CHEM-C2330 Biochemistry, Exam 17. Oct. 2022

Please answer all questions. 40 points (P) = 40% of final grade. (5 questions on 2 pages)
No resources, no devices allowed.
4 h time (but ca. 1-2 h should be enough)

1. Questions about proteins (6P, 1P each)
Shortly explain related to proteins:
A) Primary structure.
B) Secondary structure.
C) Tertiary structure.
D) Quaternary structure.
E) Which type of non-covalent interactions are responsible for beta-sheet formation?
F) By which "machinery" are proteins synthesized in biological cells?

2. Peptide hydrolysis (6P)
A) Draw a peptide bond (which is supposed to be part of a peptide) and label the N-terminal part with *R* and the C-terminal part with *R'* (2P)
B) Draw the relevant other resonance structure of the peptide bond. (0.5P)
C) Draw the correct arrow between the 2 resonance structures. (0.5P)
D) Draw a detailed reaction mechanism for peptide bond hydrolysis under acidic conditions. Draw the acid as "H-B". Draw as many intermediates and steps as possible and draw all the electron pairs that are "moving around", using the correct arrows. Draw the products as they are present at pH = 0. (3P)

3. Enzyme catalysis (12P)
A) Draw a draw "reaction vs. free energy diagram" (label the axes!) for an enzyme that converts one substrate (S) to one product (P). Include the step of substrate binding. (2P)
B) Label the transition state. (1P)
C) Highlight the activation energy with an arrow. (1P)
D) Draw into the same diagram (with dotted line) the situation where the substrate binds 11.4 kJ mol^{-1} weaker (there is no change to the transition state, no change for unbound substrate). (2P)
E) In the case of situation **D)** (dotted), if there is <u>very little</u> substrate present: About how much faster/slower would the rate be compared to A)? (3P)
F) In the case of situation **D)** (dotted), if there is <u>a lot of</u> substrate present: About how much faster/slower would the rate be compared to A)? (3P)

See also 2nd page!

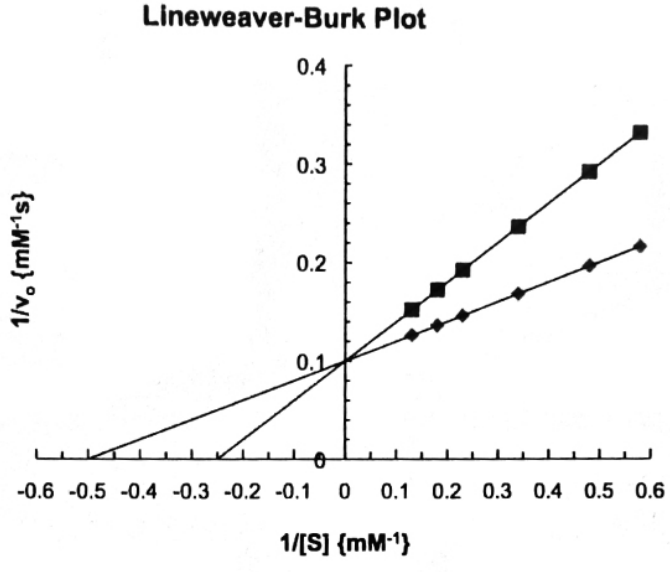
4. Initial rates (8P)

Shown below are kinetics data for an enzyme that were collected in both presence and absence of an inhibitor.

The enzyme concentration used in both experiments was 5 μM.

v_0 is the initial rate of the catalyzed reaction.

[S] is the substrate concentration.



A) Does this enzyme obey Michaelis-Menten kinetics? (Yes/No) (1P)

B) If yes: What is the K_M value? If no: Explain why. (2P)

C) What is the v_{max} value? (1P)

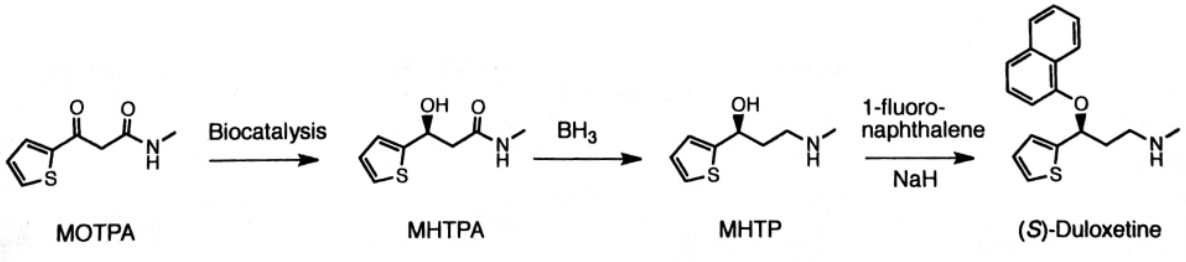
D) How many reactions does each enzyme active site catalyze per second when saturated with substrate? (2P)

E) Is the maximum rate for the uninhibited reaction diffusion limited? Short explanation. (1P)

F) Where on the enzyme does the inhibitor most likely bind? Short explanation. (1P)

5. Biocatalysis (8P)

(*S*)-Duloxetine (see fig. below) is a medication used for major depressive disorders and anxiety disorders. The "key step" for its synthesis is the conversion of MOTPA to MHTPA.



A) Why is this considered the "key step"? (1P)

B) Name advantages of using biocatalysis over classical chemistry. (2P)

C) What type of enzyme would you use for this step? Try to be as specific as possible. (1P)

D) Why is a cofactor needed here? (1P)

E) Which cofactor could it be? (1P)

F) Suggest how you can recycle this cofactor. Choose a specific auxiliary reaction and explain (drawing, or detailed explanation). (2P)