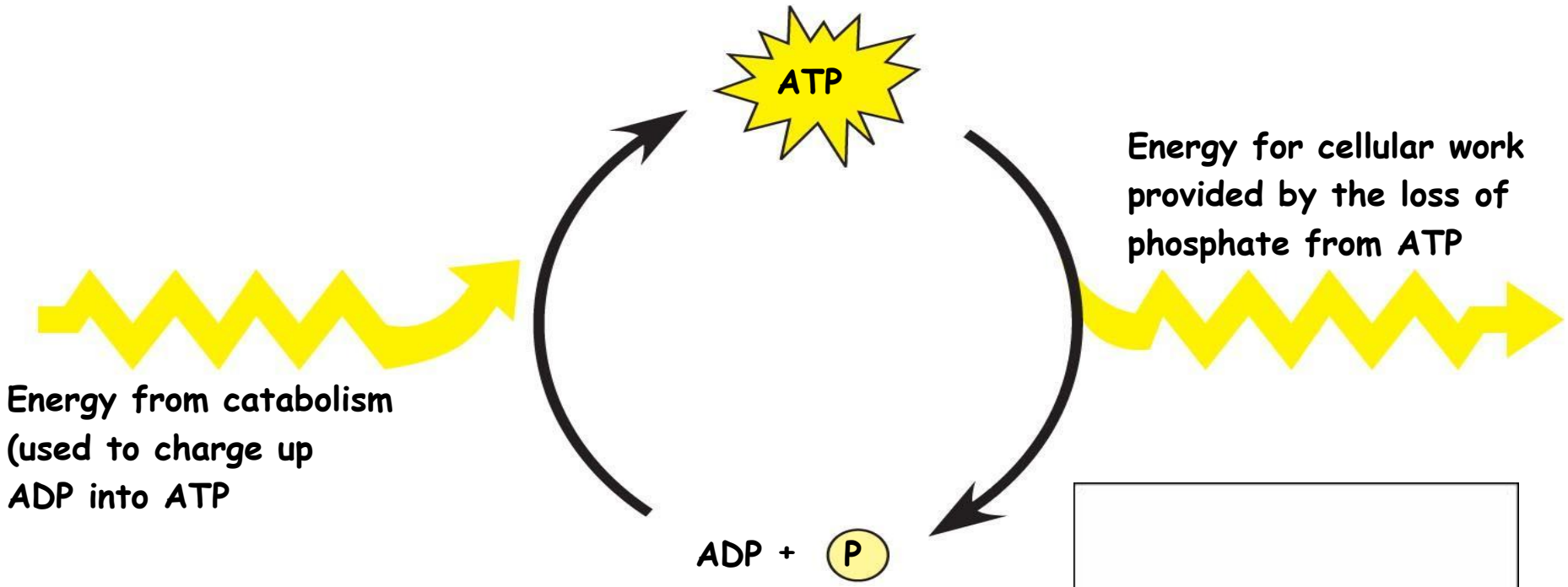




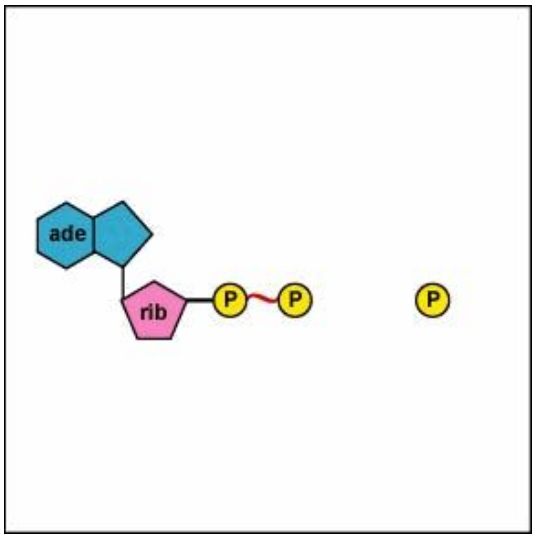
Adenosine triphosphate (ATP)



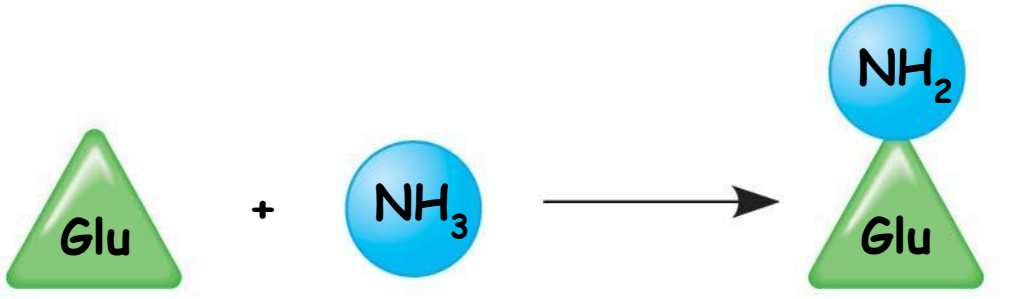
Inorganic phosphate Adenosine diphosphate (ADP)



i



Endergonic reaction:
DG is positive, reaction is not spontaneous



Glutamic acid Ammonia Glutamine

ΔG = +3.4 kcal/mol

Exergonic reaction:
DG is negative, reaction is spontaneous

ΔG = –7.3 kcal/mol

Coupled reactions:
Overall DG is negative;
Together, reactions are spontaneous

ΔG = –3.9 kcal/mol

End Show