

## Assignment Instructions for the "Biochem Fall 202x – Itchy and Scratchy Assignment"

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### General Requirements

- **Objective:** Explore the role of histamine in the body and understand why mosquito bites itch more upon consuming alcohol.
  - **Purpose:** Gain experience researching a topic, utilize computational tools to analyze protein structure and function, and communicate scientific understanding effectively.
  - **Learning Outcomes:**
    - Describe the structure and interactions of biological molecules in cells.
    - Explain the roles of proteins and the impact of the cellular environment on their function.
    - Contrast experimental approaches used to purify and study proteins.
    - Locate and summarize relevant peer-reviewed publications.
    - Use online scientific resources to demonstrate understanding of protein structure/function.
    - Communicate scientific concepts effectively in written form.
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### Formatting and Submission Guidelines

- **Length:**
    - Maximum **1 page (~500 words)** per section.
    - **Figures, figure titles, and reference list are not included** in the word count.
  - **Formatting:**
    - **12-point font, single-spaced.**
    - Margins no smaller than **1.5 cm.**
    - **Do not include a title page.**
  - **Figures and Tables:**
    - Include relevant **figures and tables** near the corresponding text.
    - **Refer to all figures and tables** in the text.
    - **Figure titles go below** figures; **table titles go above** tables.
  - **References:**
    - Use **CSE citation format** (Author Year).
    - Include a **reference list** at the end (not included in word count).
  - **Academic Integrity:**
    - **Paraphrase** ideas that are not your own and **cite sources** properly.
    - Do **not** use generative AI tools like ChatGPT.
    - Assignments will be screened for plagiarism.
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### Assignment Sections and Requirements

#### 1. Introduction (Max 1 Page)

- **Overview of Histamine:**
  - Explain **why histamine is produced** following a mosquito bite.
  - Describe histamine's **role in the body**, including where it is found and produced.
- **Histamine as an Amino Acid Derivative:**
  - Discuss **why histamine is considered** an amino acid derivative.

- Provide the **chemical structure** of histamine.
- **Properties Based on Functional Groups:**
  - Describe the **properties of histamine** based on its functional groups.
  - Use resources like [MetaCyc](#) to explore histamine synthesis and confirm its amino acid precursor.
- **Contextual Relevance:**
  - Provide context and relevance for the assignment.
  - Link your ideas coherently to set up the rest of the assignment.
  - Emphasize **why biochemistry is important** in understanding histamine.

**Style Tips:**

- Ensure clarity and proper grammar.
  - Organize content into coherent paragraphs.
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## 2. Histamine Metabolism (Max 1 Page)

- **Enzymatic Production and Metabolism:**
  - Research and describe the **enzymatic synthesis and breakdown** of histamine in humans.
- **Create a Figure:**
  - Illustrate the **synthesis and degradation pathways** of histamine.
  - Include **names and structures** of substrates and products.
  - Show **enzymes** and any **cofactors** involved.
- **Describe Enzyme Mechanisms:**
  - For the **three main enzymes** involved:
    - Provide their **classification** (enzyme class and subclass).
    - Explain **how they catalyze reactions** at the molecular level.
    - Discuss the role of **any required cofactors** (e.g., structural, catalytic).
- **Use the BRENDA Database:**
  - Gather enzyme information from the [BRENDA Enzyme Database](#).

**Note:**

- Replace any tables from the draft with detailed written descriptions.
  - Provide specific details to demonstrate a thorough understanding of the enzymes' mechanisms.
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## 3. Protein Structure (Max 1 Page)

- **Select a Protein:**
  - Choose **one** protein structure: **PDB ID 1JQD** or **PDB ID 3HI7**.
- **Visualize the Protein:**
  - Use the **RCSB PDB** website to view the protein structure.
  - Orient the protein to display comprehensively in **cartoon chainbow** format.
  - **Export an image** of the protein.
- **Label Key Features:**
  - Indicate the **N-terminus and C-terminus**.
  - Highlight any **physiologically relevant molecules** or binding sites.
- **Describe the Protein Structure:**

- **Primary Structure:**
  - Discuss the **amino acid sequence**.
  - Note any **gaps or missing residues**.
- **Secondary Structure:**
  - Identify types of **secondary structures** present (alpha-helices, beta-sheets).
  - Specify their locations.
- **Tertiary Structure:**
  - Describe any **motifs or domains**.
  - Explain how they contribute to the protein's function.
- **Quaternary Structure** (if applicable):
  - Discuss interactions between **subunits**.
- **Cite Specific Examples:**
  - Refer to specific **amino acids** by their **residue numbers**.
  - Discuss **functional groups** important for binding interactions.
- **Include a Zoomed-In Image:**
  - Focus on a region important for **mediating a binding interaction**.
  - Show side chains and nearby amino acids involved.
  - Examine **non-covalent interactions** (e.g., hydrogen bonds, ionic interactions).

**Figures:**

- Include **titles below** each figure.
- Refer to figures within the text to support your explanations.

**4. Protein Purification and Characterization (Max 1 Page)**

- **Summarize the Purification Protocol:**
  - Create a **figure or flowchart** outlining the methods used to obtain the protein structure.
    - Include steps such as **expression system, protein construct details, lysis procedures, chromatography techniques, and structural determination methods**.
- **Provide a Rationale (Half-Page Paragraph):**
  - Explain **why each step** was taken.
  - Discuss the **biochemical conditions and experiments** needed to obtain a pure protein.
  - Relate the methods to any applicable concepts below: Cell Lysis Methods, Chromatography Techniques: (Size Exclusion Chromatography (SEC), Ion-Exchange Chromatography, Affinity Chromatography, Dialysis, High-Pressure Liquid Chromatography (HPLC)), SDS-PAGE for Purity Assessment, Protein Identification Methods: (SDS-PAGE, Immunoblotting (Western Blotting), Mass Spectrometry (MS), Edman Degradation, Enzymatic and Chemical Cleavage), Protein Characterization Methods [Spectroscopy Techniques(UV-Visible Spectroscopy, Infrared (IR) Spectroscopy, Circular Dichroism (CD) Spectroscopy, Nuclear Magnetic Resonance (NMR) Spectroscopy, Fluorescence Spectroscopy), Structural Determination Techniques(X-ray Crystallography, Cryo-Electron

Microscopy (Cryo-EM), AlphaFold and Computational Prediction), Fluorescence Microscopy, Fusion Proteins and Tags, Protein-Protein Interaction Studies (Pull-Down Assays, Co-Immunoprecipitation (Co-IP), Cross-Linking Reagents, BioID (Proximity-Dependent Biotinylation)), Monitoring Enzyme Catalysis, Practical Applications of pH and Enzymes]

- **Read the Associated Journal Article:**
    - Find detailed methods in the **Experimental Procedures** section.
    - Supplement your summary with information from the article.
  - **Figure Formatting:**
    - The figure and its title must fit on **one page**.
    - Place the **figure title below** the figure.
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## 5. The Effects of Alcohol Consumption (Max 1 Page)

- **Answer the Central Question:**
  - “Why do mosquito bites itch more upon alcohol consumption?”
- **Formulate a Hypothesis:**
  - Based on your understanding and research.
- **Conduct Additional Research:**
  - Gather evidence to **support your hypothesis**.
- **Explain the Molecular Mechanisms:**
  - Discuss the **biochemical basis** for increased itching.
  - Explain the effects of **alcohol and its metabolites** on:
    - **Histamine levels.**
    - **Enzyme activity.**
    - **Receptor interactions.**
- **Integrate Course Concepts:**
  - Highlight the importance of **binding interactions**.
  - Describe how molecules interact with specific **proteins and enzymes**.
  - Discuss implications for **regulation and function**.
- **Summary and Conclusion:**
  - Summarize your findings and their significance.
  - Provide a brief conclusion (2-3 sentences) reflecting on the **importance of biochemistry** in understanding bodily processes.

### Style Tips:

- Ensure your argument is logical and evidence-based.
  - Use clear, concise language.
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### Style and Presentation

- **Clarity and Organization:**
    - Present ideas logically and coherently.
    - Use proper grammar and sentence structure.
  - **Evidence-Based Statements:**
    - Support all claims with **evidence** from reputable sources.
    - **Cite all references** properly in CSE format.
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### Submission Details

- **Deadline:**
    - Submit your assignment by **Tuesday, Oct. 15, 2024, at 5 pm ET.**
    - **Submit at least 30 minutes early** to avoid technical issues.
  - **Late Submissions:**
    - **Penalty: -10%** of the assignment grade.
    - **No submissions accepted** more than **one week** after the due date.
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### Final Checklist

- **Content:**
    - Have you addressed all required sections thoroughly?
  - **Formatting:**
    - Does your document meet all formatting requirements?
    - Are all figures and tables properly labeled and referred to in the text?
  - **References:**
    - Have you cited all sources in CSE format?
    - Is your reference list complete and correctly formatted?
  - **Academic Integrity:**
    - Have you paraphrased properly and cited all non-original ideas?
    - Have you avoided the use of prohibited AI tools?
  - **Proofreading:**
    - Have you checked for spelling and grammatical errors?
    - Is your writing clear and professional?
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### Criteria and Point Breakdown:

#### 1. Introduction (4 pts)

- **Requirements:**
  - Provide clear and concise background information on histamine, its role in the body, and its origin.
  - Include the molecular structure of histamine.
  - Describe functional groups and types of non-covalent interactions during protein binding.
  - Set up the assignment by explaining how biochemistry contributes to understanding molecular binding and histamine's effects in the body.
- **Ratings:**
  - **Well done (4 pts):** Thoroughly written and thoughtful analysis.
  - **Very good (3.5 pts):** Minor details needed for thorough understanding.
  - **Good (3 pts):** Good understanding; needs additional organization or analysis.
  - **Ok (2.5 pts):** Deeper understanding and more analysis needed.
  - **Adequate (2 pts):** Minimum information; more details and clarifications needed.
  - **Satisfactory (1.5 pts):** Significant improvement needed; seek assistance.
  - **Needs Significant Improvement (1 pt):** Missing major elements; does not meet criteria.

- **No Marks (0 pts)**

## 2. Histamine Metabolism (4 pts)

- **Requirements:**

- Describe the steps involved in histamine production and metabolism.
- Include enzyme-catalyzed reactions with structures of substrates and products.
- Provide physiological and cellular locations.
- Detail the three main enzymes: classification, mechanisms, and cofactors.

- **Ratings:**

- **Well done (4 pts):** Thorough explanations of enzymes involved in histamine metabolism.
- **Very good (3.5 pts):** Minor details needed for thorough understanding.
- **Good (3 pts):** Good understanding; additional details needed.
- **Ok (2.5 pts):** Deeper understanding of enzymes required.
- **Adequate (2 pts):** Minimum information; more details needed on enzyme catalysis.
- **Satisfactory (1.5 pts):** Significant improvement needed; seek assistance.
- **Needs Significant Improvement (1 pt):** Missing major elements; does not meet criteria.
- **No Marks (0 pts)**

## 3. Protein Structure (4 pts)

- **Requirements:**

- Provide a thorough description of the enzyme's structure with figures from the RCSB website.
- Discuss overall structure and levels of protein structure visible in the figures.
- Provide examples of non-covalent interactions with specific details.

- **Ratings:**

- **Well done (4 pts):** Thoroughly written with thoughtful analysis.
- **Very good (3.5 pts):** Minor details needed for thorough understanding.
- **Good (3 pts):** Good understanding; more details or analysis needed.
- **Ok (2.5 pts):** Deeper understanding and analysis of protein structure needed.
- **Adequate (2 pts):** Minimum information; more details on protein structure needed.
- **Satisfactory (1.5 pts):** Significant improvement needed; seek assistance.
- **Needs Significant Improvement (1 pt):** Missing major elements; does not meet criteria.
- **No Marks (0 pts)**

## 4. Protein Purification and Characterization (4 pts)

- **Requirements:**

- Provide a written description of the purification protocol with a flow chart.
- Detail the biochemical techniques used in correct order to obtain a pure protein.
- Explain how the protein is identified and its structure deduced experimentally.

- **Ratings:**

- **Well done (4 pts):** Thoroughly written with thoughtful analysis.
- **Very good (3.5 pts):** Minor details needed for thorough understanding.

- **Good (3 pts):** Basic experiments provided; more details and rationale needed.
- **Ok (2.5 pts):** Deeper understanding of purification protocol needed.
- **Adequate (2 pts):** Minimum information; more details on purification needed.
- **Satisfactory (1.5 pts):** Significant improvement needed; seek assistance.
- **Needs Significant Improvement (1 pt):** Missing major elements; does not meet criteria.
- **No Marks (0 pts)**

#### 5. The Effects of Alcohol Consumption (4 pts)

- **Requirements:**
  - Provide the biochemical basis for why mosquito bites itch more after consuming alcohol.
  - Address the role of proteins and enzyme regulation or effects by metabolites.
  - Provide a conclusion connecting ideas from the entire assignment; demonstrate learning.
- **Ratings:**
  - **Well done (4 pts):** Thoroughly written with thoughtful analysis.
  - **Very good (3.5 pts):** Minor details needed for thorough understanding.
  - **Good (3 pts):** Good understanding; more organization or analysis needed.
  - **Ok (2.5 pts):** Deeper understanding and analysis needed.
  - **Adequate (2 pts):** Minimum information; more details needed.
  - **Satisfactory (1.5 pts):** Significant improvement needed; seek assistance.
  - **Needs Significant Improvement (1 pt):** Missing major elements; does not meet criteria.
  - **No Marks (0 pts)**

#### 6. Style (4 pts)

- **Requirements:**
  - Write clearly and effectively using easy-to-understand language.
  - Ensure ideas are communicated clearly.
  - Eliminate typos and grammatical errors.
  - Consistently use standard CSE bibliographic format.
- **Ratings:**
  - **Well done (4 pts):** Fantastic work; no changes needed.
  - **Very good (3.5 pts):** Minor errors noted.
  - **Good (3 pts):** Some editing or formatting attention needed.
  - **Ok (2.5 pts):** More editing required.
  - **Adequate (2 pts):** Ideas need clearer communication; editing required.
  - **Satisfactory (1.5 pts):** Significant improvement needed; seek assistance with writing.
  - **Needs Significant Improvement (1 pt):** Writing is difficult to follow; significant editing needed.
  - **No Marks (0 pts)**