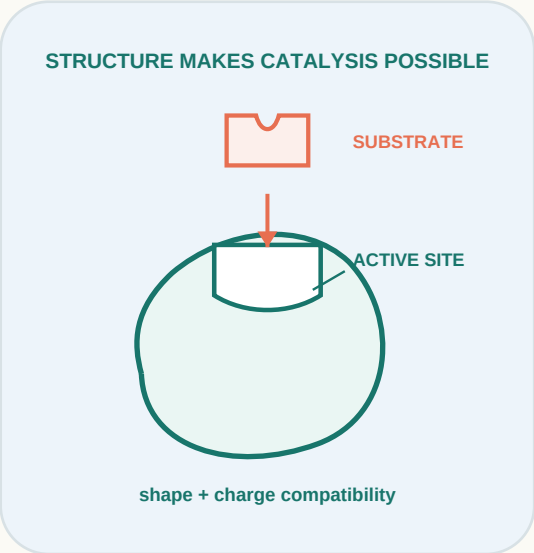
AP BIOLOGY | UNIT 3

TOPIC 3.1

Enzymes

An enzyme's three-dimensional structure creates an active site that binds specific substrates and lowers activation energy.



THE CORE CAUSAL CHAIN

STRUCTURE	→	ACTIVE SITE	→	LOWER Ea	→	FASTER RATE
folded protein		specific fit		easier pathway		enzyme unchanged

BY THE END, YOU SHOULD BE ABLE TO...

1. Explain how enzymes increase reaction rate.
2. Interpret activation energy with and without an enzyme.
3. Connect active-site structure to substrate specificity.

BIG IDEA

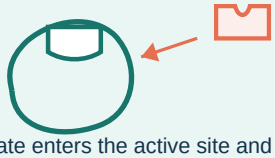
Enzymes change the pathway and rate of a reaction, not the overall energy difference between reactants and products.

1 How enzymes accelerate reactions

An enzyme binds substrates and stabilizes the transition state, lowering activation energy and increasing successful reactions per unit time.

THE CATALYTIC CYCLE

1 BINDING



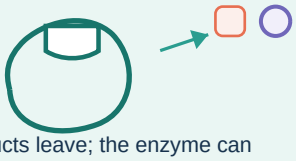
Substrate enters the active site and forms a temporary complex.

2 CATALYSIS



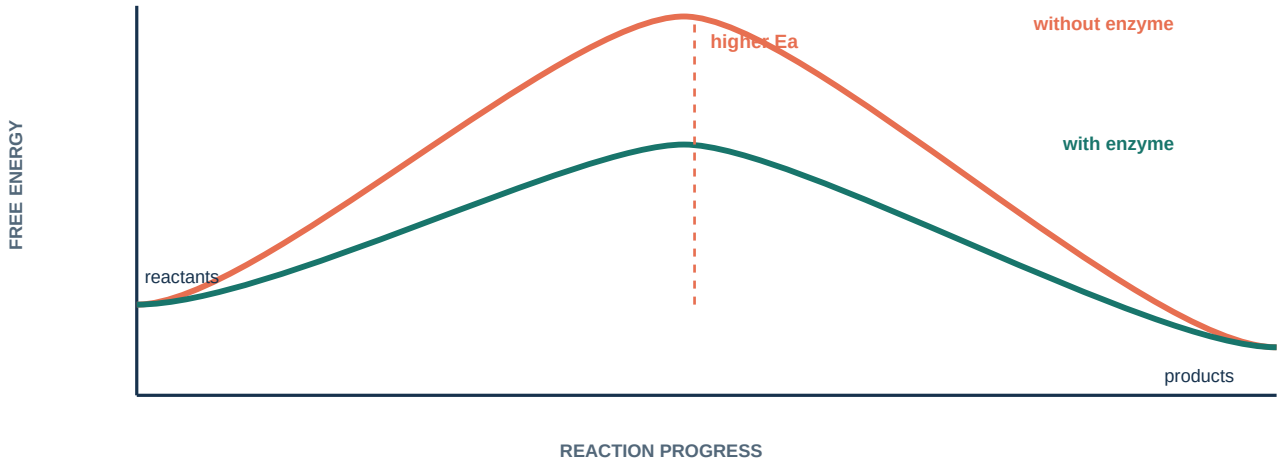
Active-site interactions help bonds break or form through a lower-energy route.

3 RELEASE



Products leave; the enzyme can catalyze another reaction.

ACTIVATION ENERGY



WHAT DOES NOT CHANGE

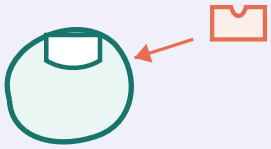
The enzyme is not consumed, and it does not change the reaction's overall free-energy difference or equilibrium position.

2 Specificity and induced fit

Binding depends on compatible shape and chemical properties; substrate contact can then shift the active site into a catalytically useful fit.

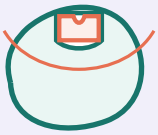
BINDING IS DYNAMIC

1 RECOGNITION



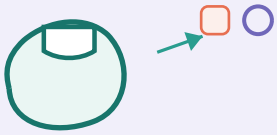
A compatible substrate approaches the active site.

2 INDUCED FIT



Binding causes a small shape change that positions catalytic groups.

3 PRODUCTS LEAVE



The enzyme returns to a form ready for another cycle.

WHAT DETERMINES SPECIFICITY?

SHAPE

The substrate must fit the active-site geometry closely enough to bind.

CHARGE AND POLARITY

Attractions and repulsions help determine whether binding is favorable.

THREE-DIMENSIONAL FOLD

The protein's amino-acid sequence ultimately establishes active-site structure.

STRUCTURE CONTROLS RATE

AMINO-ACID SEQUENCE → 3D FOLD → ACTIVE SITE → BINDING + CATALYSIS

COMMON ERROR

Enzymes do not make unfavorable reactions favorable. They lower activation energy but do not change free-energy difference or equilibrium.