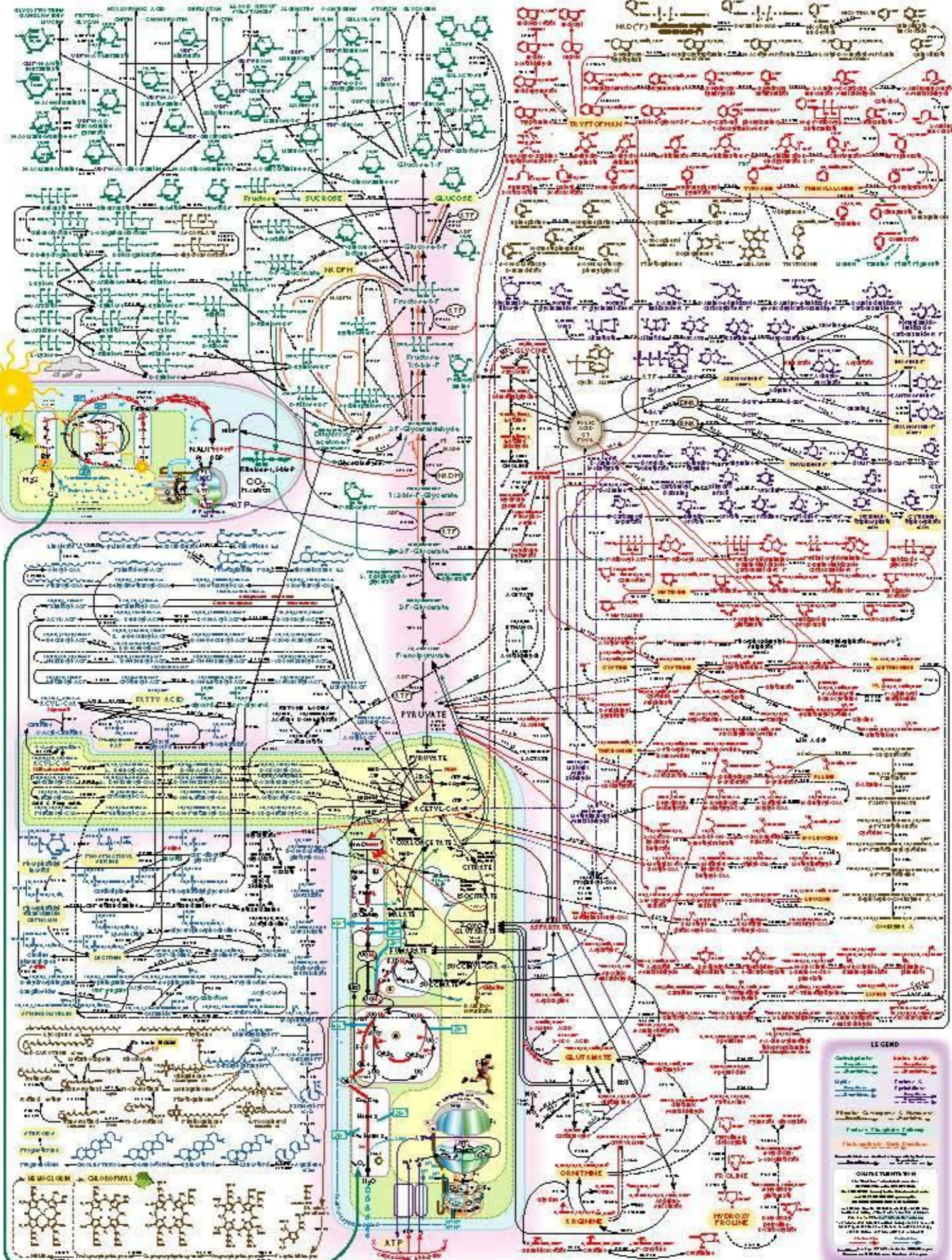


Metabolism

- **Metabolism is** “the chemical reactions of life; all the various processes by which you obtain energy, grow, heal, think, feel, and dispose of wastes”.
- Metabolic reactions are controlled by **enzymes**.



SUNLIGHT
 CARBOHYDRATE
 AMINO ACIDS
 NITROGEN
 PHOSPHORUS
 SULFUR
 CALCIUM
 MAGNESIUM
 POTASSIUM
 SODIUM
 CHLORINE
 IODINE
 ZINC
 COPPER
 MANGANESE
 SELENIUM
 CHROMIUM
 VANADIUM
 MOLYBDENUM
 COBALT
 NICKEL
 SILICON
 BORON
 FLUORINE
 BROMINE
 CADMIUM
 LEAD
 MERCURY
 ALUMINUM
 BARIUM
 STRONTIUM
 THALLIUM
 URANIUM
 RADIUM
 POLONIUM
 ACTINIUM
 THORIUM
 URANANIUM
 PLUTONIUM
 AMERICIUM
 CURIUM
 BERKELEYIUM
 CALIFORNIUM
 EINSTEINIUM
 FERMIUM
 MENDELIUM
 NUBIUM
 UNQUANTIFIED ELEMENTS



CARBOHYDRATE
 AMINO ACIDS
 NITROGEN
 PHOSPHORUS
 SULFUR
 CALCIUM
 MAGNESIUM
 POTASSIUM
 SODIUM
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 CURIUM
 BERKELEYIUM
 CALIFORNIUM
 EINSTEINIUM
 FERMIUM
 MENDELIUM
 NUBIUM
 UNQUANTIFIED ELEMENTS

LEGEND

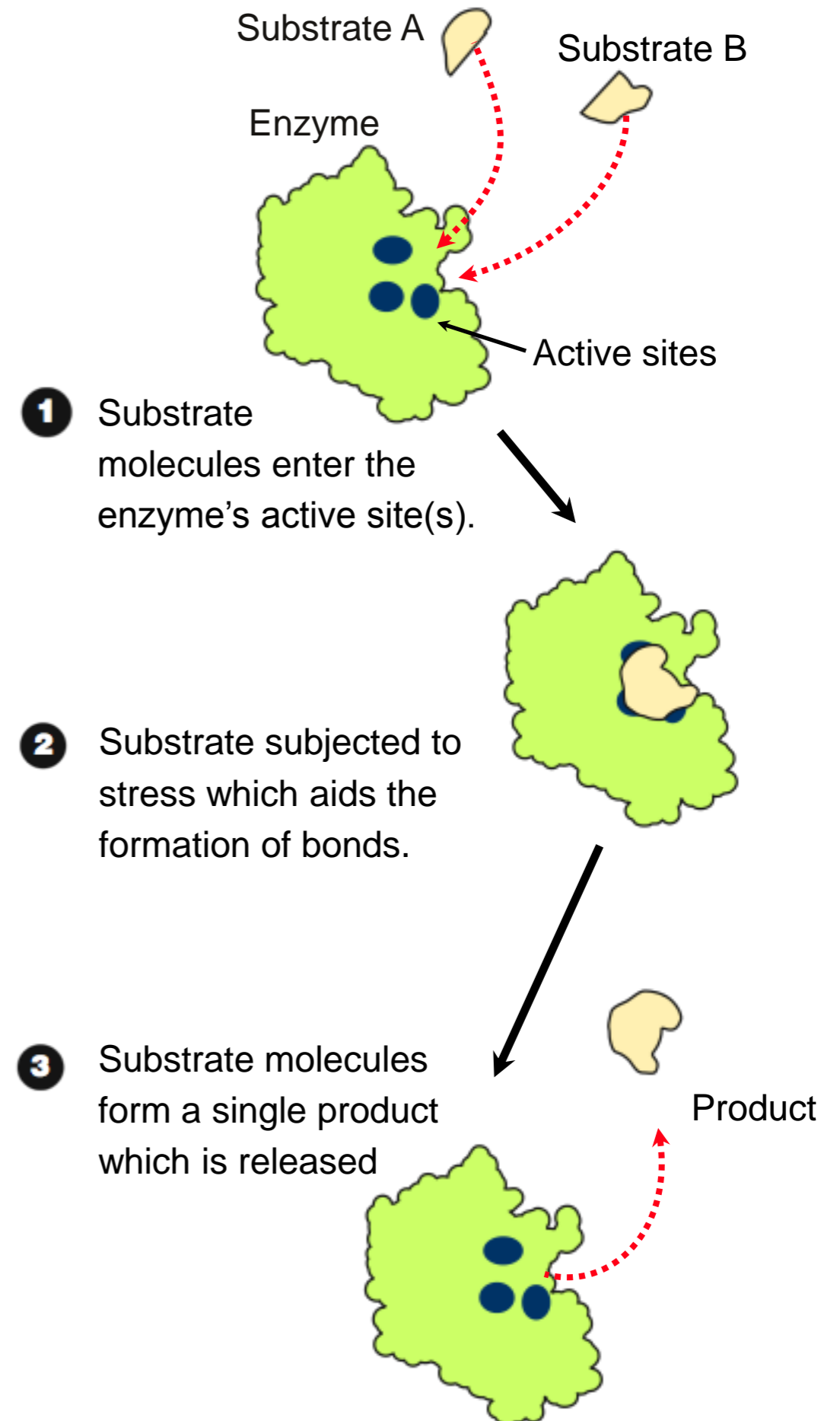
Green: Carbohydrate
 Red: Amino Acid
 Blue: Lipid
 Yellow: Nucleic Acid
 Purple: Energy

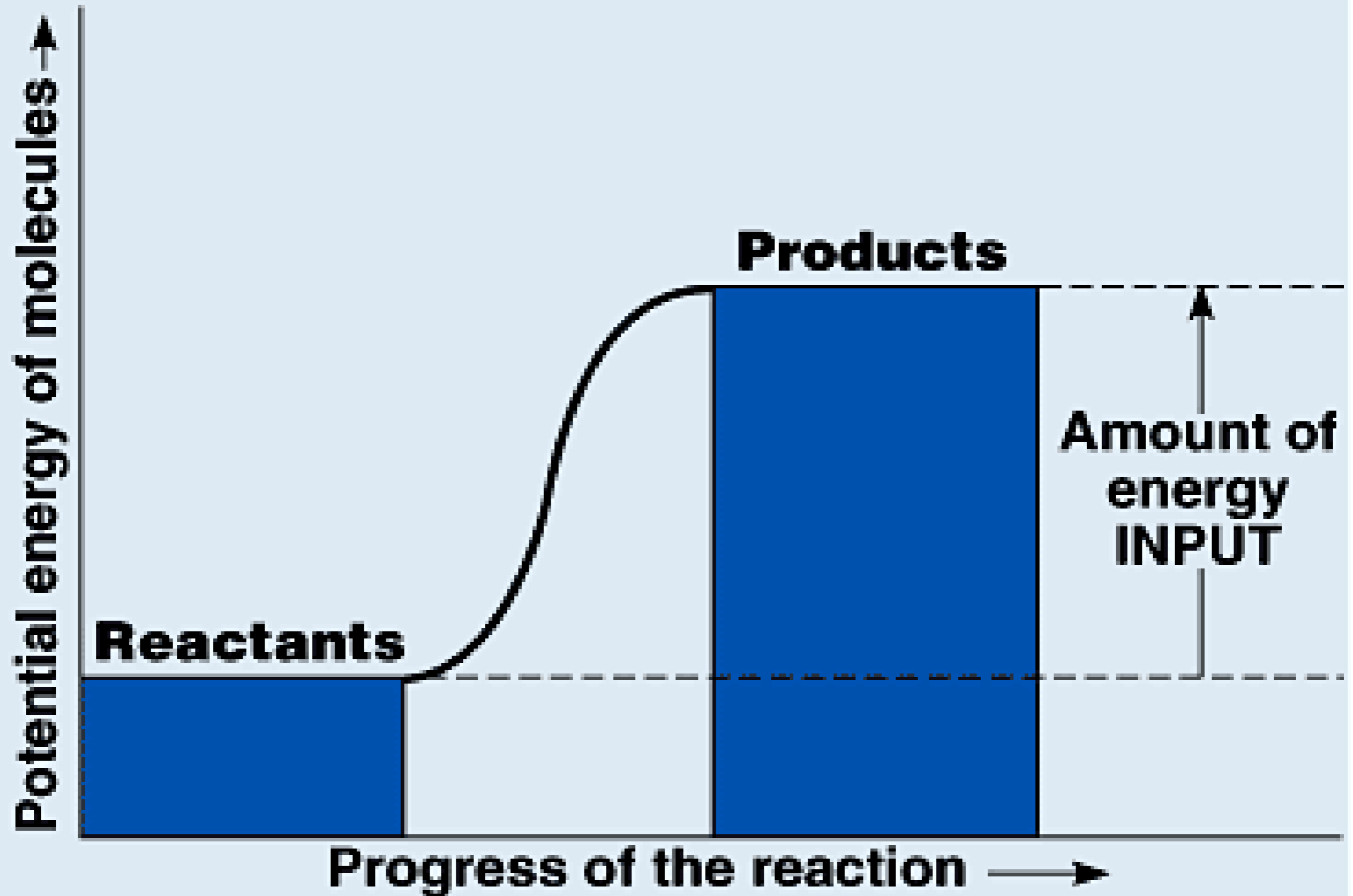
Solid line: Catabolic pathway
 Dashed line: Anabolic pathway
 Dotted line: Regulatory pathway

Circle: Enzyme
 Square: Cofactor
 Triangle: Hormone
 Diamond: Vitamin
 Star: Mineral
 Hexagon: Water

ABBREVIATIONS
 ADP: Adenosine Diphosphate
 AMP: Adenosine Monophosphate
 ATP: Adenosine Triphosphate
 CoA: Coenzyme A
 GDP: Guanosine Diphosphate
 GTP: Guanosine Triphosphate
 NAD: Nicotinamide Adenine Dinucleotide
 NADH: Reduced Nicotinamide Adenine Dinucleotide
 NADPH: Nicotinamide Adenine Dinucleotide Phosphate
 NADPHH: Reduced Nicotinamide Adenine Dinucleotide Phosphate
 FAD: Flavin Adenine Dinucleotide
 FADH: Reduced Flavin Adenine Dinucleotide
 PEP: Phosphoenolpyruvate
 Pyruvate: Pyruvate
 Citrate: Citrate
 Oxaloacetate: Oxaloacetate
 Malate: Malate
 Fumarate: Fumarate
 Succinyl-CoA: Succinyl-Coenzyme A
 Succinate: Succinate
 Malonate: Malonate
 Fumarate: Fumarate
 Oxaloacetate: Oxaloacetate

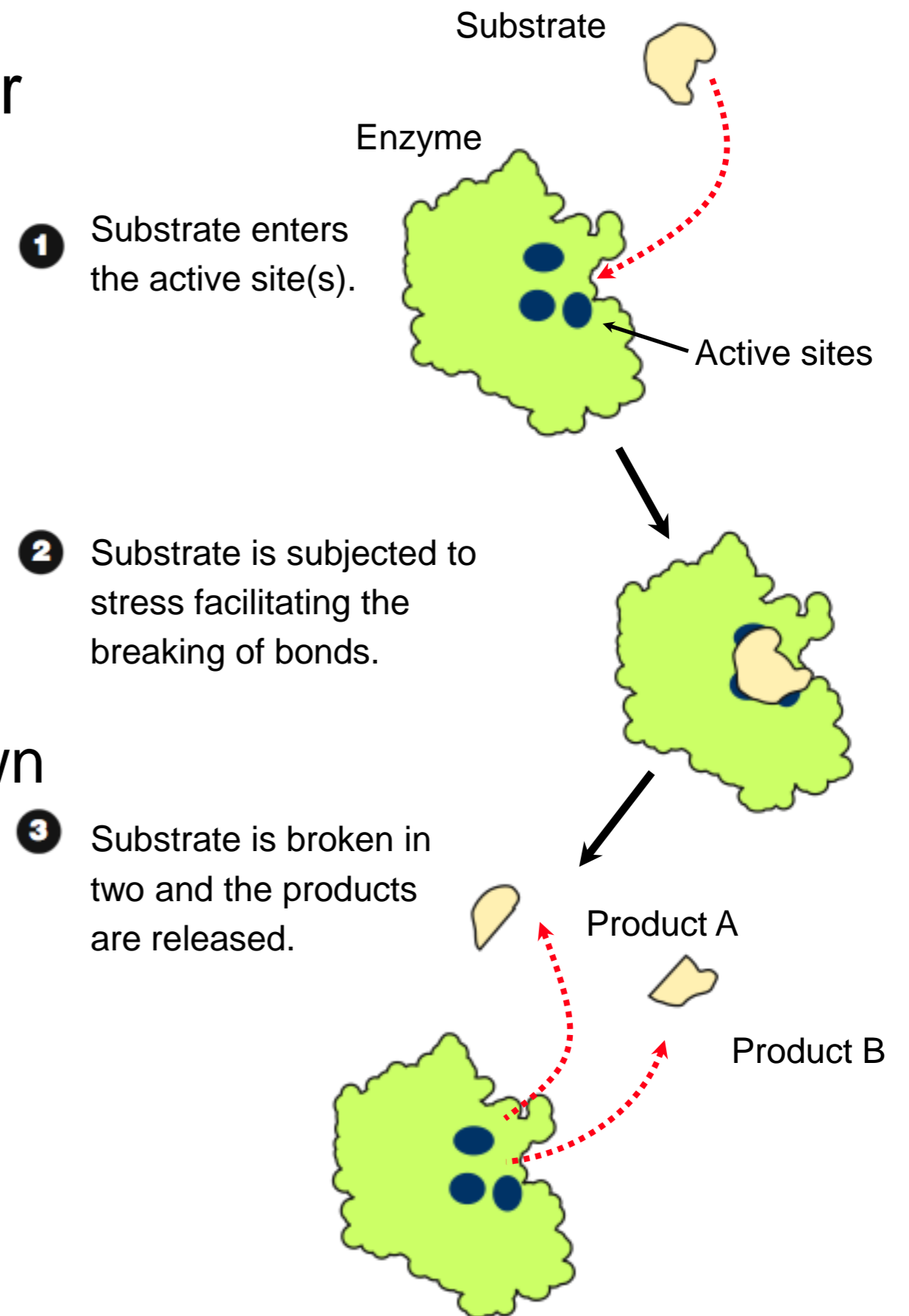
- **Anabolism** is the synthesis of complex molecules from simpler ones.
- Requires energy to be added → **ENDERGONIC**
- **Examples** include:
 - *Protein synthesis*: proteins are assembled from amino acids.
 - *Photosynthesis*: glucose is made from water and carbon dioxide with the input of light energy.

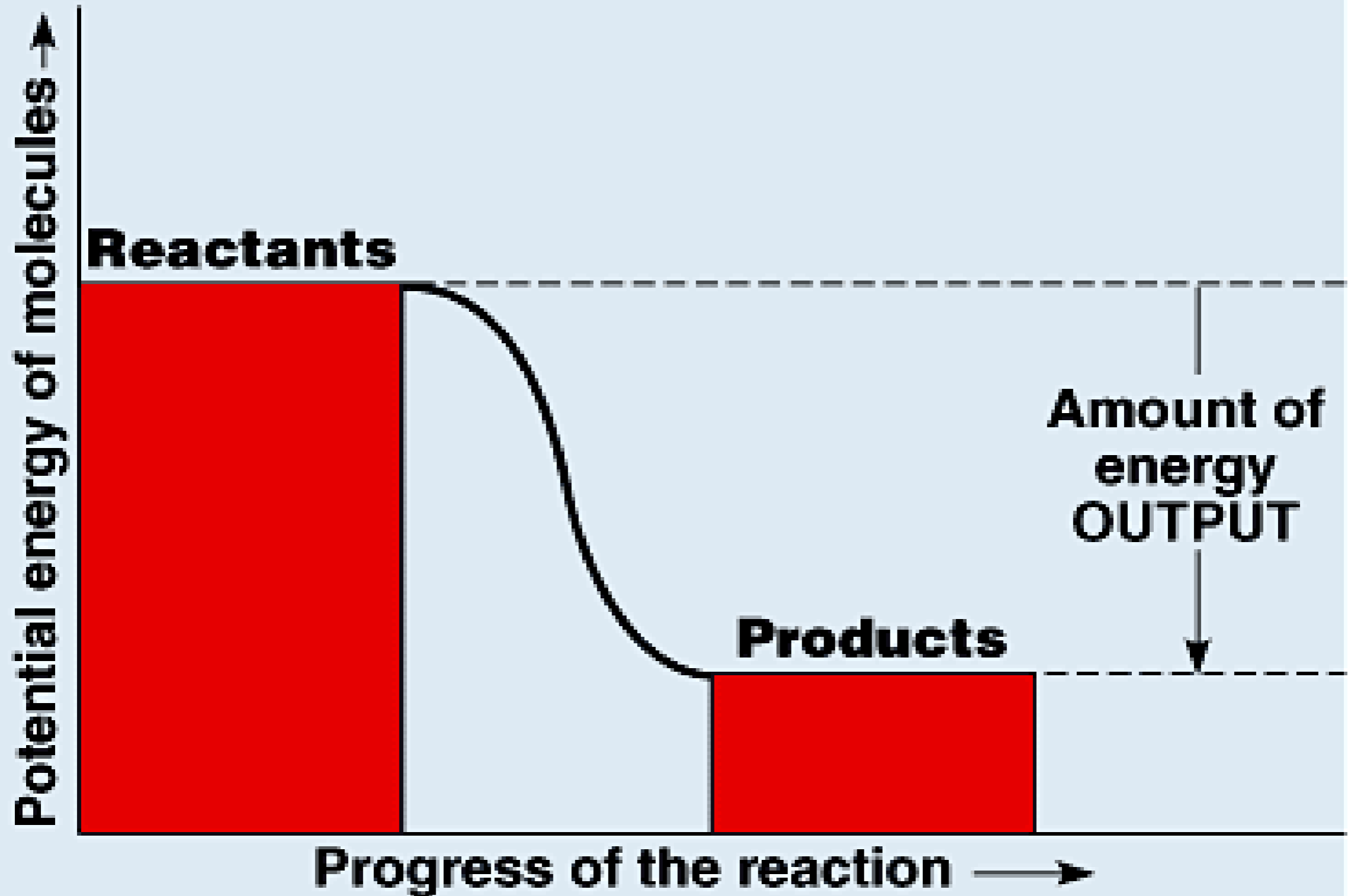




**(b) Endergonic reaction
(energy required; $\Delta G > 0$).**

- **Catabolism** is the break down of complex molecules into simpler ones
- This process releases energy
→ **EXERGONIC**
- **Examples** include:
 - *Digestion of food:* carbohydrates, proteins, and fats are broken down into their constituent parts for absorption.
 - *Cellular respiration:* glucose molecules are broken down to release energy (as ATP).

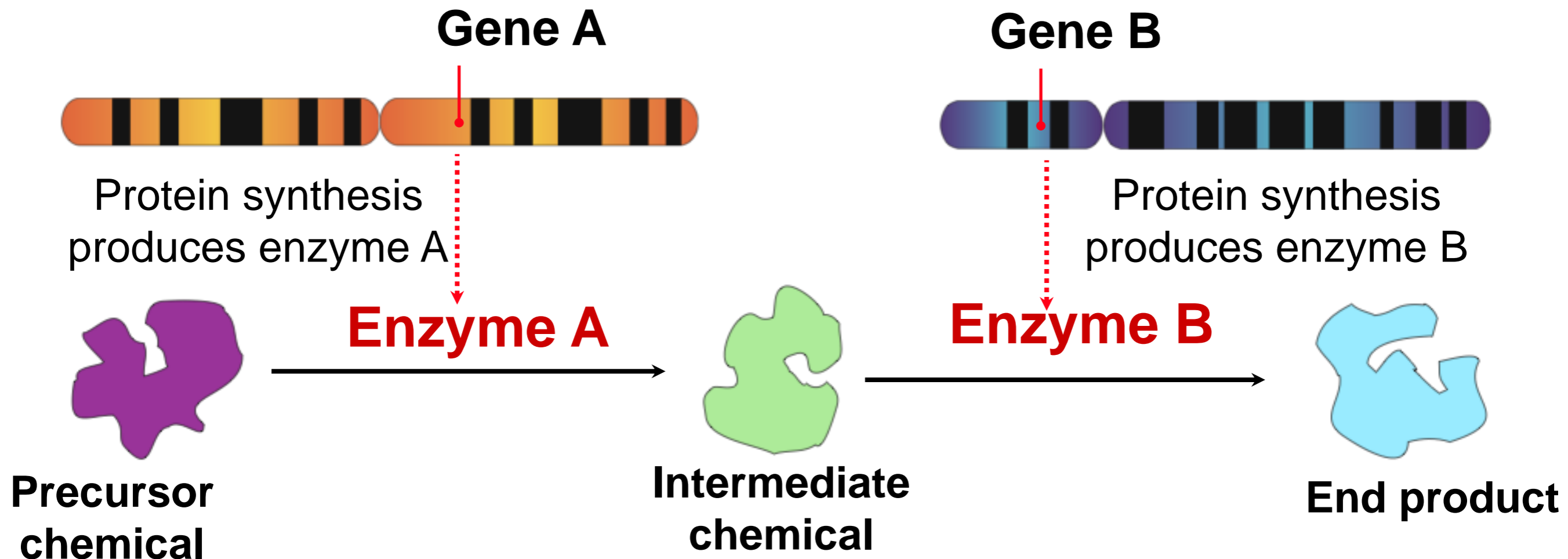




**(a) Exergonic reaction
(energy released; $\Delta G < 0$).**

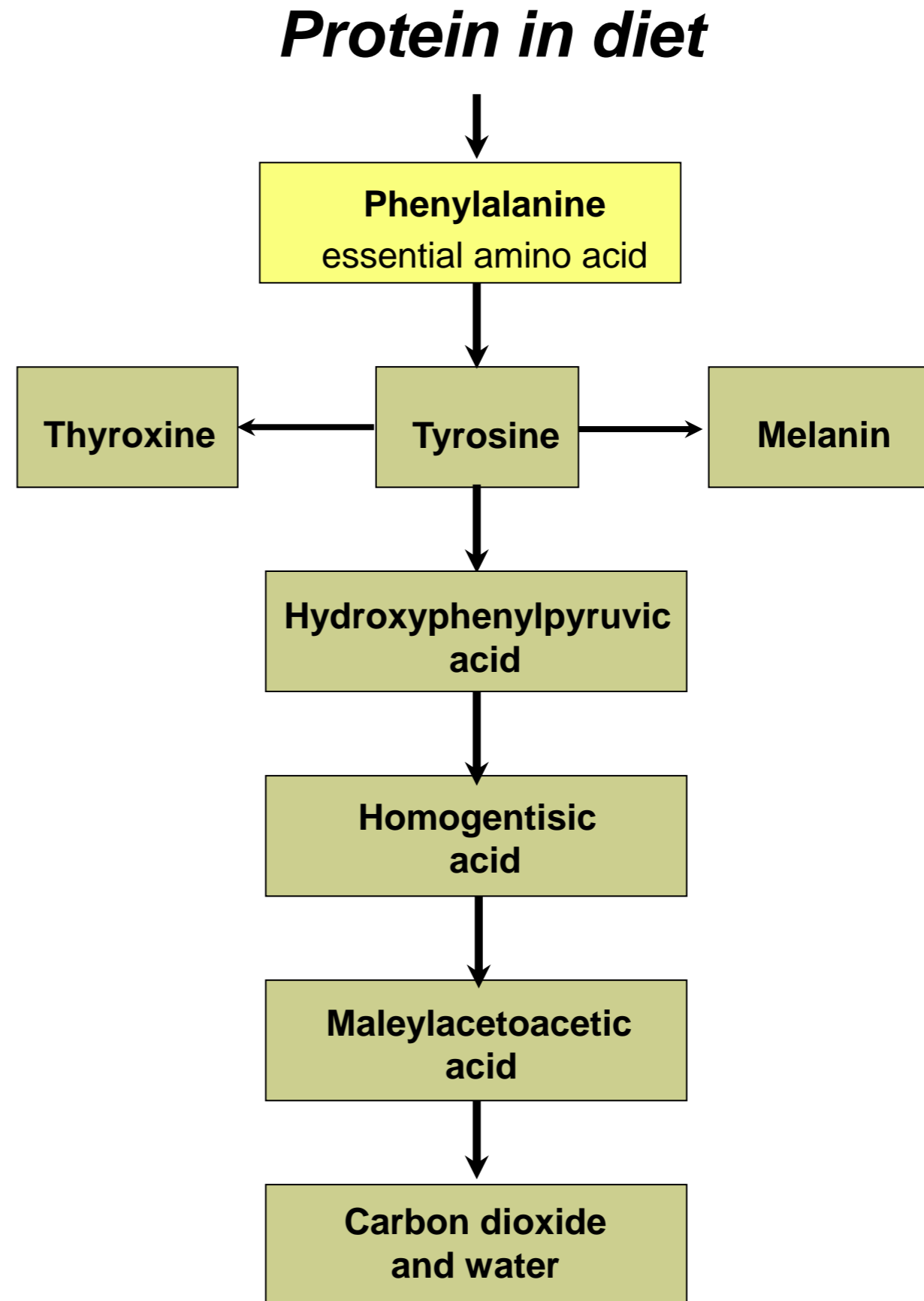
Metabolic Pathways

- A series of 'steps' from a starter molecule or **precursor** toward a final **end product**.
- Each step is catalyzed by a different enzyme.



Metabolism of Phenylalanine

- The metabolism of phenylalanine is an example of a **metabolic pathway**.
- Failure of the enzymes controlling the metabolic pathway leads to a range of **metabolic disorders**.





Protein in Diet

Phenylalanine
essential amino acid

Phenylalanine hydroxylase

Faulty enzyme results in buildup of

Tyrosine

Phenylketonuria

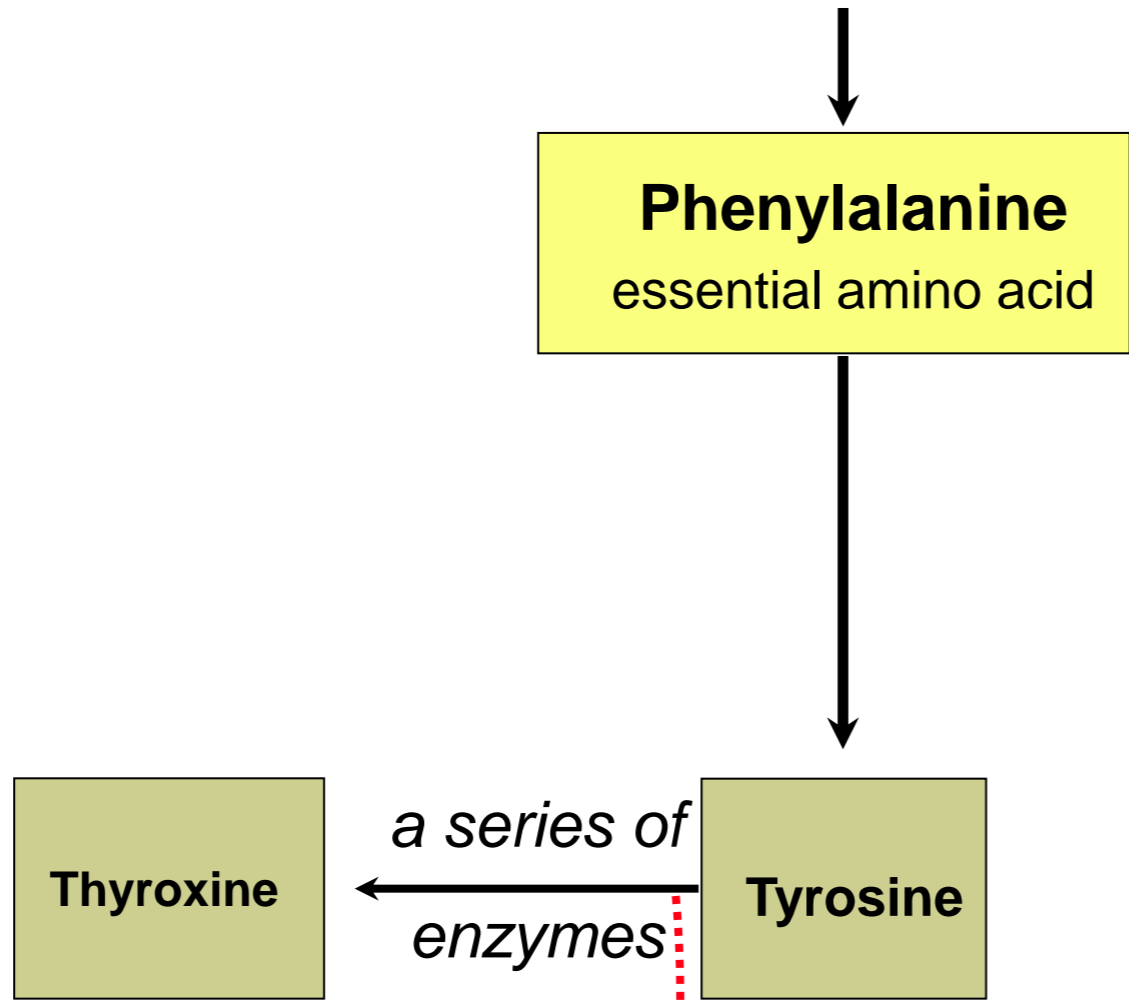
This in turn causes

Phenylpyruvic acid

Mental retardation, 'mousy' body odor, light skin color, eczema, excessive muscular tension and activity.



Protein in Diet



Faulty enzymes
cause

Cretinism

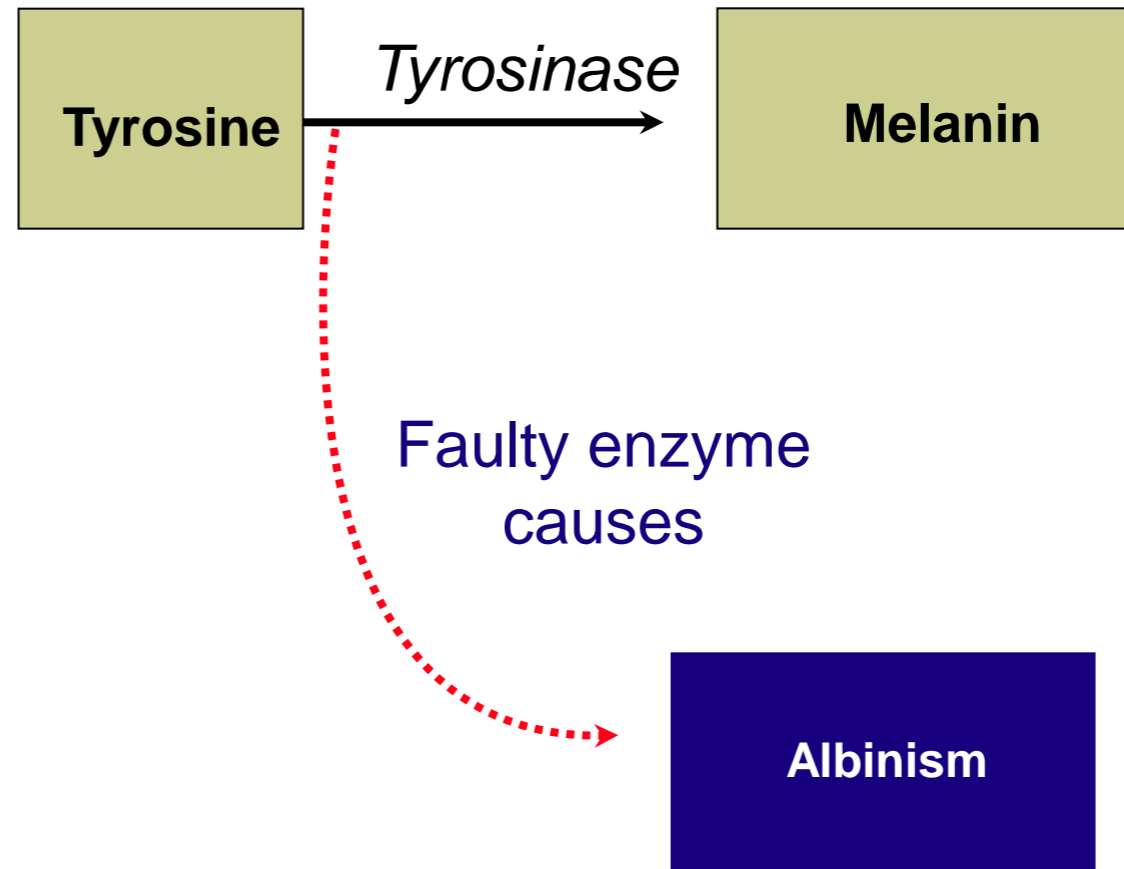


Dwarfism, mental retardation, low levels of thyroid hormones, retarded sexual development, yellowish skin color.

Protein in Diet

Phenylalanine
essential amino acid

Complete lack of the pigment melanin in body tissues, including the skin and hair



Protein in Diet



Phenylalanine
essential amino acid

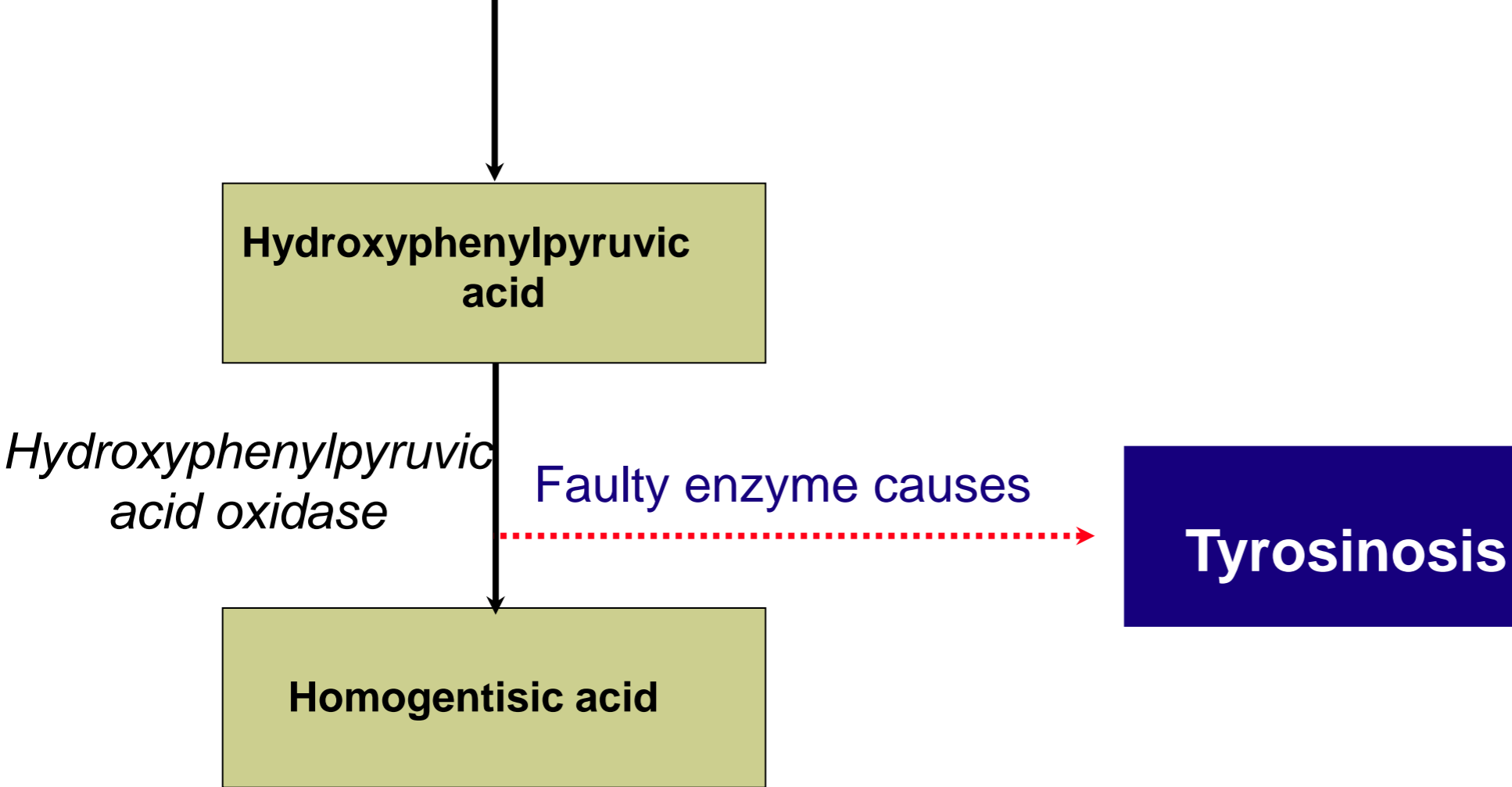


Tyrosine

Trans-aminase



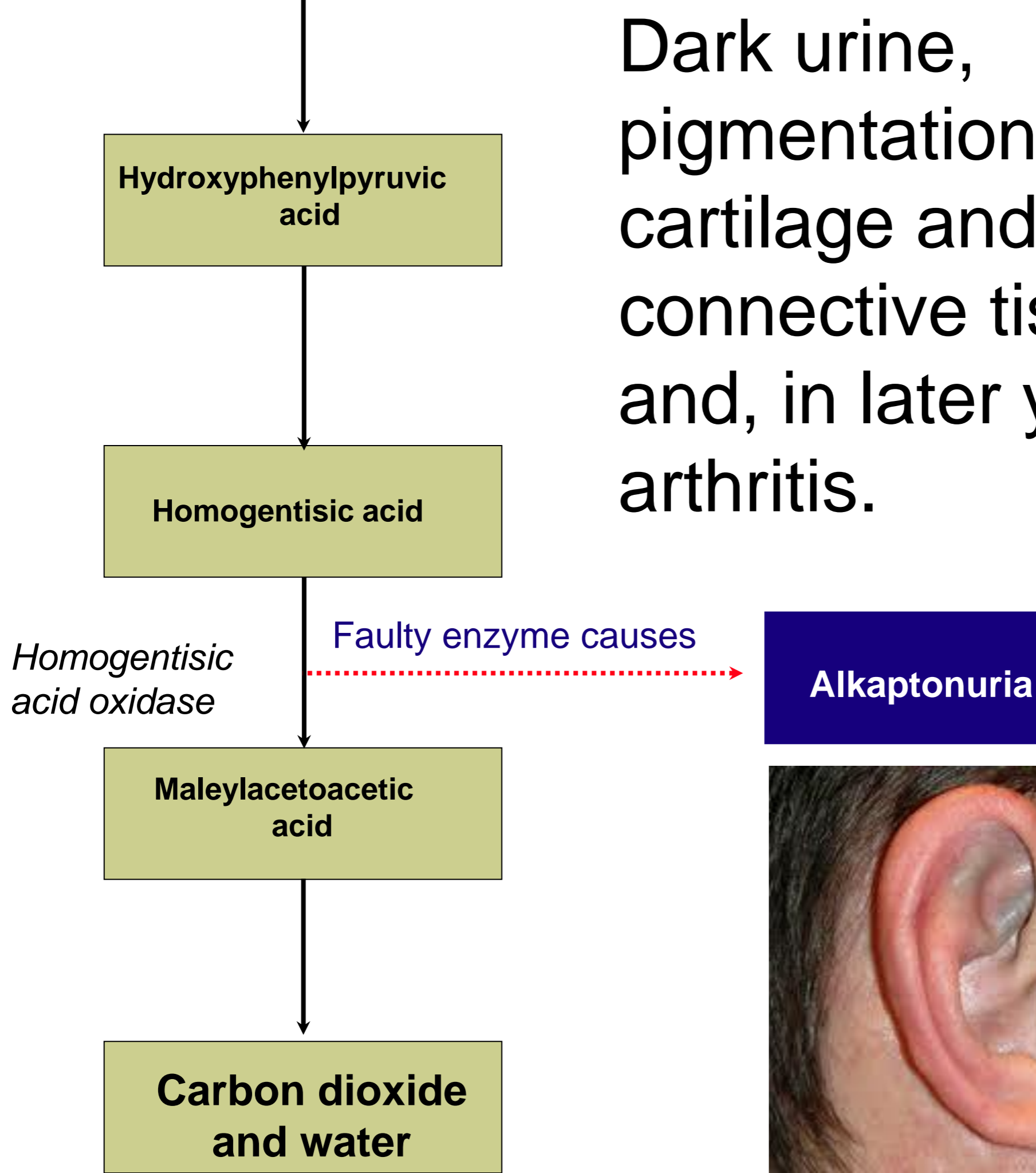
**Hydroxyphenylpyruvic
acid**



Death from liver failure or, if surviving, chronic liver and kidney disease.



Dark urine,
pigmentation of
cartilage and other
connective tissues,
and, in later years,
arthritis.



Alkaptonuria



