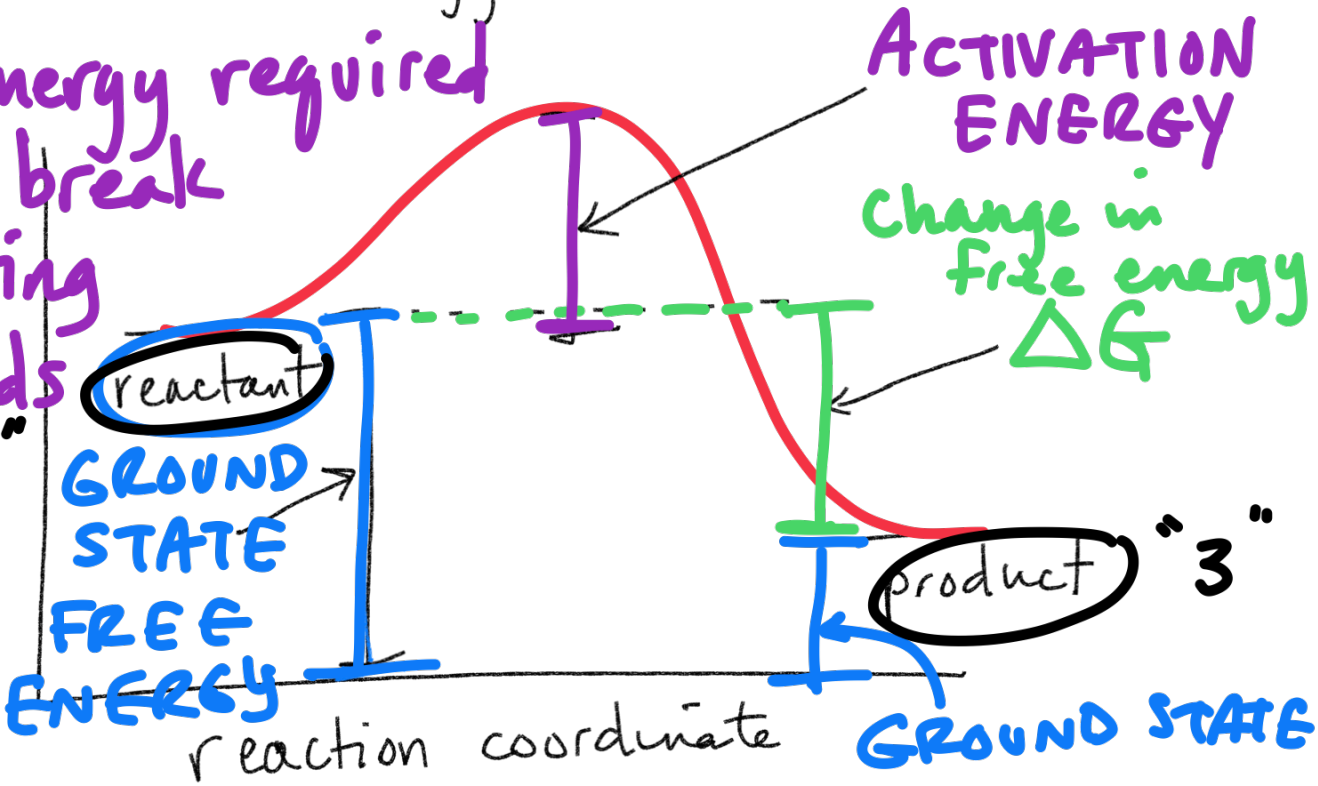
T-GB General Biology Week 22 7/20

E_A → energy required to break existing bonds



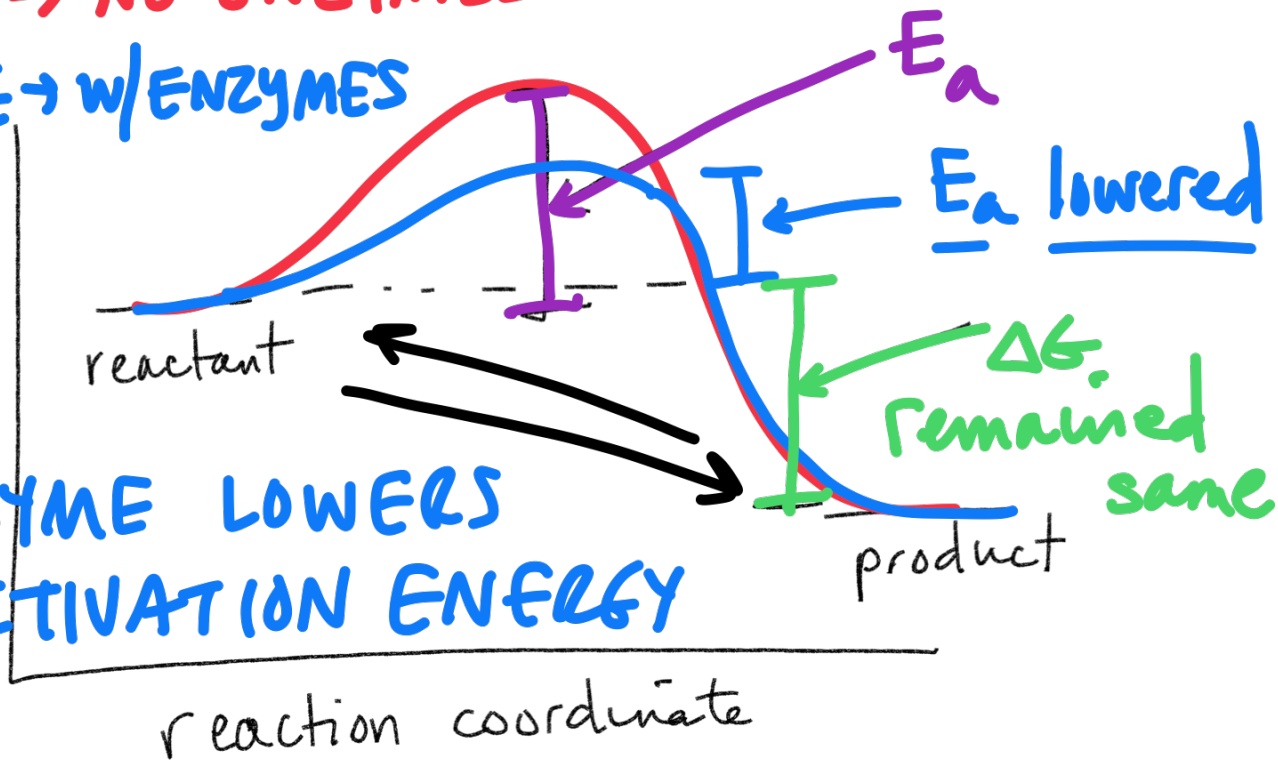
$-\Delta G$ → EXERGONIC
energy is released
spontaneous

$G_p - G_r$

$3 - 5 = -2$

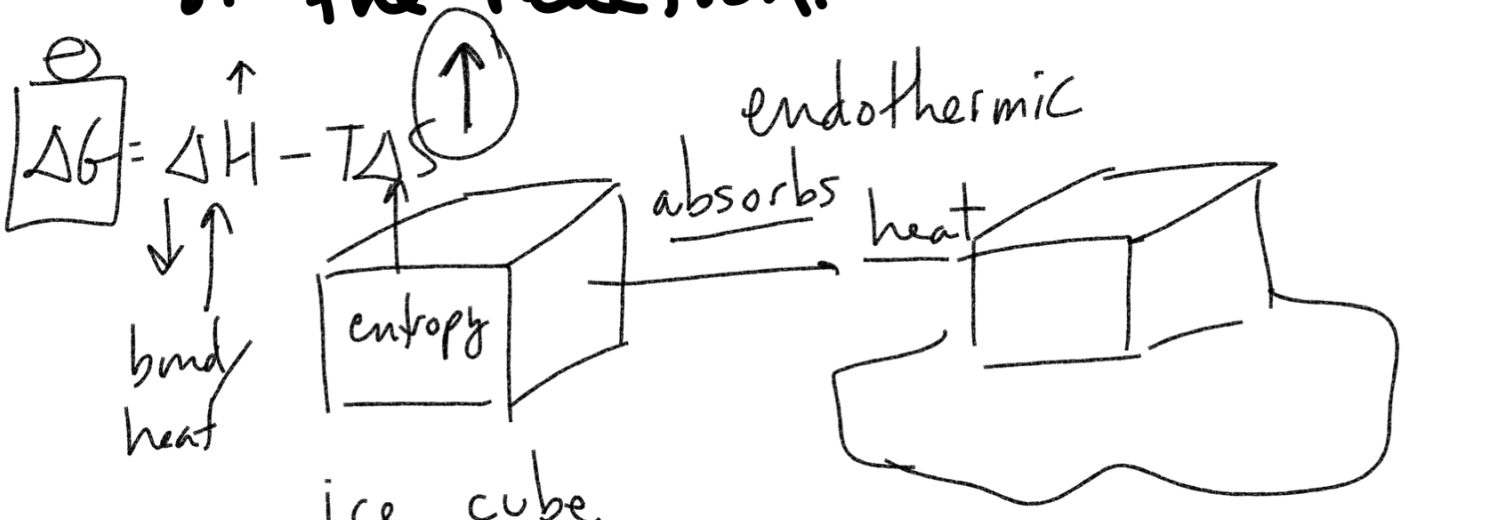
RED → NO ENZYMES

BLUE → W/ENZYMES



ENZYME LOWERS ACTIVATION ENERGY

ENZYMES change the rate (speed) of the reaction.



spontaneously melts

released energy

↳ exergonic

why → entropy

endothermic → absorbs heat

exothermic → releases heat

endergonic → absorbs energy

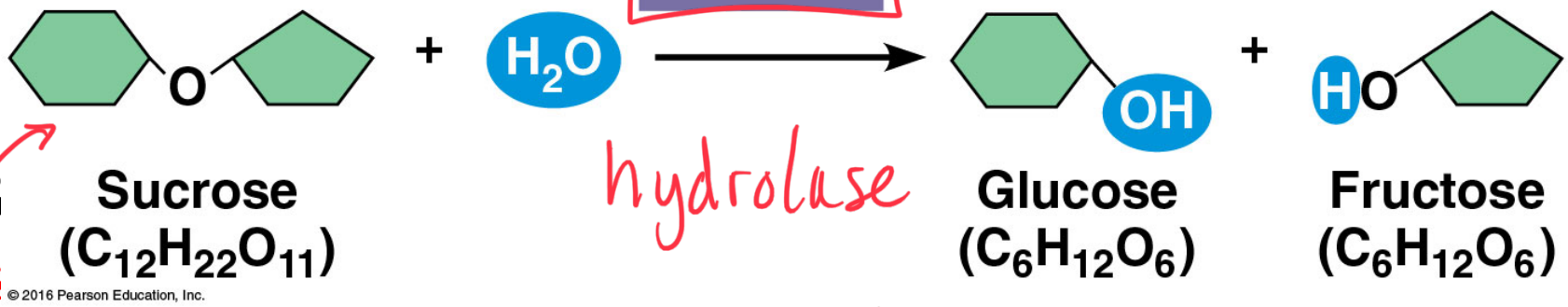
exergonic → releases energy

- Catalyst: substance that can change the rate of a reaction without being altered in the process
- Enzyme = biological catalyst

enzyme must be regenerated

enzyme that cuts sucrose

table sugar



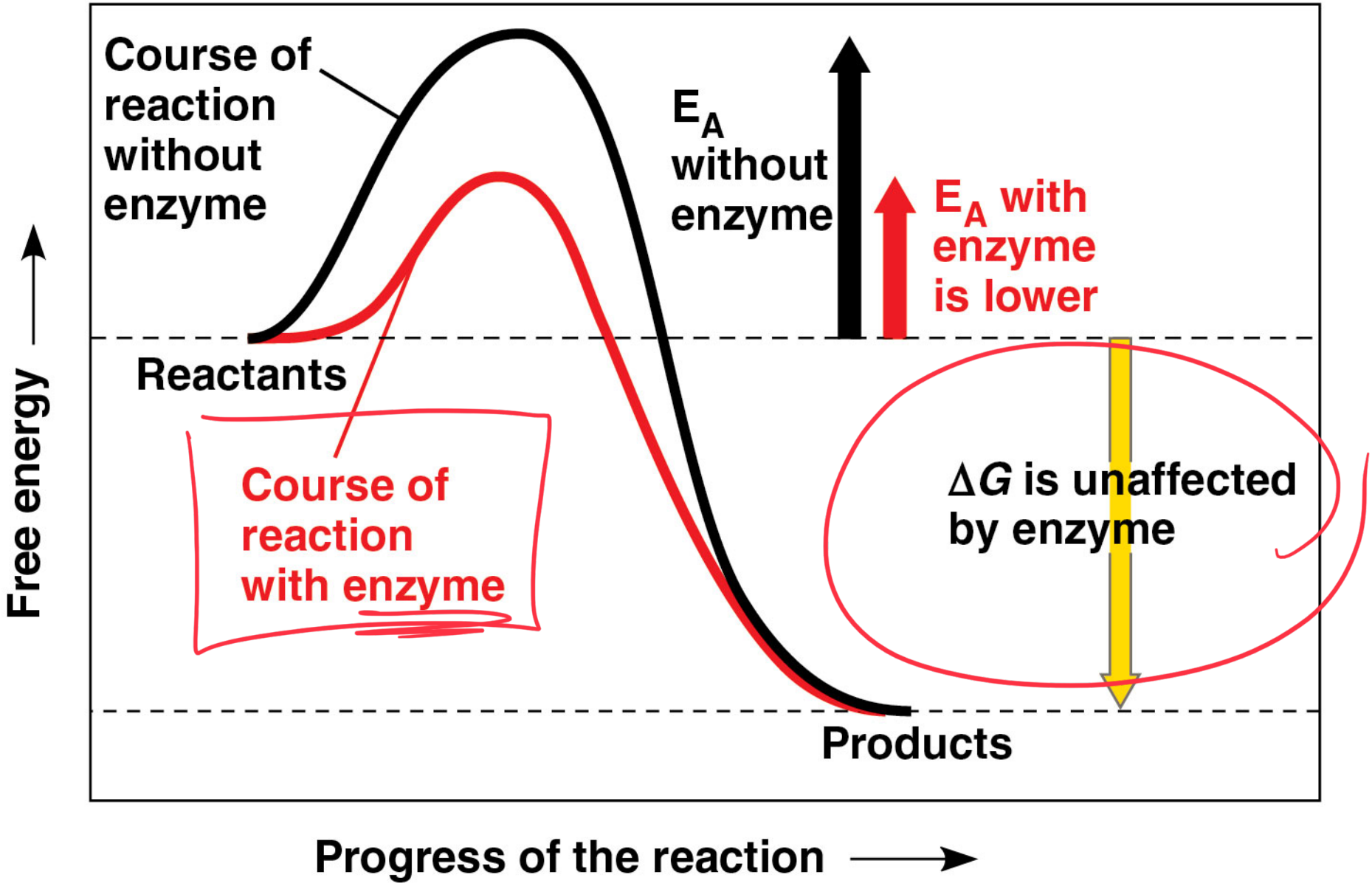
hydrolase

- breaking bonds)

disaccharide

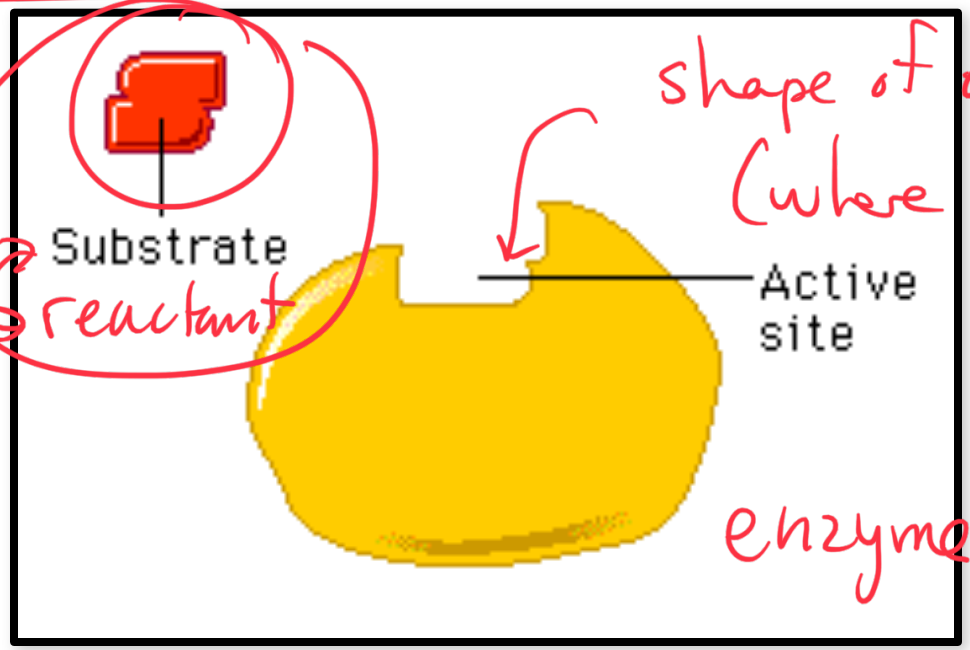
cuts with water

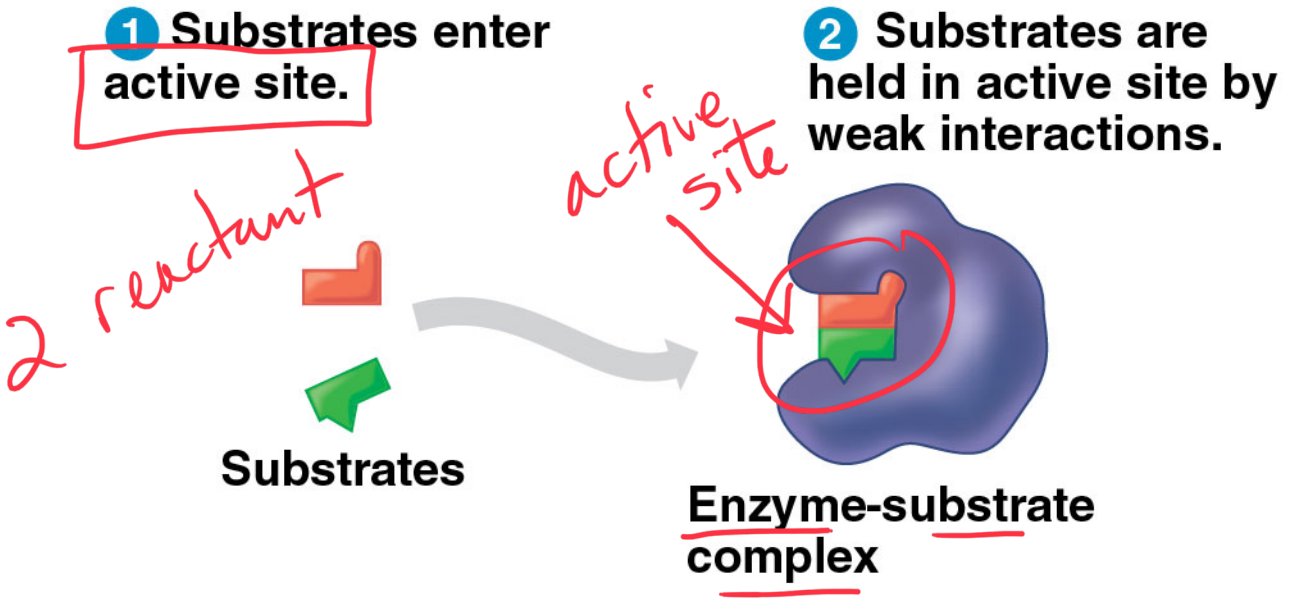
[amylose → amylase] [lipid → lipase]

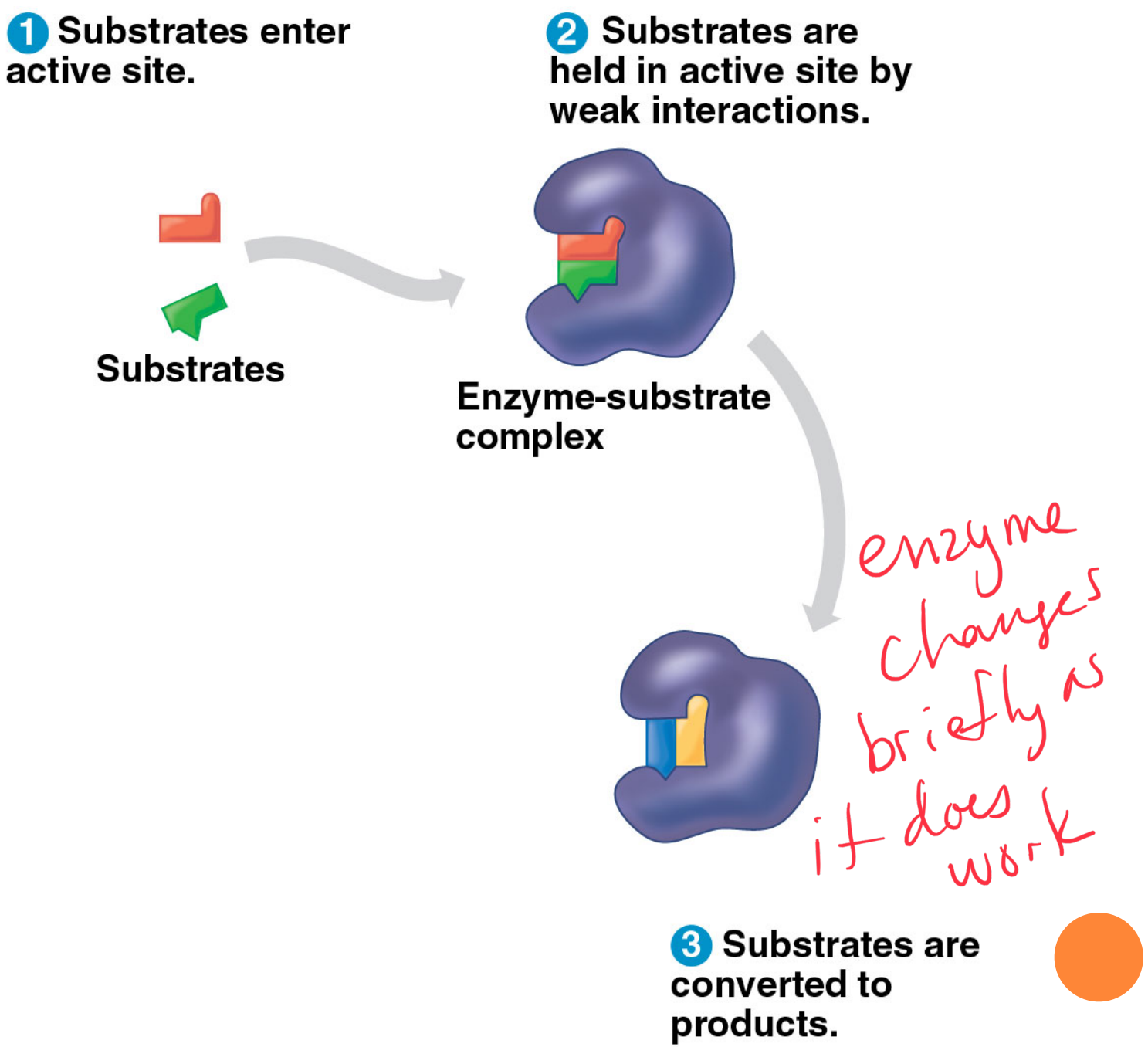


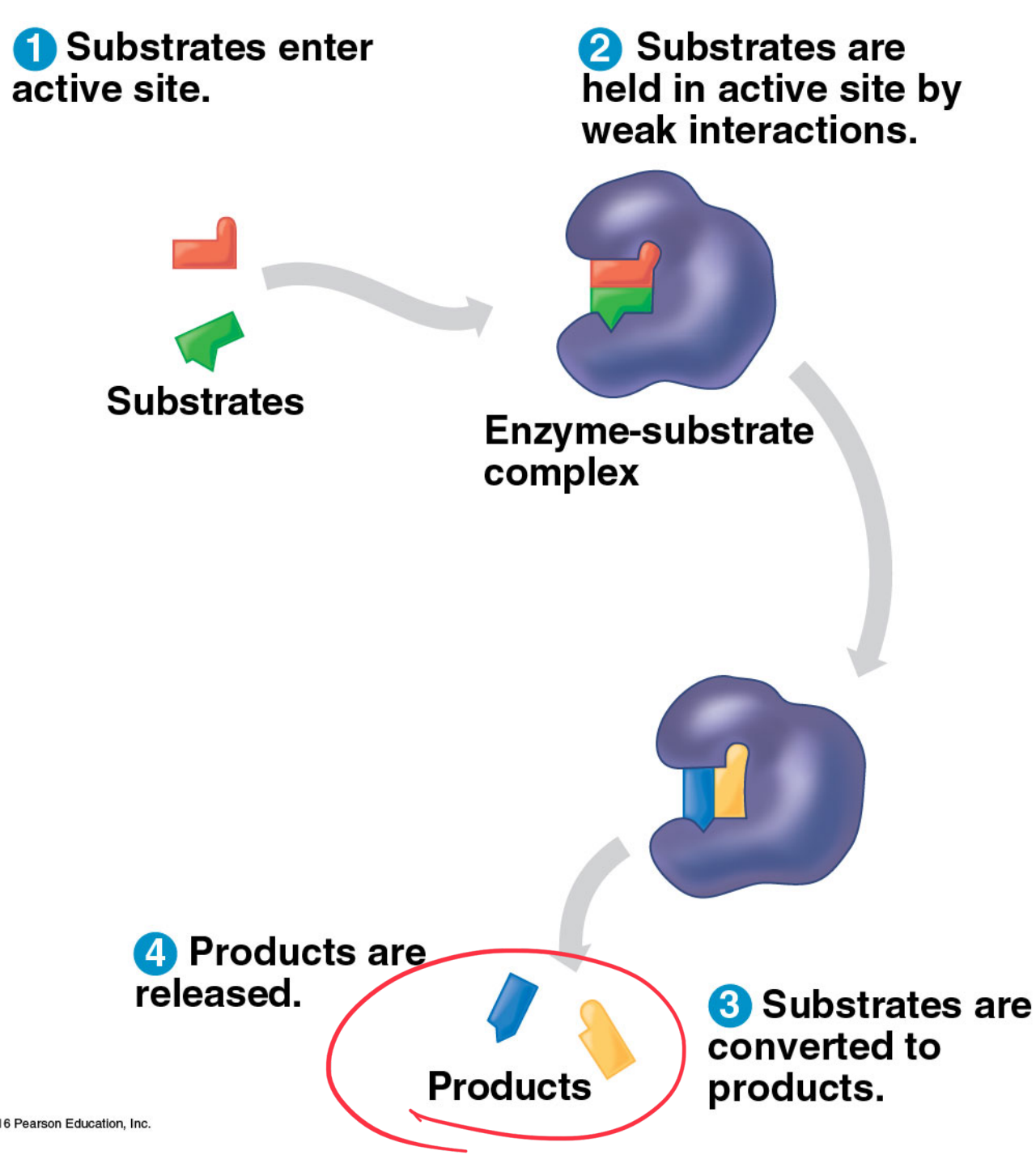
SUBSTRATE SPECIFICITY OF ENZYMES

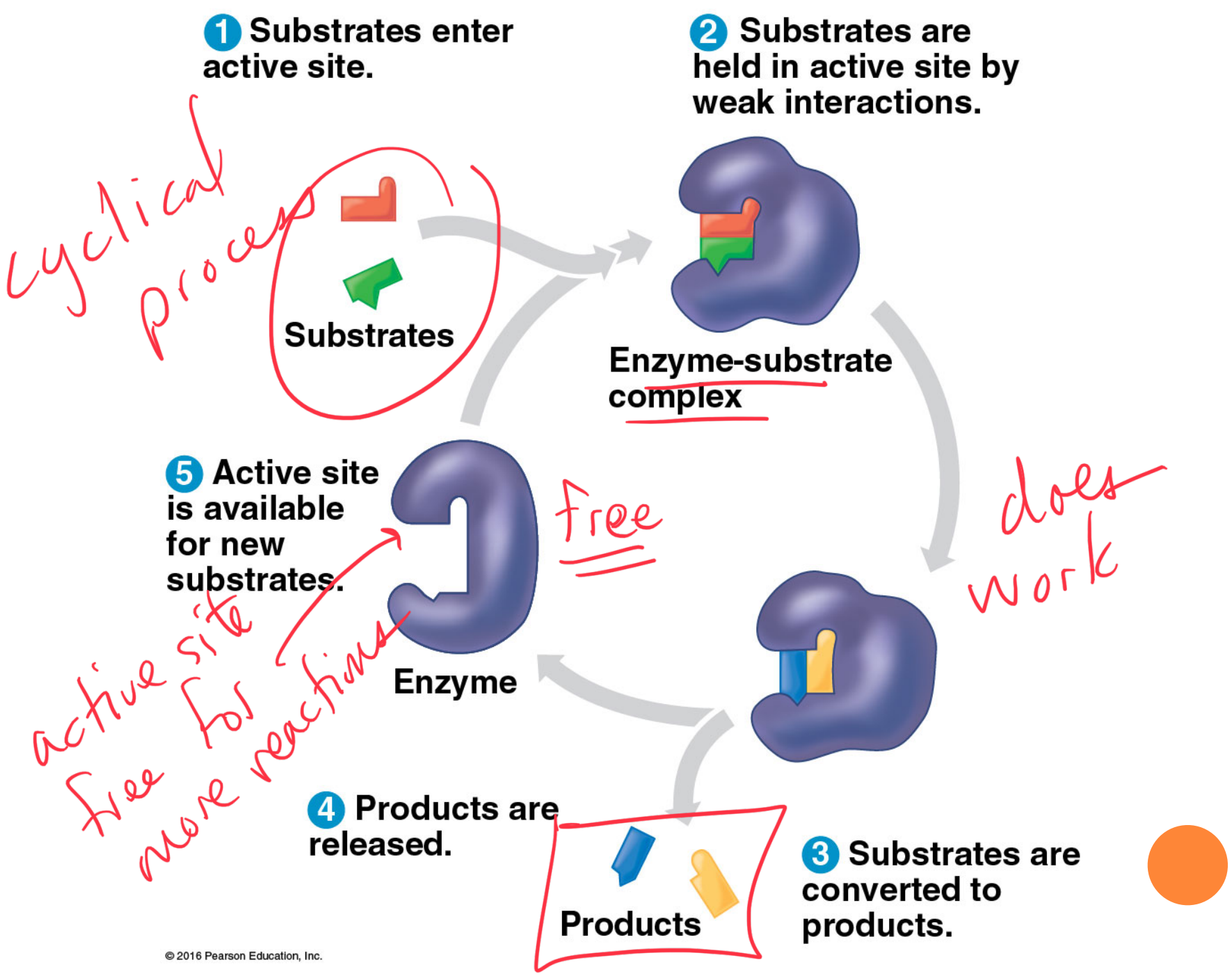
- The reactant that an enzyme acts on is called the enzyme's substrate
- The enzyme binds to its substrate, forming an enzyme-substrate complex
- The active site is the region on the enzyme where the substrate binds










1 Substrates enter active site.
2 Substrates are held in active site by weak interactions.
Substrates
Enzyme-substrate complex
3 Substrates are converted to products.
Products
4 Products are released.
5 Active site is available for new substrates.
Enzyme
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ENZYME ACTION: CATABOLISM

Breaks down large into small

releases energy

$-\Delta G$

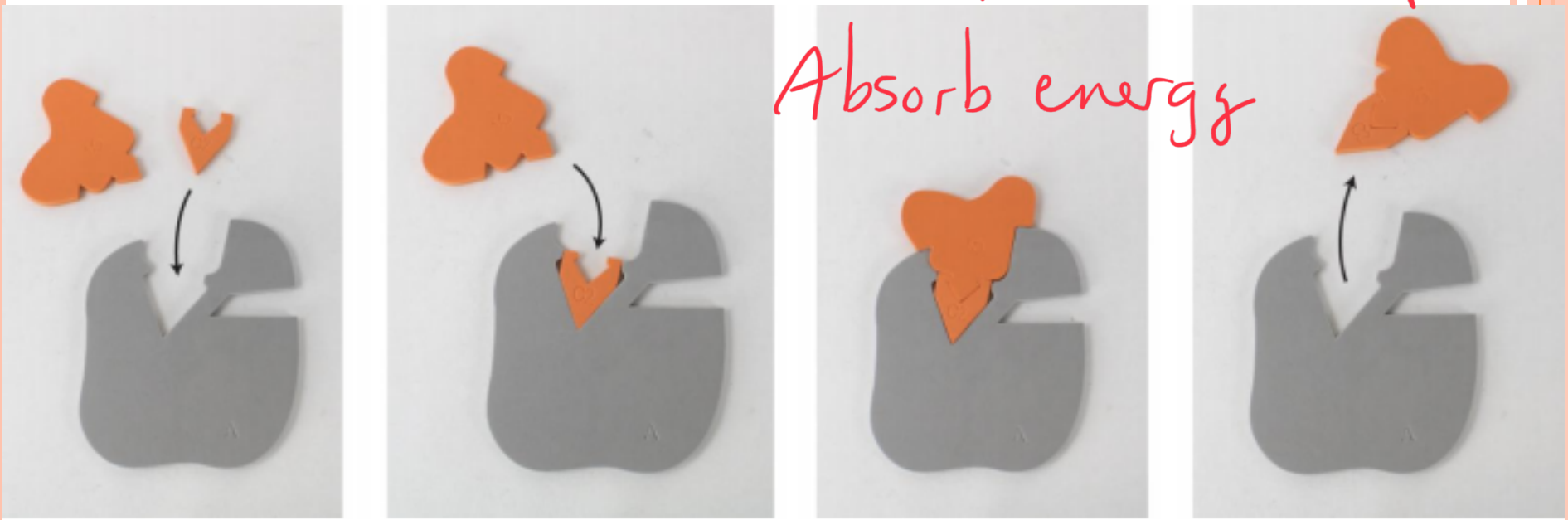
Step 1 Step 2 Step 3

EXERGONIC

ENZYME ACTION: ANABOLISM

small compounds → larger compound

Absorb energy



Step 1 Step 2 Step 3 Step 4

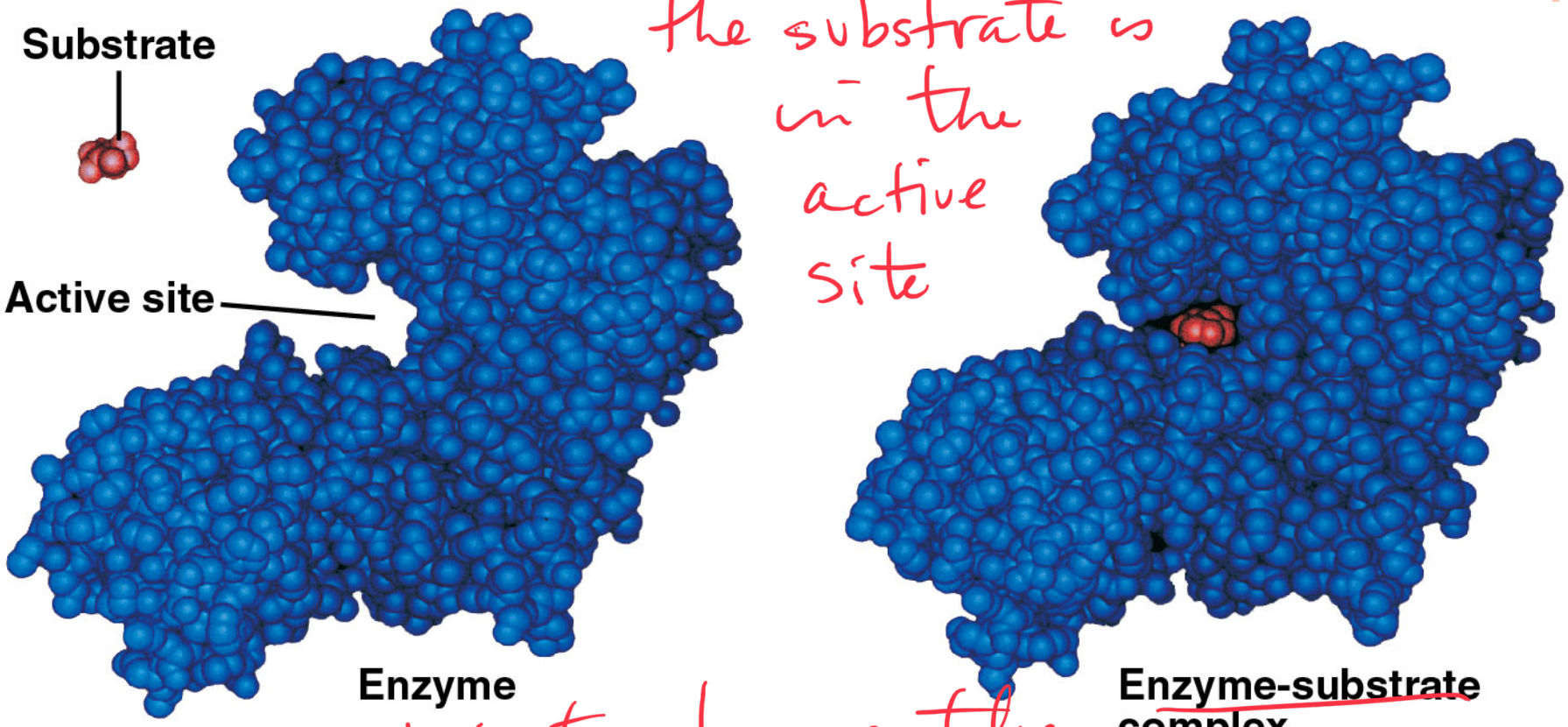
+ΔG

endergonic

movie theater seat

INDUCED FIT: ENZYME FITS SNUGLY AROUND SUBSTRATE -- "CLASPING HANDSHAKE"

sometimes enzymes don't work unless the substrate is in the active site

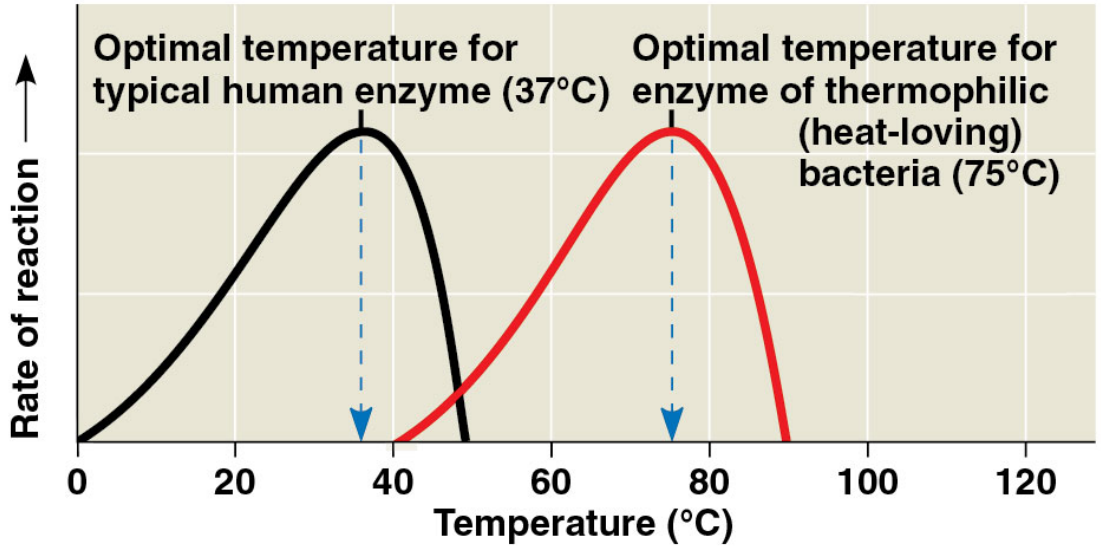


substrate changes the shape of enzyme when it forms complex

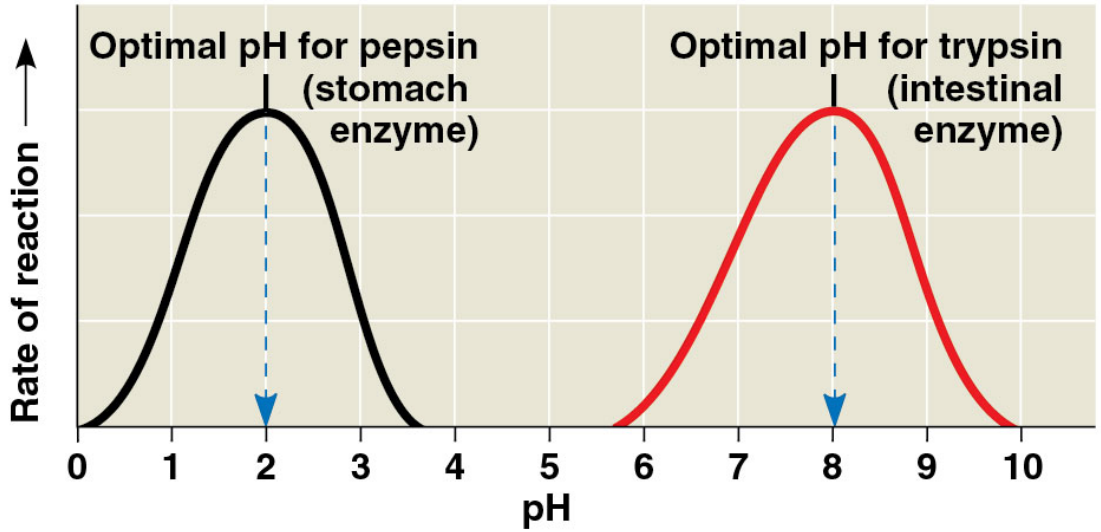
An enzyme's activity can be affected by:

- Temperature
- pH
- Chemicals

denatured



(a) Optimal temperature for two enzymes



(b) Optimal pH for two enzymes

ENZYME STRUCTURE & FUNCTION

- Change to the **molecular structure** of a component in an enzymatic system may result in a change of **function** or **efficiency** of the system
- **Denaturation**: disrupt protein structure → reduce enzymatic activity
- **Environmental pH**: alter efficiency of enzyme activity; disruption of H-bonds
- In some cases, enzyme denaturation is *reversible* → enzyme regains activity to an extent

COFACTORS

vitamin vital amine

- Cofactors: nonprotein enzyme helpers such as minerals (eg. Zn, Fe, Cu)
- Coenzymes: organic cofactors (eg. vitamins)

enzyme helpers

Enzyme Inhibitors

- Competitive inhibitor: binds to the *active site* of an enzyme, competes with substrate
- Noncompetitive inhibitor: binds to *another part* of an enzyme → enzyme changes shape → active site is nonfunctional

ENZYME SPECIFICITY

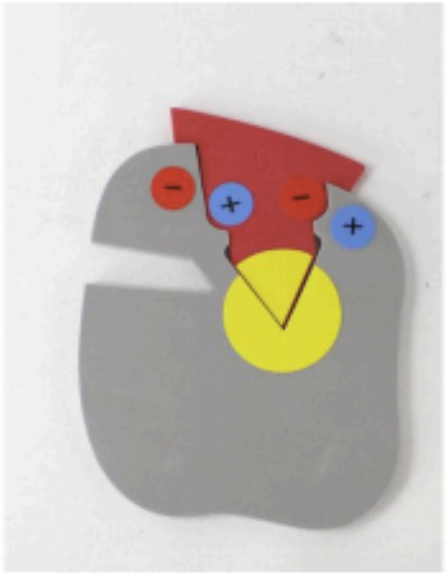


Figure 1: Enzyme-substrate complex

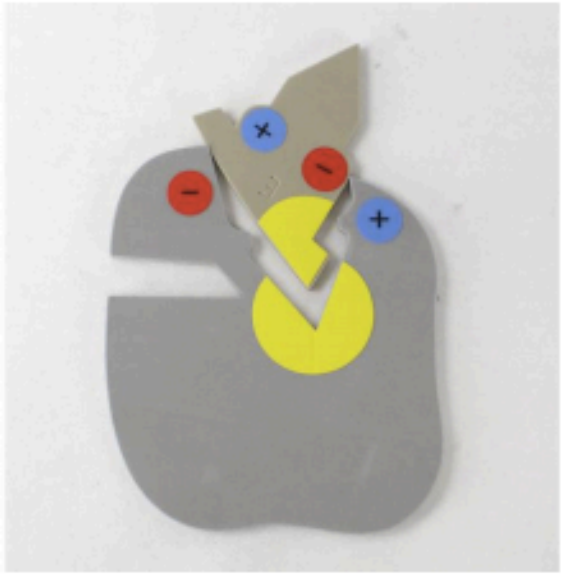


Figure 2: The charges align between the enzyme and the substrate; however, the enzyme's shape will not "fit".

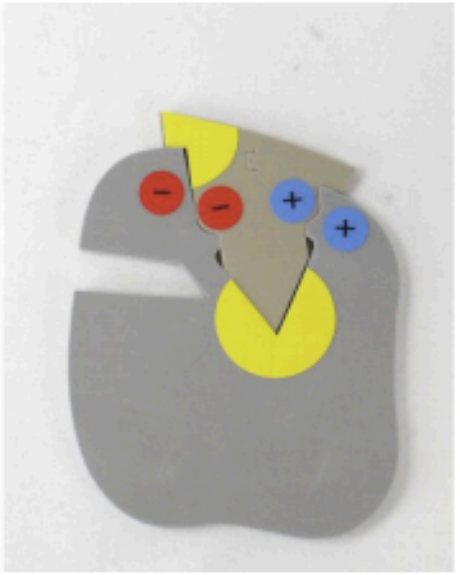
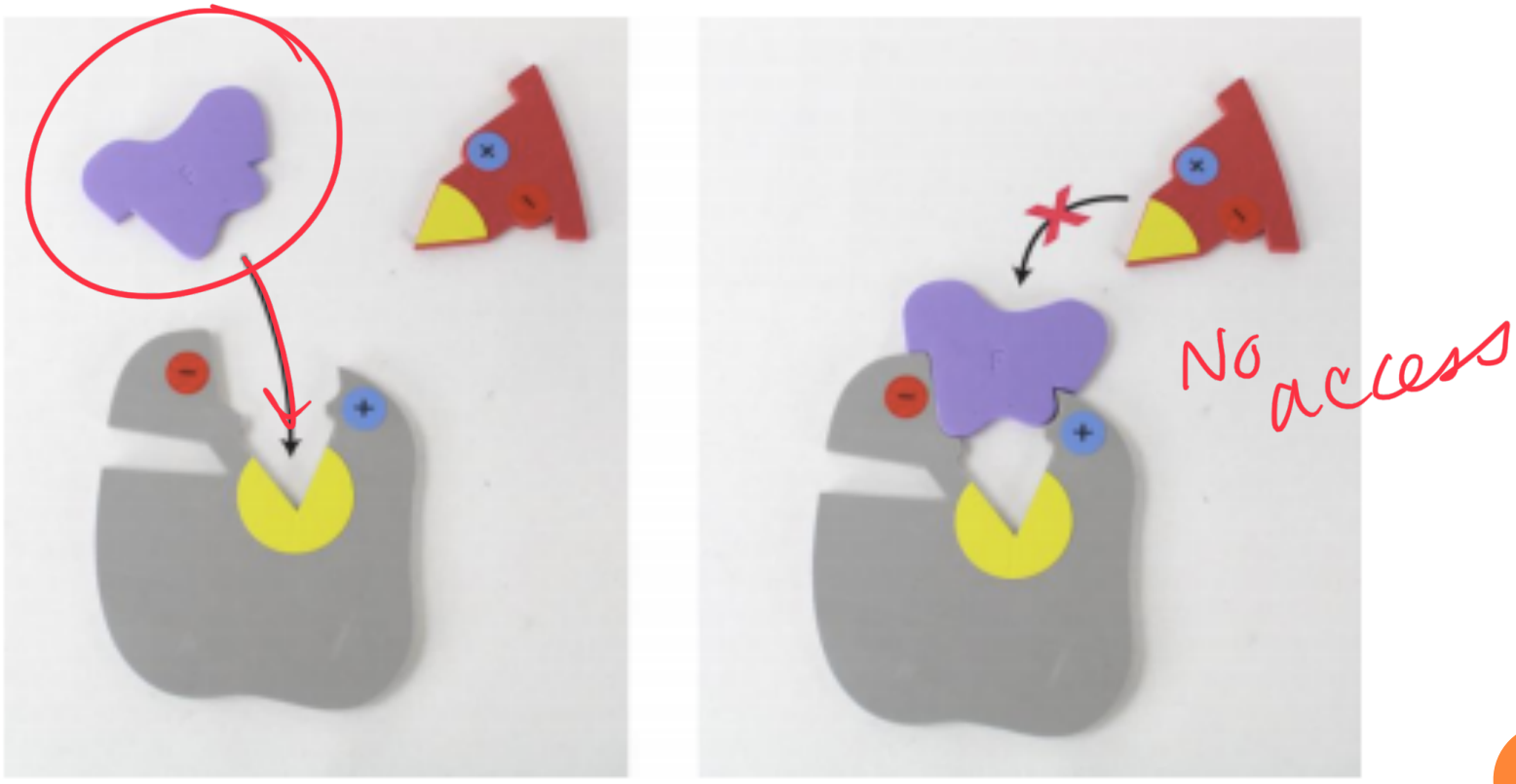
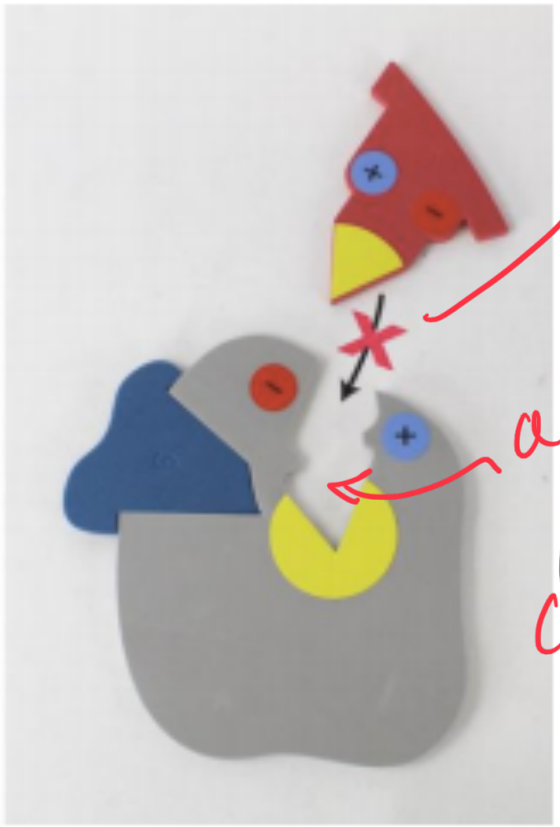


Figure 3: The shape of the substrate appears to fit but the charges do not align in the active site of the enzyme.

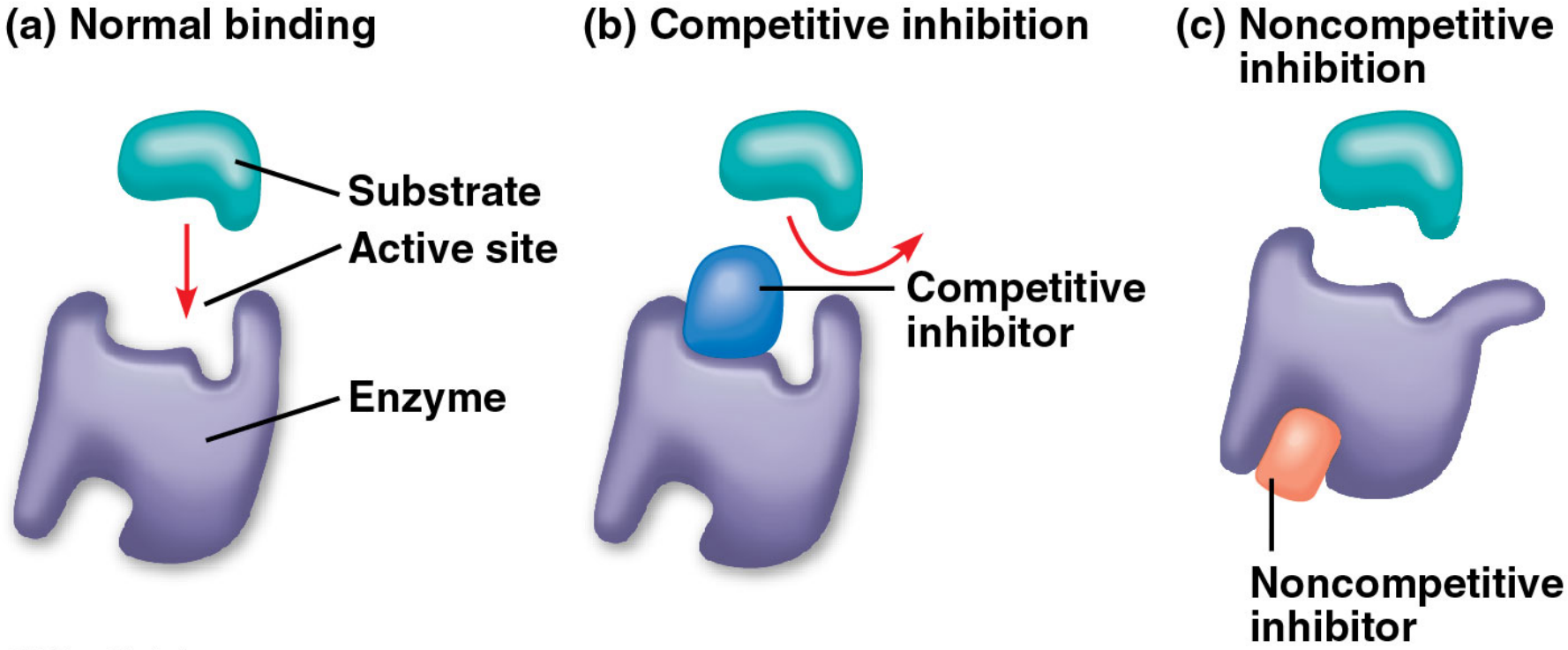
COMPETITIVE INHIBITION



NONCOMPETITIVE INHIBITION

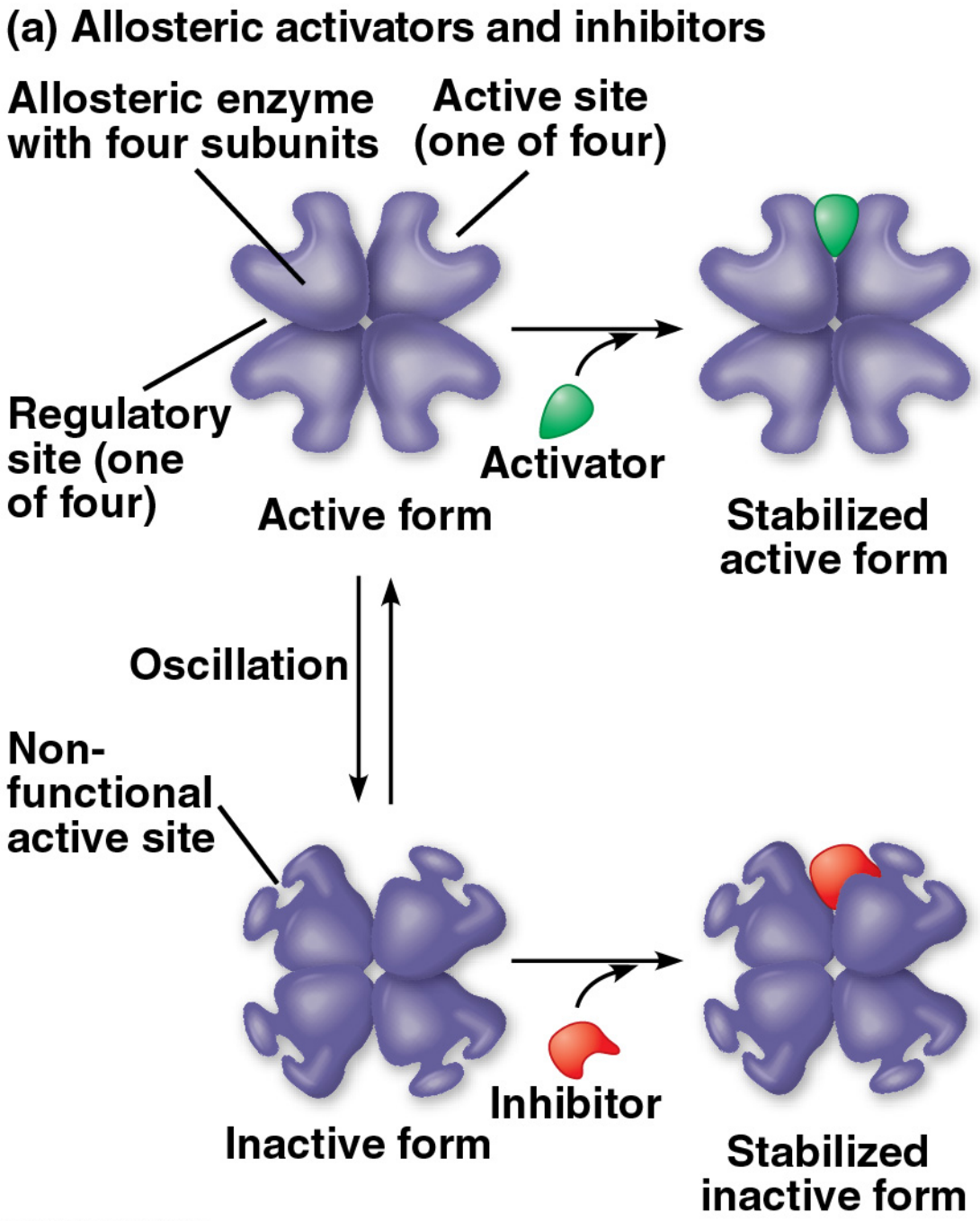


INHIBITION OF ENZYME ACTIVITY

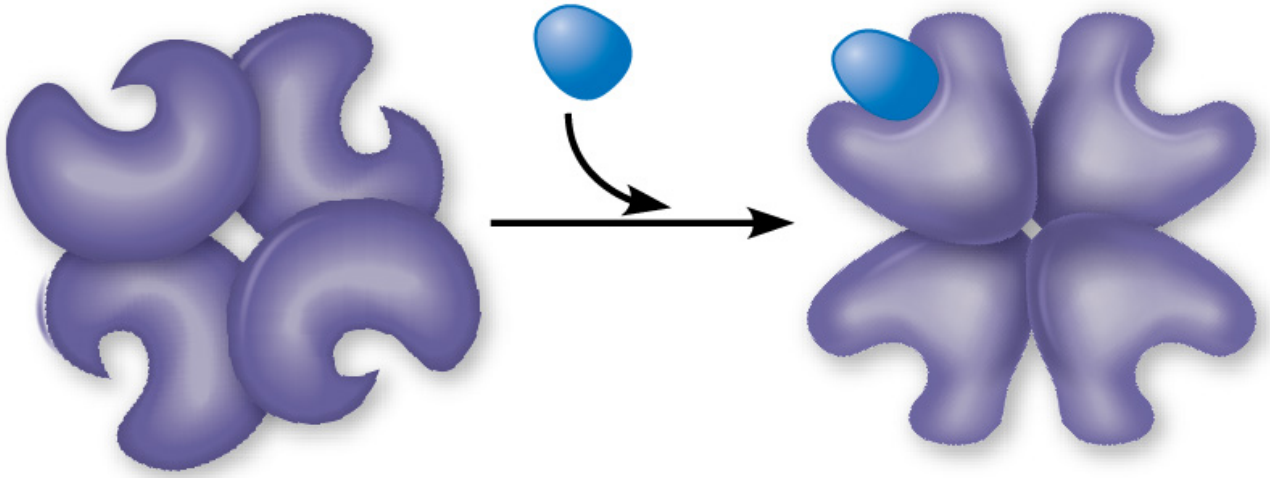


REGULATION OF ENZYME ACTIVITY

- To regulate metabolic pathways, the cell switches on/off the genes that encode specific enzymes
- **Allosteric regulation**: protein's function at one site is affected by binding of a **regulatory molecule** to a separate site (allosteric site)
  - Activator – stabilizes active site
  - Inhibitor – stabilizes inactive form
  - Cooperativity – one substrate triggers shape change in other active sites → increase catalytic activity



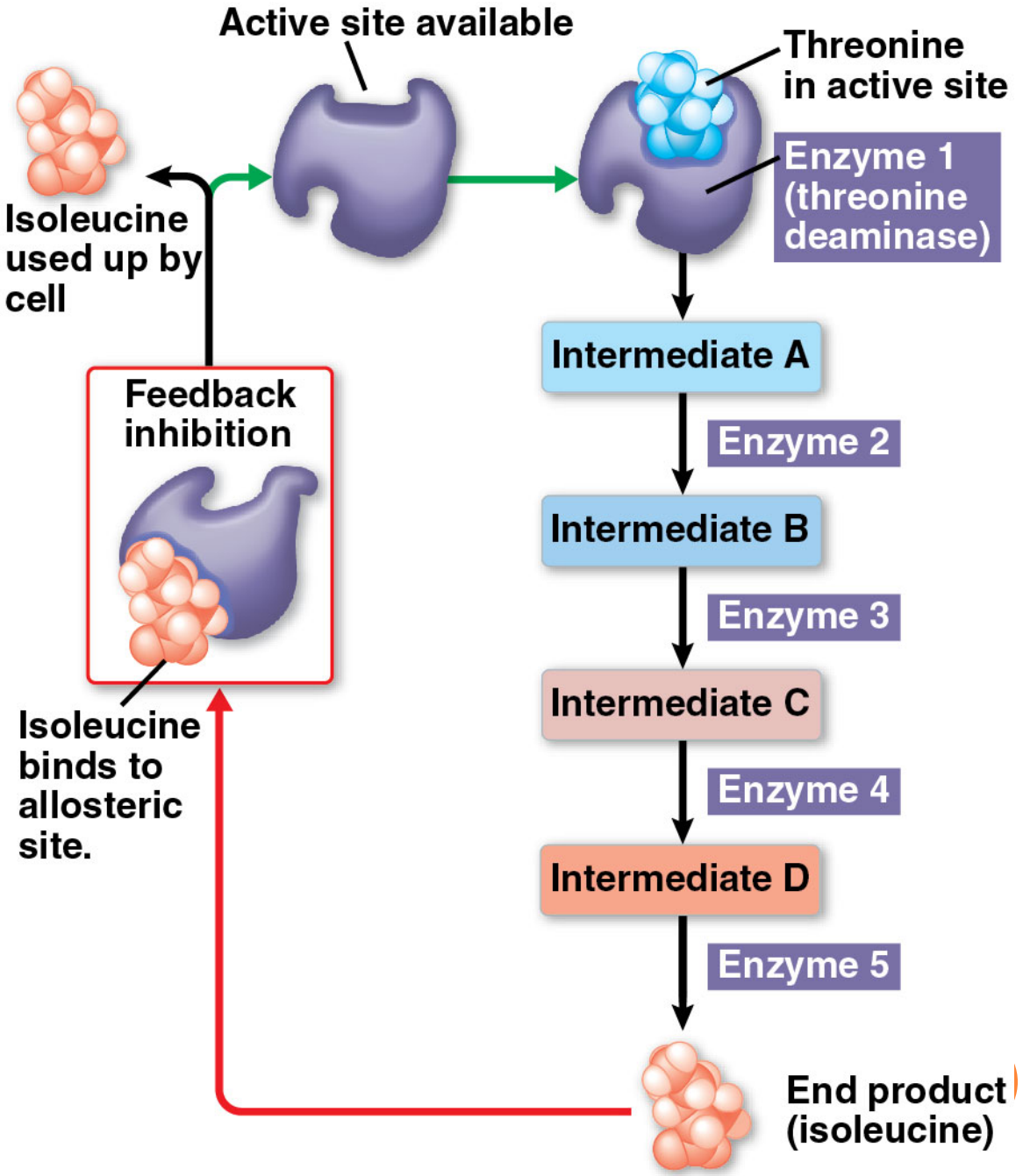
(b) Cooperativity: another type of allosteric activation



FEEDBACK INHIBITION

- End product of a metabolic pathway shuts down pathway by binding to the allosteric site of an enzyme
- Prevent wasting chemical resources, increase efficiency of cell

FEEDBACK INHIBITION



ORGANIZATION OF ENZYMES WITHIN A CELL