Teacher’s Manual for Unit III: Cholinergic Neurotransmitters

SNS College of Pharmacy and Health Sciences

Medicinal Chemistry

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Course Overview

This manual outlines a 10-session plan (50 minutes each) for Unit III: Cholinergic Neurotransmitters, designed for pharmacy students at SNS College of Pharmacy and Health Sciences. The curriculum covers the biosynthesis and catabolism of acetylcholine, cholinergic receptors, parasympathomimetic agents, cholinesterase inhibitors, cholinesterase reactivators, and cholinergic blocking agents. Each session integrates Design Thinking (DT) activities (Empathize, Define, Ideate, Prototype, Test) to foster critical thinking and application. Student workbook tasks are included for hands-on learning.

1 Session Plans

1.1 Session 1: Introduction to Cholinergic Neurotransmitters

Topic: Overview of cholinergic neurotransmitters, focusing on acetylcholine (ACh) biosynthesis and catabolism.
DT Activity: *Empathize* - Students interview peers to understand challenges in learning complex biochemical pathways. Conduct a 10-minute group discussion to share insights on prior knowledge gaps.
Workbook Task:

- Draw and label the biosynthesis pathway of acetylcholine (choline + acetyl-CoA $\rightarrow$ ACh via choline acetyltransferase).
- List two enzymes involved in ACh catabolism and their roles.

1.2 Session 2: Cholinergic Receptors - Muscarinic and Nicotinic

Topic: Structure, function, and distribution of muscarinic and nicotinic receptors.
DT Activity: *Define* - In groups, students define key challenges in distinguishing receptor types based on their distribution (e.g., muscarinic in smooth muscles, nicotinic in skeletal muscles). Create a problem statement for receptor-targeted drug design.
Workbook Task:

- Create a table comparing muscarinic and nicotinic receptors (location, mechanism, physiological effects).
- Sketch a diagram of a muscarinic receptor with labeled binding sites.

1.3 Session 3: Parasympathomimetic Agents - Introduction and SAR

Topic: Overview of parasympathomimetic agents and their Structure-Activity Relationship (SAR).
DT Activity: *Ideate* - Brainstorm modifications to acetylcholine's structure to enhance stability or receptor affinity. Groups sketch 3-5 molecular modifications.
Workbook Task:

- Draw the chemical structure of acetylcholine and annotate key functional groups affecting its SAR.
- Propose one structural change to improve its stability and explain its impact.

1.4 Session 4: Direct-Acting Parasympathomimetic Agents

Topic: Acetylcholine, Carbachol, Bethanechol, Methacholine, Pilocarpine.
DT Activity: *Prototype* - Design a model (paper or digital) of a direct-acting agent's interaction with a muscarinic receptor. Present prototypes to the class.
Workbook Task:

- Draw the chemical structures of Carbachol and Bethanechol.
- Write a short paragraph comparing their clinical uses and receptor selectivity.

1.5 Session 5: Indirect-Acting Agents - Reversible Cholinesterase Inhibitors

Topic: Physostigmine, Neostigmine, Pyridostigmine, Edrophonium chloride, Tacrine hydrochloride, Ambenonium chloride.
DT Activity: *Test* - Test group prototypes from Session 4 by discussing their feasibility in clinical scenarios (e.g., myasthenia gravis treatment). Refine designs based on feedback.
Workbook Task:

- Draw the structure of Neostigmine and highlight its cholinesterase-binding moiety.
- List two clinical applications of reversible cholinesterase inhibitors.

1.6 Session 6: Indirect-Acting Agents - Irreversible Cholinesterase Inhibitors

Topic: Isofluorphate, Echothiophate iodide, Parathione, Malathion.
DT Activity: *Empathize* - Discuss the societal impact of organophosphates (e.g., pesticides like Malathion) in small groups. Identify safety concerns for patients and agricultural workers.
Workbook Task:

- Draw the structure of Echothiophate iodide and indicate its irreversible binding mechanism.
- Write a brief note on the toxicological risks of organophosphates.

1.7 Session 7: Cholinesterase Reactivator - Pralidoxime Chloride

Topic: Mechanism and clinical use of Pralidoxime chloride as a cholinesterase reactivator.
DT Activity: *Define* - Define the problem of organophosphate poisoning and the role of reactivators. Groups create a flowchart for Pralidoxime's mechanism.
Workbook Task:

- Draw the structure of Pralidoxime chloride and annotate its nucleophilic site.
- Describe its mechanism of action in reactivating acetylcholinesterase.

1.8 Session 8: Cholinergic Blocking Agents - SAR and Solanaceous Alkaloids

Topic: SAR of cholinolytic agents; Atropine sulphate, Hyoscyamine sulphate, Scopolamine hydrobromide, Homatropine hydrobromide, Ipratropium bromide.
DT Activity: *Ideate* - Brainstorm modifications to Atropine's structure to reduce side effects (e.g., CNS effects). Sketch and justify changes.
Workbook Task:

- Draw the structure of Atropine sulphate and label key functional groups for its SAR.
- List two clinical uses of Ipratropium bromide.

1.9 Session 9: Synthetic Cholinergic Blocking Agents - Part 1

Topic: Tropicamide, Cyclopentolate hydrochloride, Clidinium bromide, Dicyclomine hydrochloride, Glycopyrrolate.
DT Activity: *Prototype* - Create a prototype of a patient education pamphlet explaining the use of Dicyclomine for IBS. Share and critique in groups.
Workbook Task:

- Draw the structure of Dicyclomine hydrochloride.
- Write a short note on its mechanism and therapeutic use in gastrointestinal disorders.

1.10 Session 10: Synthetic Cholinergic Blocking Agents - Part 2

Topic: Methantheline bromide, Propantheline bromide, Benztropine mesylate, Orphenadrine citrate, Biperidine hydrochloride, Procyclidine hydrochloride, Tridihexethyl chloride, Isopropamide iodide, Ethopropazine hydrochloride.
DT Activity: *Test* - Test the patient education pamphlets from Session 9 with peers acting as patients. Refine based on feedback for clarity and accuracy.
Workbook Task:

- Draw the structure of Procyclidine hydrochloride.
- Compare the therapeutic uses of Benztropine and Procyclidine in Parkinson's disease.

2 Student Workbook Guidelines

- Each workbook task is designed to reinforce session content through hands-on activities.
- Students should maintain a dedicated notebook for drawings, tables, and written responses.

- Tasks should be completed individually unless specified as group work.
- Faculty will review workbook submissions weekly to provide feedback.

3 Assessment and Evaluation

- **Formative Assessment**: Workbook tasks (40
- **Summative Assessment**: End-of-unit quiz on key concepts and structures (20
- Faculty should use a rubric for DT activities, assessing creativity, collaboration, and application of medicinal chemistry principles.

4 Resources

- **Textbooks**:
  - Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry.
  - Foye's Principles of Medicinal Chemistry.
- **Online Resources**:
  - PubChem (`https://pubchem.ncbi.nlm.nih.gov`) for chemical structures.
  - DrugBank (`https://go.drugbank.com`) for pharmacological data.