

DRUGS ACTING ON THE CENTRAL NERVOUS SYSTEM (21)

Subcommittee:

<u>NAME</u>	<u>SCHOOL</u>
Richard M. Eisenberg	University of Minnesota Duluth reisenbe@mail.d.umn.edu
Paul Carvey	Rush
George Condouris	New Jersey Medical School
Brian Cox	Uniformed Services University
Adrian Dunn	LSU in Shreveport
S. J. Enna	University Kansas
Carl Faingold	Southern Illinois University, Springfield
Joseph Goldfarb	Mount Sinai School of Medicine
Israel Hanin	Loyola University Chicago
Billy Martin	MCV
Gary C. Rosenfeld	University of Texas Medical School at Houston
Lynn Wecker	University South Florida

1. Neurotransmitters, receptors and neurochemistry (1.5)
2. General anesthetics (2)
3. Local anesthetics (1)
4. Opioid analgesics, agonist-antagonists, antitussives & expectorants, other pain-relieving agents (3)
5. Drugs used in treatment of motor disorders (1)
6. Antiepileptics (1)
7. Antidepressants and mood stabilizing drugs (2)
8. Antipsychotics (Neuroleptics) (2)
9. Sedative-Hypnotics, anxiolytics, and centrally acting muscle relaxants (3 hr)
10. Substance Abuse (4.5)
 - a. Drug dependence(0.5)
 - b. Stimulants and anorexigenic agents (0.5)
 - c. Ethanol and alcoholism (1.0)
 - d. Hallucinogens and designer drugs(0.3)
 - e. Marijuana (0.3)
 - f. Organic solvents, inhalants (0.3)
 - g. Opioids, sedative-hypnotics, anxiolytics(1)
 - h. Drugs and the law(0.5)
11. Treatment of Alzheimer's Disease (.25)

Introduction to Pharmacology of the Central Nervous System

Understanding how drugs affect the central nervous system depends upon an integral knowledge of neuroanatomy, biochemistry, physiology, and basic pharmacological principles. A core medical curriculum in pharmacology of the central nervous system requires at least 25 hours.

1. **Neurotransmitters, Neuromodulators, and Receptors**

- a. List the major neurotransmitters in the brain, their predominant anatomical pathways, and their associated relevant disorders.
- b. Compare and contrast G protein coupled receptors and ligand gated ion channels.
- c. Describe how neurotransmitter receptor function may be altered as a consequence of chronic agonist or antagonist administration.
- d. Identify the molecular, cellular, and biochemical sites where drugs can act to affect neuronal function.
- e. List the factors that determine whether a drug will gain access to the central nervous system.

- 1) Endogenous Agents
 - ACETYLCHOLINE (ACH)
 - ADENOSINE TRIPHOSPHATE (ATP)
 - aspartate (Asp)
 - beta-amyloid
 - beta-endorphin
 - bradykinin
 - DOPAMINE (DA)
 - epinephrine
 - dynorphins
 - endomorphins
 - enkephalins
 - 5-HYDROXYTRYPTAMINE (5-HT)
 - GAMMA-AMINOBUTYRIC ACID (GABA)
 - GLUTAMATE (glu)
 - glycine
 - histamine
 - leptin
 - nerve growth factor (and other growth factors)
 - NOREPINEPHRINE
 - nitric oxide
 - SUBSTANCE P

2. General Anesthetics (2)

- a. Define the terms “general anesthesia”, “neuroleptic analgesia”, and “dissociative anesthesia.”
- b. State the objectives of general anesthesia, characteristics of an ideal anesthetic, and the stages of general anesthesia.
- c. Explain how the solubility of a gas in a liquid is defined. List the conditions that must be specified to determine the concentration of gas in the liquid phase.
- d. Define MAC (minimal alveolar concentration), name the physical property of an inhalation anesthetic that correlates best with its MAC, and explain how the concept of MAC is used in anesthesiology
- e. Describe how the physical properties of inhalation anesthetics influence the rate of equilibration of anesthetic in the inspired air to anesthetic in alveoli, blood, brain, muscle and fat. Explain how this information is related to onset and recovery from inhalation anesthesia.
- f. Define “second gas effect” and explain why it occurs.
- g. List and explain the complications that may ensue with the use of Nitrous Oxide as a direct result of the high concentrations at which it is administered and its solubility in blood relative to that of nitrogen.
- h. List the current theories of the mechanisms of action of inhalation anesthetics, of intravenous anesthetics.
- i. Compare the available inhalation anesthetics with respect to their pharmacokinetic properties, effects on various organ systems, biotransformation, and disadvantages and advantages.
- j. Compare and contrast commonly used intravenous induction agents—their adverse effect profile, speed of onset, and duration of action. Describe the relative roles of distribution and metabolism in determining duration of action and how duration of action may change with repeated administration of an iv anesthetic.
- k. List clinical conditions that make general anesthesia hazardous and alternative means for preparing patients for surgery.

- l. Describe malignant hyperthermia, list some common triggering agents, and discuss its prevention and treatment.
- m. Describe the utility and adverse effects of drugs commonly used as preanesthetic medications or as adjuncts to anesthesia. Include: atropinics, neuromuscular blocking agents, benzodiazepines, and opioids in your discussion. Indicate how the concomitant use of these drugs may affect the concentrations of inhaled anesthetics used to maintain the anesthetic state.

Drugs to Consider:

alfentanil
desflurane
enflurane
etomidate
FENTANYL
HALOTHANE
ISOFLURANE
KETAMINE
methohexital
methoxyflurane
MIDAZOLAM
MORPHINE
NITROUS OXIDE (N₂O)
PROPOFOL
SEVOFLURANE
sufentanil
THIOPENTAL

3. Local Anesthetics (1)

- a. Discuss the mechanism of action of local anesthetics. Explain how the actions of clinically used anesthetics might be influenced by the frequency of impulse transmission in peripheral nerves, pH, and by the vascularity of the injected area.
- b. List the factors that influence the sensitivity of different classes of nerve fibers to local anesthetics. Explain how this relates to the order in which function is lost upon application of local anesthetic to a peripheral nerve.
- c. List the significant differences between amide and ester-type local anesthetics.

- d. List the common adverse effects of local anesthetics and indicate appropriate treatments should they occur.
- e. Describe the common routes of administration of local anesthetics. List anesthetics that cannot be used topically, that cannot be used for infiltration. Explain why these routes are not effective.
- f. Describe methods used to restrict local anesthetics to a desired site of action and indicate how these methods reduce adverse effects.
- g. Discuss epidural and intrathecal administration of selected opioids and local anesthetics

Drugs to Consider:

BENZOCAINE
 BUPIVACAINE
 cocaine
 LIDOCAINE
 prilocaine
 PROCAINE
 ROPIVACAINE
 tetracaine

4. Opioid Analgesics, Agonist-antagonists, and Antitussives (3.0)

- a. Opioid Analgesics and Antagonists(2.0)
 - 1) Present the clinical indications for the opioids and opioid antagonists and explain the basis for their use.
 - 2) Describe the pharmacologic responses associated with the stimulation of the Mu-, Kappa-, and Delta-opioid receptor subtypes. Correlate with the pharmacological characteristics of the various endogenous opioid agonists (endorphins, dynorphins, enkephalins, endomorphins).
 - 3) Describe the distribution of opioid receptors in relation to the types of pain and—pain perception, and how morphine interferes with these processes.
 - 4) List and explain the advantages and disadvantages of using mixed opioid agonists/antagonists.
 - 5) Describe the pharmacological effects and sites of action of the prototype opioid agonist, morphine, and its utility in relieving different types of pain. In the description of morphine's pharmacology include its actions and major adverse actions on the following systems: CNS, Cardiovascular, G.I.-biliary, respiratory, genitourinary.

- 6) Describe the pharmacokinetic processes affecting morphine, absorption, distribution, metabolism, excretion and how these are relevant to its therapeutic use. Describe the distribution of opioids in the body, including their ability to cross the blood-brain barrier and the placenta.
- 7) Discuss the salient differences in pharmacology between morphine and each of the following full agonists: meperidine, fentanyl, methadone. List other opioid agonists that are metabolized to morphine and indicate the salient differences in their pharmacology from that of morphine.
- 8) List and explain the major drug interactions of morphine.
- 9) Contrast the analgesic effects of morphine with those of the nonsteroidal antiinflammatory drugs, with those of antidepressants, and with those of carbamazepine. Discuss the rationale for using mixtures of opioid analgesics and NSAIDS
- 10) Explain how agonist-antagonists and partial agonists differ in their utility and adverse effect profile when compared to morphine. Contrast the pharmacology of pentazocine with morphine. Describe why TALWIN-NX is useful in reducing the abuse of pentazocine.
- 11) List the contraindications for morphine and its surrogates.
- 12) Describe the characteristics of opioid tolerance and dependence. Describe the opioid abstinence syndrome and how it differs from that for sedative-hypnotics.
- 13) Discuss abuse liability for opioids and how it differs among the various drugs.
- 14) Describe the symptoms of morphine and heroin overdose and how they are managed.
- 15) Discuss the salient differences between naloxone and naltrexone and how these are reflected in clinical use of these drugs.
- 16) Define precipitated abstinence and indicate under what circumstances it might occur following the clinical use of opioid analgesics or antagonists.
- 17) Explain the rationale for using methadone to treat heroin abusers. List the aspects of methadone's pharmacokinetics and pharmacodynamics that make it useful for this purpose.

Drugs to Consider:

- a) Agonists
CODEINE
diphenoxylate
fentanyl
heroin
HYDROCODONE

l-alpha-acetyl-methadol
levomethadyl acetate
loperamide
MEPERIDINE
METHADONE
MORPHINE
OXYCODONE
d-propoxyphene
combinations - opioids plus acetaminophen and ASA
TRAMADOL

b) Agonist/Antagonists and Antagonists

BUPRENORPHINE
butorphanol
nalbuphine
nalorphine
NALOXONE
NALTREXONE
nalmefene
pentazocine

b. Antitussives, Expectorants and Mucolytics (0.5)

Describe the cough reflex and the sites of action of antitussive drugs, expectorants and mucolytic agents.

Discuss the mechanism of action of antitussive drugs.

Drugs to Consider:

CODEINE
DEXTROMETHORPHAN
HYDROCODONE

5. Drugs Used in the Treatment of Motor Disorders (1)

- a. Describe the major anatomical pathways and neurotransmitter systems involved in control of motor function.
- b. Understand how the "Balance Hypothesis of Striatal Function" predicts management and side effects of all extra-pyramidal movement disorders.
- c. Discuss current hypotheses about the etiology and pathophysiology of Parkinson's disease.
- d. Describe the rationale for the use of levodopa in Parkinson's disease and the rationale for its use in combination with

peripheral L-amino acid decarboxylase inhibitor. Discuss how the drug combination alters levodopa's therapeutic and adverse effect profiles.

- e. Differentiate the two major classes of direct DA receptor agonists, and indicate how they are used therapeutically and any significant differences in their adverse effects.
- f. Discuss the use of other classes of drugs in treating Parkinson's disease: anticholinergics, MAO inhibitors, COMT inhibitors, amantadine.
- g. Discuss drugs that can induce Parkinson's disease and specific treatments.
- h. Describe Huntington's Chorea and discuss drugs available for its treatment and their effectiveness.
- i. Discuss the pathophysiological basis of spasticity and muscle spasm.
- j. List drugs useful for treatment of spasticity and compare and contrast the mechanisms of action and adverse effects of benzodiazepines, baclofen and dantrolene when used for this purpose.
- k. Describe how the therapeutic utility of cyclobenzaprine for treatment of muscle spasm differs from that of baclofen and benzodiazepines.

Drugs to Consider:

AMANTADINE
BACLOFEN
BENZODIAZEPINES
BENZTROPINE
BROMOCRIPTINE
CARBIDOPA
cyclobenzaprine
DANTROLENE
DOPAMINE
ENTACAPONE
haloperidol
L-DOPA
pergolide
PRAMIPREXOLE
ropinerole

SELEGILINE (deprenyl)
trihexyphenidyl

6. Antiepileptics (1 hr)

- a. Describe the pathophysiology of seizures, and the types and incidence of epilepsy.
- b. Discuss each of the following with respect to their possible relevance to the initiation and spread of seizure activity: mirror foci, kindling, post-tetanic potentiation, long-term potentiation, paroxysmal depolarizing shift.
- c. List the major classes of antiepileptic drugs, the seizure types against which they are effective, their cellular mechanisms of action, and how these actions might be relevant to their roles as antiepileptic agents.
- d. Describe the pharmacokinetic factors relevant to appropriate therapy with antiepileptic drugs. Explain why the clearance of phenytoin changes with dose. Discuss the rationale for the common practice of monitoring plasma concentrations of many antiepileptic drugs
- e. List the antiepileptic medications that induce of hepatic enzymes and describe the consequences for treatment of epilepsy and for interactions with drugs used for other conditions.
- f. List and describe the adverse and teratogenic effects of the major antiepileptic drugs.
- g. Define status epilepticus and explain how it is managed pharmacologically.
- h. Discuss the therapeutic use of antiepileptic drugs for conditions other than epilepsy, including their use as analgesics and as mood stabilizers.

Drugs to Consider:

acetazolamide
CARBAMAZEPINE
clonazepam
DIAZEPAM
ETHOSUXIMIDE
felbamate
GABAPENTIN

Lamotrigine
LORAZEPAM
PHENOBARBITAL
PHENYTOIN
primidone
TIAGABINE
topiramate
VALPROIC ACID
vigabatrin

7. Drugs Used In Affective Disorders (1 hr)

- a. Describe the concept of affect, the current neurochemical theories regarding affect and how it can be altered by drugs.
- b. Define depression and list its symptoms, signs and causes. Define bipolar disorder and its subtypes, and describe its signs and symptoms and its natural history. Describe manic disorder.
- c. List the major classes of antidepressant drugs and their primary cellular targets. (Tricyclic ADs, SSRIs, SNRIs, atypical antidepressants, and MAO inhibitors)
- d. Explain and contrast the time course for the neurochemical mechanisms and therapeutic action of the different classes of antidepressant drugs. Discuss the importance of active metabolite formation.
- e. Describe and compare the most common adverse effects of the major classes of antidepressants, and where known, explain the mechanism for these effects. Identify significant drug and dietary interactions.
- f. Describe the signs and symptoms of overdose with each of the major classes of antidepressants and the appropriate treatment (tricyclic antidepressant toxicity, serotonin syndrome, tyramine effect).
- g. Discuss the utility of the various classes of antidepressants for other indications: Obsessive compulsive disorder, neuropathic pain, smoking cessation, enuresis.
- h. Discuss the use of herbal antidepressants, such as St. John's wort.

- i. List drugs useful for treating mania and describe the major theories explaining their presumed mechanisms of action (lithium, antiepileptics, antipsychotics). Describe the effects of lithium on CNS neurotransmitter systems. Distinguish between acute control of a manic episode and prevention of cycling.
- j. Discuss the pharmacokinetics of lithium and its relationship to the following: alteration in dietary sodium, effects of exercise, use of diuretics, monitoring of plasma lithium levels, and treatment of lithium overdose.
- k. Differentiate adverse side effects of lithium from signs and symptoms of lithium overdose. Explain why there is a contraindication to the use of lithium in patients with impaired renal function or cardiovascular disease.
- l. Discuss the use of antiepileptic drugs for treatment of bipolar disorder, their efficacies and toxicities relative to that of lithium.

Drugs to Consider:

- 1) Antidepressants
 AMITRIPTYLINE
 BUPROPION
 citalopram
 clomipramine
 desipramine
 FLUOXETINE
 fluvoxamine
 IMIPRAMINE
 NORTRIPTYLINE
 PAROXETINE
 phenelzine
 SERTRALINE
 TRAZODONE
 TRANYLCPROMINE
 VENLAFAXINE
- 2) Antimanic drugs
 CARBAMAZEPINE
 LITHIUM CARBONATE
 VALPROIC ACID

8. Antipsychotics (neuroleptics) (2 hrs)

- a. Describe schizophrenia and discuss the theories regarding the underlying neurochemical basis.

- b. Discuss the current theories regarding the therapeutic mechanism of action of antipsychotic drugs. Include in this discussion acute and chronic effects of these drugs on major dopaminergic systems in the CNS. Distinguish the properties, relative efficacies and side effects of the major classes of classical (or typical antipsychotic drugs, the low potency and the high potency.
- c. Describe the time course and symptoms of antipsychotic drug-induced acute dystonia, akathisia, Parkinson's syndrome, tardive dyskinesia, and neuroleptic malignant syndrome. Discuss the management of these conditions. Where known, discuss the receptors/pathways mediating the drug effects.
- d. Explain how atypical antipsychotics differ from classical antipsychotics in their cellular actions, efficacies and side-effect profiles. Contrast the mechanisms of action of phenothiazines and haloperidol with clozapine, risperidone, and olanzapine. Describe the implications for the theories of the mechanism of antipsychotic action.
- e. Discuss the hypersensitivity reactions to antipsychotic drugs including those affecting liver, blood and skin.
- f. List nonpsychiatric uses of phenothiazines and butyrophenones.
- g. Discuss the use of dopamine antagonists in Tourette's Syndrome.

Drugs to Consider:

CHLORPROMAZINE (CPZ)
 CLOZAPINE
 FLUPHENAZINE
 HALOPERIDOL
 OLANZAPINE
 quetiapine
 RISPERIDONE
 sertindole
 thioridazine
 thiothixene
 ziprasidone

9. Sedative-Hypnotics, Anxiolytics, and Centrally Acting Muscle Relaxants (3 hr)

- a. Sedative-Hypnotics

- 1) Briefly describe the concepts of sedation, hypnosis, anesthesia, and coma. List and describe the stages of sleep.
- 2) Briefly discuss benzodiazepine action, and the action of non-benzodiazepines acting at the benzodiazepine site, as they pertain to the induction of sleep; explain the mechanism of action; and describe the primary side effects (an expanded discussion of benzodiazepine is included in the section on antianxiety agents).

b. Barbiturates

- 1) Discuss the relationship between the chemical structure of barbiturates and their pharmacokinetics (absorption, distribution, biotransformation, elimination).
- 2) Describe the actions of the barbiturates on the CNS, (including tolerance), respiration, cardiovascular system, kidney, and liver.
- 3) Discuss the consequences of barbiturate and benzodiazepine induction of enzymes, specifically on aminolevulinic acid synthetase (porphyria) and on vitamin D metabolism (osteomalacia). Explain the significance of redistribution vs. metabolism on duration of action.
- 4) List the therapeutic uses of barbiturates, and indicate a prototype for each use; discuss adverse reactions.
- 5) Describe the interactions of barbiturates with other CNS agents and their effects on the metabolism of other drugs. Indicate the effects of combining barbiturates with alcohol and other CNS depressants on CNS function.
- 6) Describe the effects of ionization and lipid solubility on tissue distribution and duration of action of barbiturates. Describe the effects of altering urinary pH on the rate of barbiturate elimination.
- 7) Describe acute barbiturate intoxication and its treatment.
- 8) Discuss tolerance development and physical dependence to barbiturates. Describe the symptoms of barbiturate withdrawal and treatment in a barbiturate dependent subject.

c. Non-barbiturate, non benzodiazepine sedatives and hypnotics

- 1) Discuss the use of non-barbiturate, non-benzodiazepine sedative/hypnotics (chloral hydrate, hydroxyzine) and compare therapeutic application and side effects to benzodiazepines and barbiturates.

Drugs to Consider:

alprazolam
chloral hydrate
diphenhydramine
FLUMAZENIL
FLURAZEPAM
hydroxyzine
lorazepam
oxazepam
phenobarbital
TEMAZEPAM
TRIAZOLAM
zaleplon
ZOLPIDEM

d. Drugs use in the treatment of anxiety disorders

- 1) Present the general pharmacology of benzodiazepines and buspirone (other categories of agents, i.e. antidepressants are referenced but their complete pharmacology is presented in another sections).
- 2) Define anxiety, its relationship to the amygdala, and differentiate the major anxiety disorders.
- 3) Discuss drugs other than the benzodiazepines and buspirone that are used for treating various anxiety disorders: generalized anxiety, panic disorder, obsessive compulsive disorder, specific phobias
- 4) Discuss the relationship between benzodiazepines and the GABA_A receptor. Describe how benzodiazepine action differs from that of drugs acting at the GABA recognition site. Define inverse agonism at the benzodiazepine receptor.
- 5) List the therapeutic uses of benzodiazepines, and how the pharmacokinetics of the various benzodiazepines is related to their particular therapeutic uses (short, intermediate, and long-acting active metabolites).
- 6) Compare the dependence liability, toxicity, side effects, and therapeutic actions of benzodiazepines the barbiturates and hypnotics.
- 7) Describe the effects of benzodiazepines on sleep architecture and anterograde amnesia.
- 8) Describe the interactions of the benzodiazepines with other CNS depressants.
- 9) Describe the mechanism of action of flumazenil and its uses.
- 10) Describe the pharmacology of buspirone and compare it to the pharmacology of diazepam.

e. Centrally-acting skeletal muscle relaxants

- 1) Discuss the pathophysiological basis of rigidity, spasticity, muscle spasm (if not previously discussed under motor dysfunction) and the assorted agents that are used to promote skeletal muscle relaxation.

Drugs to Consider:

ALPRAZOLAM

chlorazepate

chlordiazepoxide

DIAZEPAM

FLUMAZENIL (antagonist)

LORAZEPAM

OXAZEPAM

- 2) Non-benzodiazepine
BUSPIRONE

10. Substance Abuse (4.5)

a. Drug dependence (.5)

- 1) Define and describe physical dependence and tolerance on drugs. Discuss drug craving and positive conditioning as an issue in maintaining substance dependence.
- 2) Discuss the economic - social issues of drug dependence.
- 3) Describe the personality characteristics of an individual susceptible to substance abuse. Discuss the role of the nucleus accumbens in reward gratification and dependence liability.
- 4) Describe the clinical characteristics of drug dependence, and understand the concept of 'gateway' drugs.
- 5) Describe the withdrawal and detoxification techniques for different drugs of abuse.
- 6) Review the mortality and morbidity of dependence to various drugs.
- 7) Compare dependence on and associated abstinence signs of opioids, CNS depressants, stimulants and other drugs subject to abuse

b. Psychostimulants (cocaine, amphetamine, methylphenidate) and anorexigenic agents

- 1) Discuss the major groups of psychostimulant drugs, and discuss current theories of their mechanisms of action.

- 2) Discuss the therapeutic uses of central and psychostimulants as appetite suppressants, in attention deficit hyperactivity disorder, and in narcolepsy.
- 3) Discuss the current theories of substance dependence on stimulant drugs and the influence of pharmacokinetics on dependence liability.
- 4) Describe the adverse effects of stimulants on the CNS and on other organ systems.
- 5) Discuss the role of adenosine receptor antagonism in the action of caffeine.
- 6) Discuss the effects of caffeine's actions as a phosphodiesterase inhibitor on its CNS and peripheral nervous system effects.
- 7) Describe the major differences in mechanisms between the psychostimulants and anorexigenic agents.

Drugs to Consider:

AMPHETAMINE

CAFFEINE

COCAINE

ephedrine

METHAMPHETAMINE

METHYLPHENIDATE

phentermine

sibutramine

c. Ethanol - alcoholism (1 hr).

- 1) Summarize the therapeutic applications of ethanol.
- 2) Describe the acute CNS actions of ethanol and discuss their relationship to blood alcohol levels.
- 3) Discuss current theories about the mechanism of action of alcohol in the CNS
- 4) Describe the pharmacokinetics of ethanol, its absorption, distribution, metabolism and excretion.
- 5) Describe the acute and chronic organ toxicities of ethanol.
- 6) List drugs with which ethanol shows cross-tolerance and cross-dependence.
- 7) List drugs, both prescription and over the counter, that would entail a patient refraining from the use of alcoholic beverages. Explain the nature of the potential interactions.
- 8) List the signs and symptoms of the ethanol abstinence syndrome. Compare and contrast these with abstinence syndromes following barbiturates, benzodiazepines, and opioids.

- 9) Discuss the treatment options for acute ethanol intoxication, and for the ethanol abstinence syndrome.
- 10) Discuss the use of disulfiram and naltrexone in the treatment of chronic alcoholics. Describe their effects and the mechanistic rationale for their use.
- 11) Summarize the therapeutic applications of ethanol.
- 12) Discuss the mechanism for the synergism between chloral hydrate and ethanol.
- 13) Discuss the management of methanol toxicity.

Drugs to Consider:

DISULFIRAM

ETHANOL

METHANOL

naltrexone

d. Hallucinogens and Designer Drugs (0.3)

- 1) List the major classes of hallucinogens and describe their mechanisms of action.
- 2) Describe salient differences among the behavioral and hallucinogenic effects of the various drugs and compare and contrast drug-induced states with endogenous psychoses. Describe the cognitive, somatic, and sensory effects of the hallucinogens.
- 3) What are the three chemical classes of hallucinogens?
- 4) Discuss the variability in inter-individual responses to hallucinogens and the interaction between the social setting in which hallucinogens are taken and their behavioral effects.
- 5) Discuss tolerance to and cross-tolerance among the various hallucinogens.
- 6) Describe how the pharmacokinetics of different drugs may influence their duration of action and their detection by screening tests for illicit drug use.
- 7) Describe general principles of treatment for anxious/agitated patients with known ingestion of hallucinogens
- 8) Describe how the effects of the anticholinergics differ from those of the hallucinogens.
- 9) What are the common side effects of the anticholinergics?
- 10) Know what a designer drug is and how it differs from a hallucinogen
- 11) Discuss the differences and similarities among anticholinergic, hallucinogen, and designer drug overdose.
- 12) Discuss the social use and abuse of hallucinogens.
- 13) Discuss legislative control of designer drugs.

- 14) What are the effects of ketamine and PCP on the NMDA receptor/sigma receptor

Drugs to Consider:

atropine, scopolamine

KETAMINE

LYSERGIC ACID DIETHYLAMIDE (LSD)

MDMA (methylene dioxy-methyl amphetamine)

MESCALINE

PHENCYCLIDINE (PCP)

e. Marijuana

- 1) Discuss cannabinoid receptors and their proposed effects in brain
- 2) Understand the role of genetic source and growing environment in THC content
- 3) Understand the difference in THC content among marijuana, hashish, and 2nd hash oil
- 4) What are the proposed health benefits of marijuana? What are THC's health consequences?

Drugs to Consider:

donabinol

MARIJUANA/THC

f. Organic solvents, inhalants (gasoline, glue, fire extinguisher accelerants, nitrous oxide, toluene, carbon tetrachloride, fluorochemicals)

- 1) Describe the relationship between abuse of these drugs, hypoxic effects, and the ability to uncouple oxidative phosphorylation of these drugs.
- 2) Describe the toxicities of these agents according to their particular type.

g. Discuss opioids, sedative-hypnotics, and anti-anxiety agents with respect to their substance abuse aspects.

Drugs to Consider:

HEROIN/other opioids

MARIJUANA/THC

Organic solvents

NICOTINE

pentobarbital

h. Drugs and the law (0.5 hr).

- 1) Define the characteristics of drugs in each of the Drug Enforcement Administration classification of controlled substances into Schedules I, II, III, and IV, and give examples of some specific drugs that are included in each schedule. Discuss the ways in which this classification affects the clinical use of drugs.

11. Treatment of Alzheimer's Disease

- a. Discuss the drugs used for the treatment of Alzheimer's disease, their presumed mechanisms of action, their efficacy and their adverse effects.

Drugs to Consider:

DONEPEZIL

GALANTAMINE

RIVASTIGMINE

tacrine