



Teaching the Chemistry and Pharmacology of Psychedelics to Non-Scientists: Adaptation of PharmD Teaching Pedagogy for MS Students

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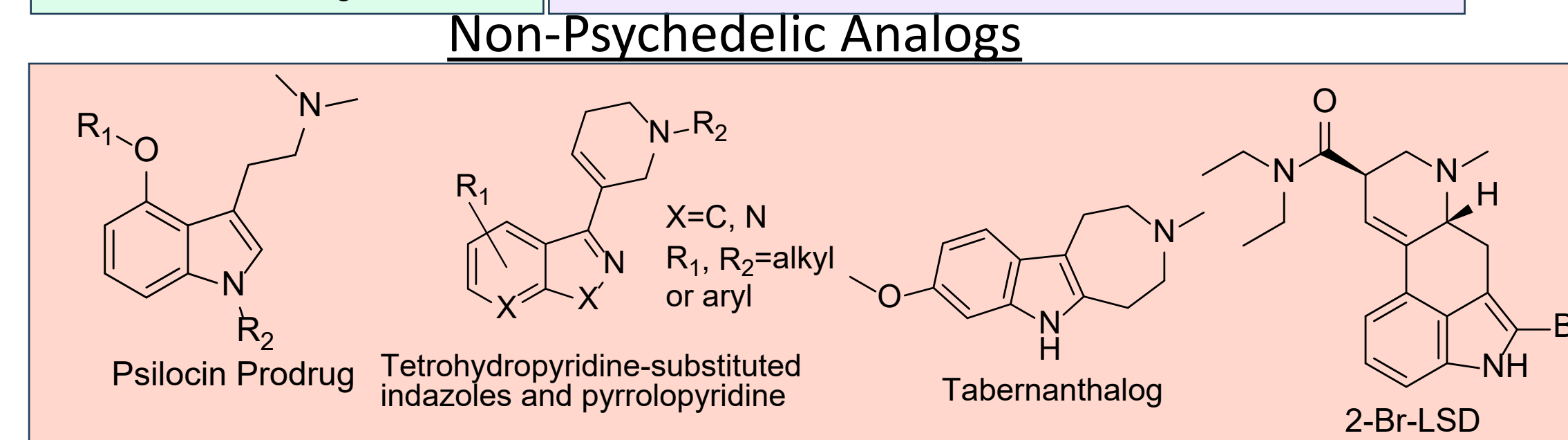
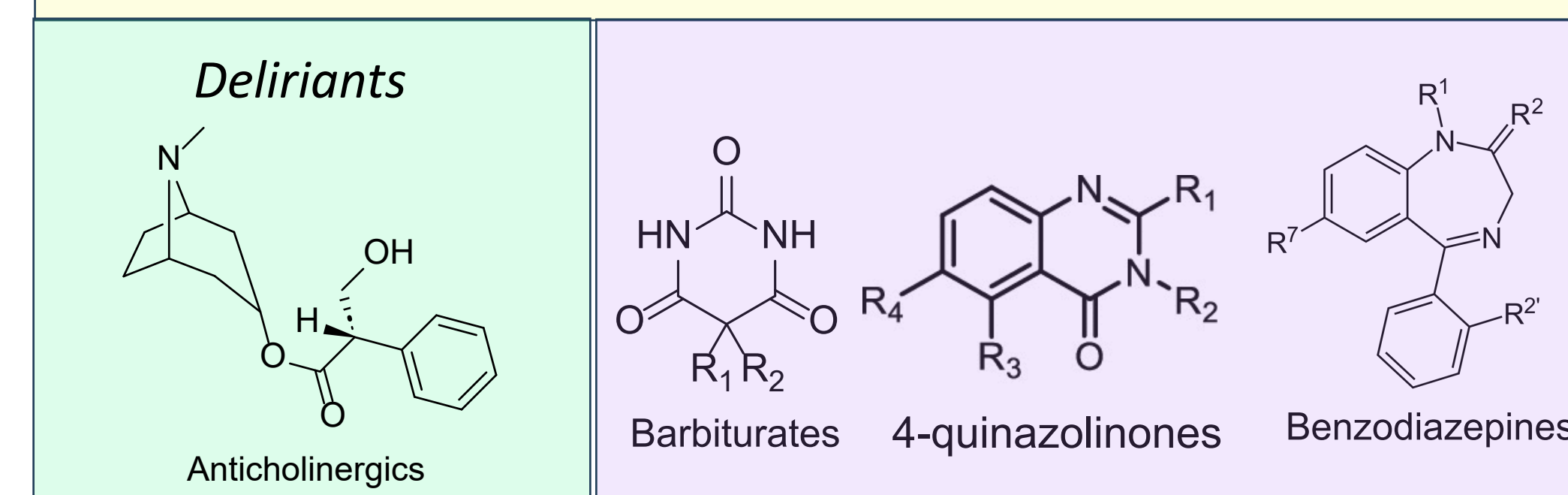
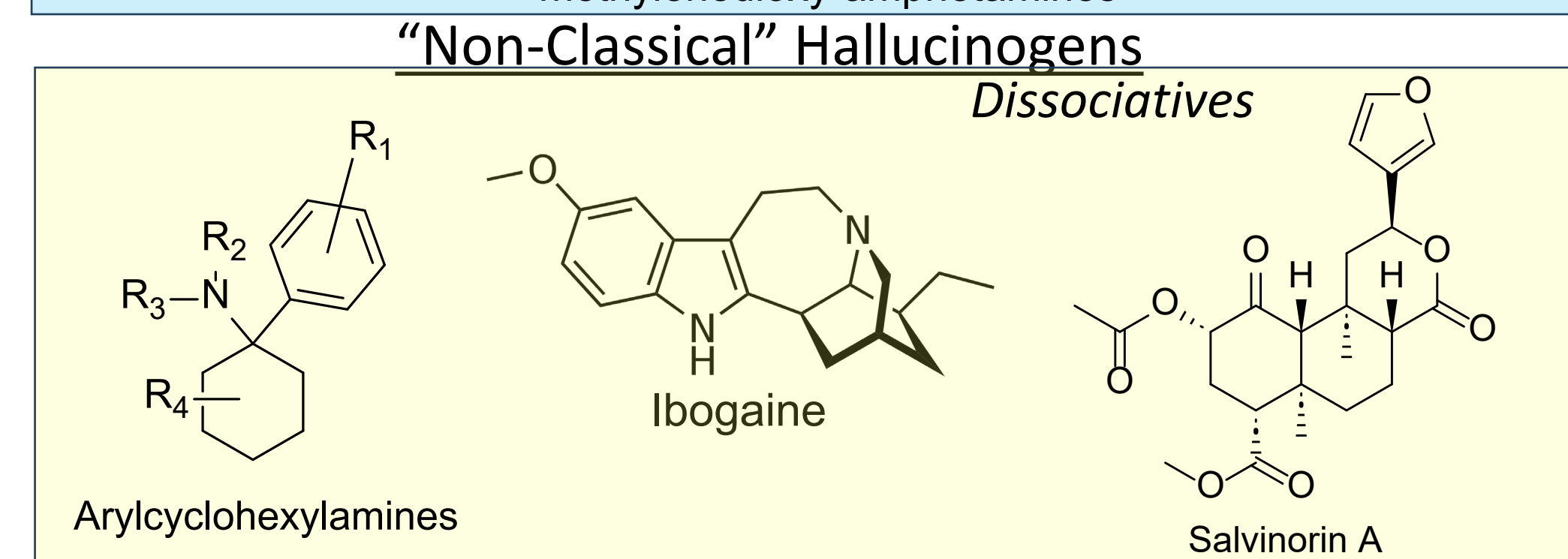
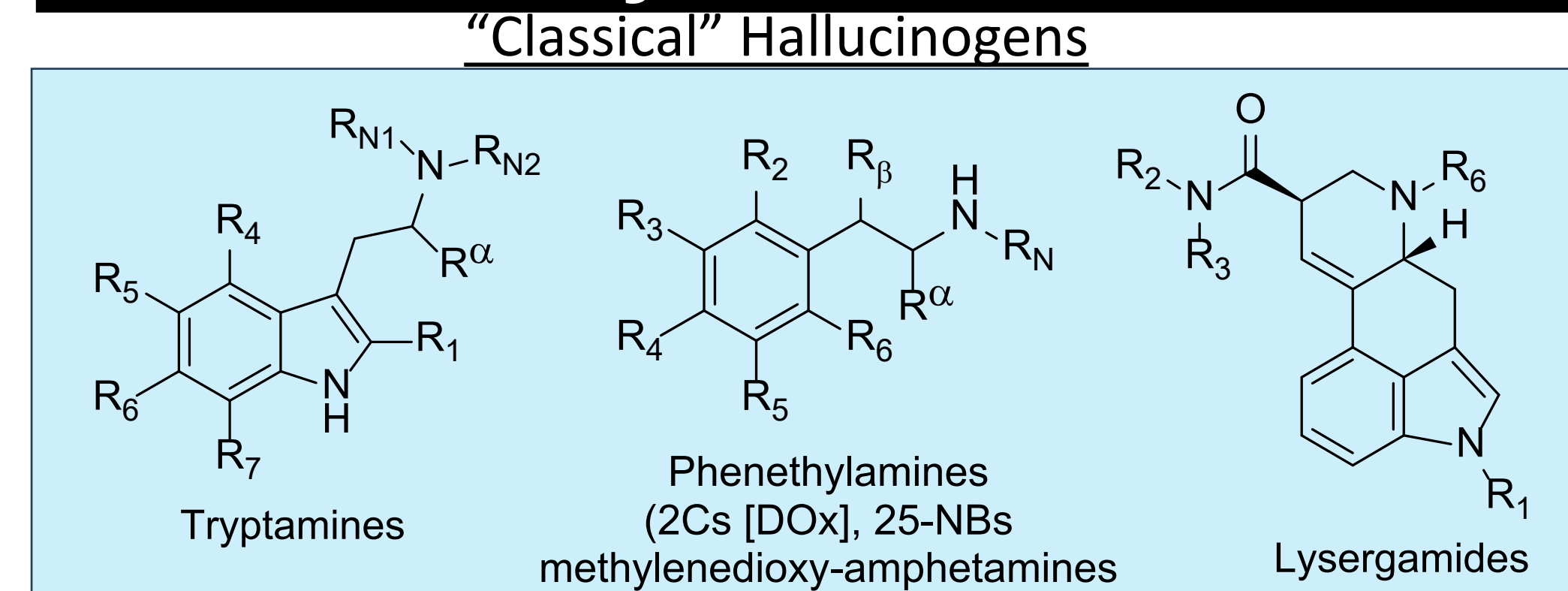
University of Maryland School of Pharmacy, Masters in Medical Cannabis Science and Therapeutics Program

Background and Objectives

Psychedelics have been known for millennia, and we are currently in the midst of a psychedelic renaissance. A new wave of research is placing hallucinogens at the forefront of treating various mental health disorders, garnering the attention of academics and industry alike. The word “psychedelic” is a broad term that includes hallucinogens, dissociatives, deliriant, empathogens, and entheogens, and each class of drug operates with a distinct pharmacological mechanism. Notably, cannabis is also grouped with psychedelics and is considered an entheogen that was used in religious and spiritual ceremonies dating back to ancient times.

In our Masters in Medical Cannabis Science and Therapeutics (MCST) program, we responded to the growing interest in psychedelics by developing a Medical Psychedelics elective course. This course was crafted based on feedback from current and former cohorts, and it encompasses the history, basic science (neurotransmitter biology, neuroplasticity, chemistry, pharmacology), and clinical aspects of psychedelic drugs. The content of the course required the introduction of several new concepts in biology, chemistry, and pharmacology, and required tailoring to our diverse group of students within the MCST program. This poster will detail the steps taken to create content that was accessible for master’s students with both science and non-science backgrounds and will serve as a resource for faculty in providing education on medical psychedelics.

Classes of Psychedelics and Pharmacology



Course Overview

- History
- How Drugs Work Part 1 (Hallucinogens)
- How Drugs Work Part 2 (Dissociatives, Deliriant, Hypnotics)
- How Drugs Work Part 3 (Empathogens/Entactogens)
- Psychedelic Therapeutics Part 1 (Psilocybin and LSD)
- Psychedelic Therapeutics Part 2 (Ketamine)
- Psychedelic Therapeutics Part 3 (MDMA)

Receptors Involved

- Serotonin (mainly 5HT_{2A})
- Dopamine
- Adrenergic
- SERT
- DAT
- NMDA
- Muscarinic Acetylcholine Receptors (mAChRs)
- Nicotinic Acetylcholine receptors (nAChRs)
- Opioid (μ , δ , κ)
- GABA
- AMPA

Methods/Results

Interviews with psychedelic experts informed the development of performance objectives. Two medicinal chemists and one clinical pharmacist adapted material from PharmD and MCST courses covering Medicinal Chemistry/Pharmacology/Pharmacokinetics concepts focusing on core foundations for non-experts.

Basic science content focused on the following:

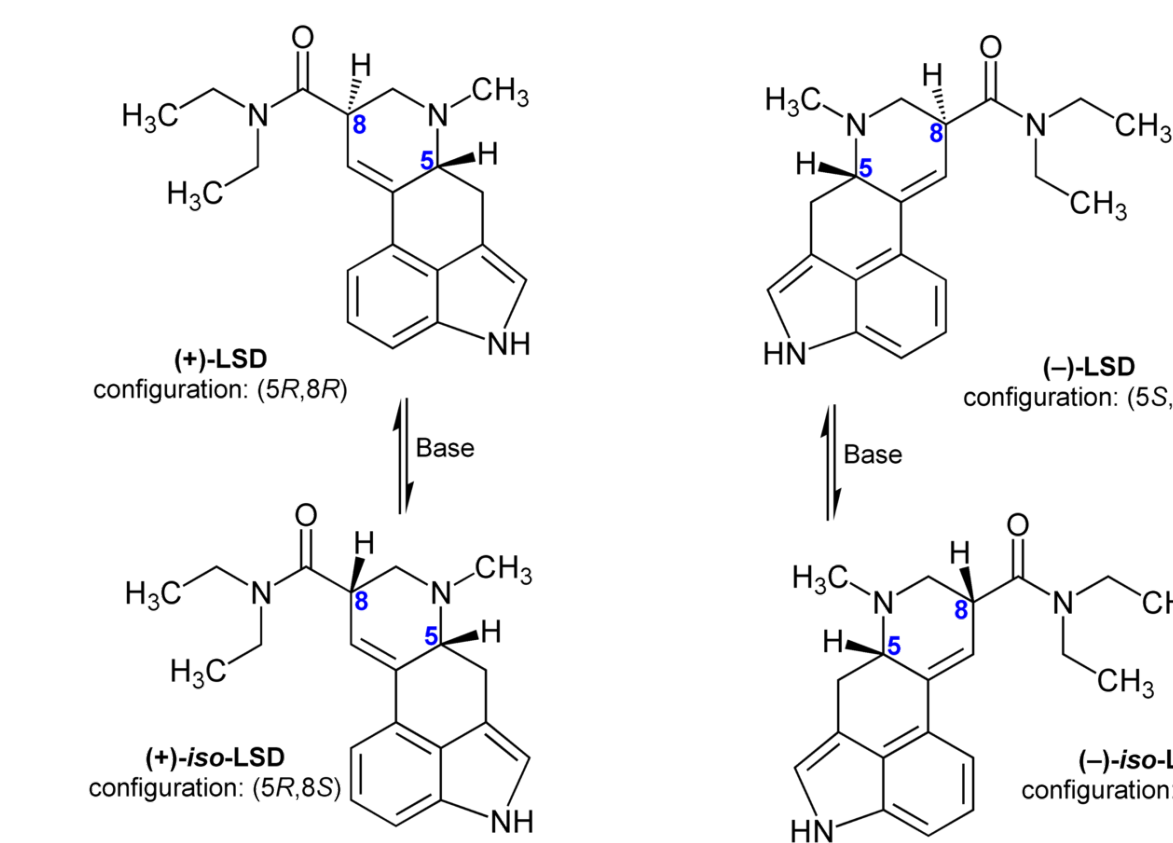
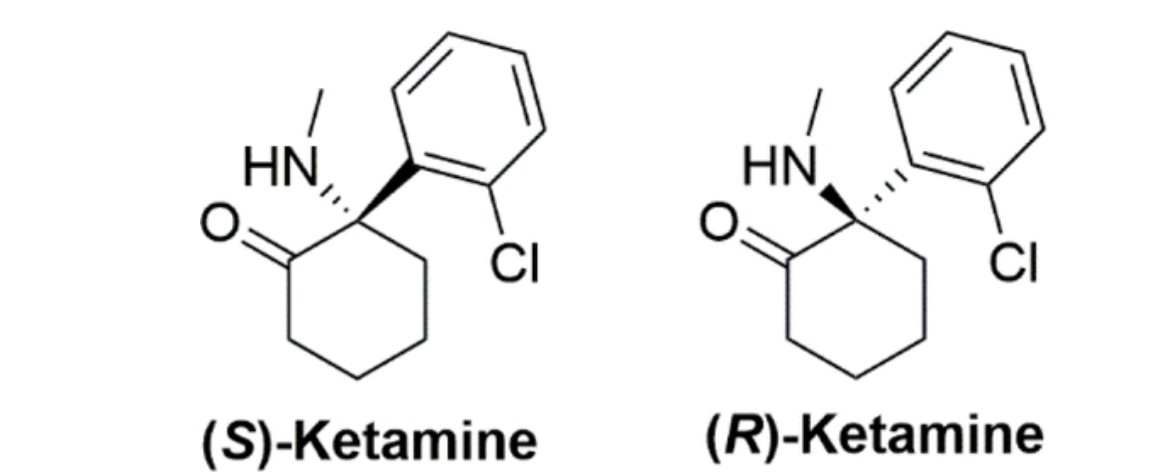
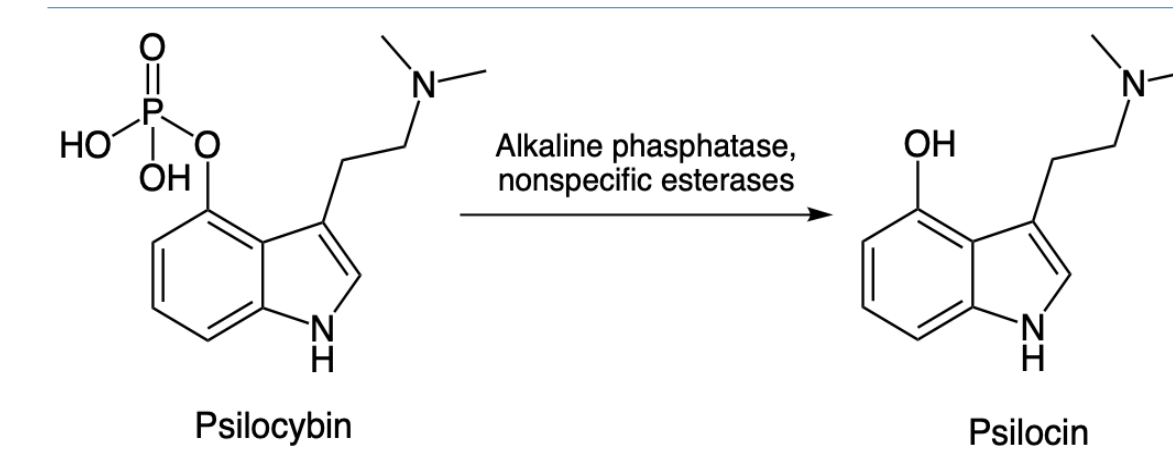
- Fundamental biology of neurons and neurotransmitters
- How psychedelics contribute to long-term therapeutic effects (e.g., neuroplasticity and neurogenesis).
- Prodrugs
- Classes of Psychedelics and their pharmacology

Most (if not all) were new concepts to the master’s students, which is not seen as frequently with PharmDs. Analysis of student feedback was positive showing the benefit of this model as a toolkit for education on medical psychedelics.

Concepts Introduced

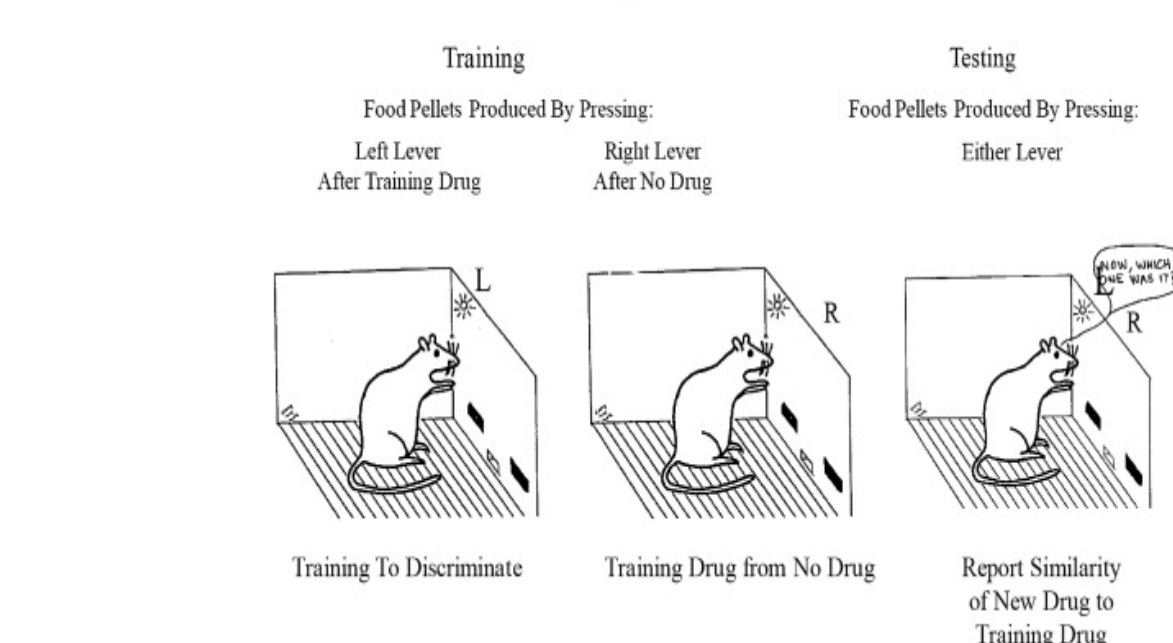
New Concepts

- Neurotransmitters
- Neurogenesis
- Neuroplasticity (or Metaplasticity)
- Prodrugs (Psilocybin)
- Stereochemistry (Enantiomers)
- Abuse Liability
- Behavioral Pharmacology
- Assays for testing psychedelic activity
- Assays for antidepressant activity
- Structure-activity Relationships
- Non-Psychedelic psychedelics
- Computer-aided drug design
- Biased-agonism



<https://pubmed.ncbi.nlm.nih.gov/19040555/>

<https://www.sciencedirect.com/science/article/abs/pii/S09780124201729000060>



While cannabis is often grouped with psychedelics as an entheogen, its pharmacological mechanism of action differs from both the classical and non-classical hallucinogens (no neurogenesis/neuroplasticity).

- Psilocybin is a natural prodrug (active drug is generated in the body after administration), which had not been encountered by our MCST students before.
- The concept of stereochemistry was re-introduced relating to LSD and Ketamine, along with the tryptamines and phenethylamines.

- Pharmacological assays utilized in preclinical development of psychedelics were reviewed.
 - Head-twitch
 - Drug discrimination
 - Self-administration
 - Forced swim test (FST)

Discussion

The course has only completed one iteration; hence one set of student feedback was available for analysis.

After reviewing student feedback (n=100) we concluded the following:

- The material was accessible and at the correct level/depth
- New concepts were introduced in an understandable way
- Students wanted more time discussing the individual classes of drugs
- Students wanted more time focused on future research involving psychedelics

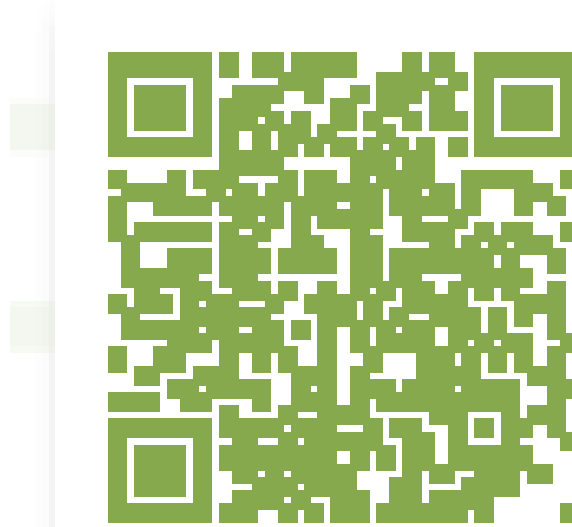
The field of medical psychedelics is progressing quickly and, as such, requires our MS programs to evolve and adapt to keep pace. For our students to be pioneers in the industry, they must have adequate knowledge of emerging trends within the field and critically evaluate available data to make effective recommendations to patients and public health professionals.

Description of the Graduate Studies in Medical Cannabis Science and Therapeutics Program

The pioneering **MS in Medical Cannabis Science and Therapeutics** is the first graduate program in the United States dedicated to the study of medical cannabis. The two-year program based at the Universities at Shady Grove in Rockville, Md., blends online instruction with face-to-face experiences with our award-winning faculty. Students will have the opportunity to meet and interact with experts in the science, therapeutics, and policy of medical cannabis at live symposia, while online coursework will allow them flexibility when completing assignments.

The **Graduate Certificate in Medical Cannabis Science, Therapeutics, and Policy** is a two-semester, 12-credit program that provides a foundation in cannabis pharmacology and clinical science, historical context, and current policy landscape. The entirely online certificate provides a more **limited course of study** than the MS degree program.

MCST Program Link



MS in Medical Cannabis Science and Therapeutics



We now have **~700 alumni** of the program, ranging from ages 21-72, representing all 50 states and over 20 countries, from a variety of different educational backgrounds