

TROPANE ALKALOIDS MULTIPLE CHOICE EXAM

Comprehensive & Accurate Assessment for Medicinal Chemistry / Pharmacognosy

Subject: Pharmacognosy & Phytochemistry

Topic: Tropane Alkaloids

Total Questions: 15 MCQs

Target Level: Advanced Pharmacy

Question 1

Which non-protein amino acid serves as the primary precursor providing the C_4N building block for the biosynthesis of the tropane ring system?

A) L-Phenylalanine

B) L-Ornithine

C) L-Lysine

D) L-Tyrosine

Question 2

Tropane is a bicyclic system composed of two fused nitrogen-containing rings. Which two heterocycles share a common nitrogen atom and carbon bridgehead positions 1 and 5?

A) Pyrrole and Pyridine

B) Pyrrolidine and Piperidine

C) Indole and Piperidine

D) Imidazole and Pyrrolidine

Question 3

What is the stereochemical configuration of the hydroxyl group in Tropine (tropan-3 α -ol) compared to Pseudotropine (tropan-3 β -ol)?

- A) Tropine has an *exo* (side) hydroxyl, while Pseudotropine has an *endo* (down) hydroxyl.
- B) Tropine has an *endo* (down) hydroxyl, while Pseudotropine has an *exo* (side) hydroxyl.
- C) Both isomers have an *endo* configuration but differ in optical rotation.
- D) Tropine contains an epoxide ring at position 3, whereas Pseudotropine does not.

Question 4

In Atropine, which portion of the ester molecule contains the asymmetric (chiral) carbon atom responsible for its optical activity?

- A) The alcohol moiety (Tropine)
- B) The acid moiety (Tropic acid)
- C) Both the Tropine alcohol and Tropic acid moieties
- D) Neither, as Atropine is completely achiral in all forms

Question 5

Atropine is clinically described as a racemic mixture. Which naturally occurring, optically active enantiomer undergoes racemization to form Atropine?

- A) (+)-Hyoscyamine
- B) (–)-Hyoscyamine (L-Hyoscyamine)
- C) (–)-Cocaine
- D) (–)-Scopolamine

Question 6

Unlike Hyoscyamine (where optical activity resides in the acid portion), the optical activity of Cocaine is due to a chiral center located in which part of the molecule?

- A) Benzoic acid moiety
- B) Ecgonine (alcohol moiety)
- C) Tropic acid moiety
- D) Cinnamic acid derivative

Question 7

Which structural feature distinguishes Scopolamine (Hyoscine) from Atropine?

- A) Presence of a mandelic acid group instead of tropic acid
- B) An epoxide (oxirane) bridge between C-6 and C-7 in the alcohol moiety
- C) Demethylation of the bridgehead nitrogen atom
- D) Replacement of the benzene ring with a pyridine ring

Question 8

What is the major Central Nervous System (CNS) effect of Scopolamine compared to Atropine at therapeutic doses?

- A) Scopolamine acts as a CNS stimulant, whereas Atropine is a strong CNS depressant.
- B) Scopolamine acts as a CNS depressant (causing sedation/amnesia), whereas Atropine acts primarily as a CNS stimulant.
- C) Both drugs produce identical CNS stimulation without sedation.
- D) Neither drug can cross the blood-brain barrier.

Question 9

To prevent dry mouth when using Scopolamine for motion sickness, how is it typically administered?

- A) As an intravenous bolus injection
- B) Via a transdermal impregnated patch worn behind the ear
- C) As a high-dose oral syrup
- D) Inhaled via a dry powder inhaler

Question 10

Which botanical source belongs to the family **Erythroxylaceae** rather than Solanaceae?

- A) *Atropa belladonna*
- B) *Datura stramonium*
- C) *Erythroxylum coca*
- D) *Hyoscyamus muticus*

Question 11

Dehydration of Tropic acid leads to the formation of Atropic acid. When Atropic acid undergoes dimerization, which product is obtained?

- A) Isotropic acid (a dicarboxylic acid)
- B) Benzoic acid
- C) Mandelic acid
- D) Cinnamic acid

Question 12

What mechanism underlies Cocaine's potent CNS stimulation and addictive euphoria?

- A) Direct stimulation of postsynaptic muscarinic M1 receptors
- B) Inhibition of dopamine reuptake, causing excess dopamine accumulation in the synaptic cleft
- C) Rapid breakdown of acetylcholinesterase in peripheral nerves
- D) Blockade of GABA receptors leading to immediate sedation

Question 13

Which semi-synthetic quaternary ammonium tropane derivative is formulated as an inhalation spray for the treatment of Chronic Obstructive Pulmonary Disease (COPD) and asthma?

- A) Homatropine
- B) Ipratropium bromide / Tiotropium bromide
- C) Scopolamine butylbromide
- D) Benzocaine

Question 14

Why are certain animals, such as rabbits, able to ingest *Atropa belladonna* without suffering fatal toxicity?

- A) They lack muscarinic acetylcholine receptors entirely.
- B) They possess specific enzymes (e.g., atropine esterase) that rapidly metabolize and deactivate the tropane alkaloids.
- C) Tropane alkaloids cannot be absorbed through the rabbit gastrointestinal tract.
- D) Their blood-brain barrier is completely impermeable to hydrophobic molecules.

Question 15

In the illegal extraction of cocaine from crushed coca leaves, why is the final paste basified (forming "crack") or converted into a free base?

- A) To make the compound highly water-soluble for oral absorption
- B) To increase the volatility of the alkaloid for inhalation/sniffing
- C) To destroy the ecgonine backbone and eliminate side effects
- D) To prevent dopamine uptake in the brain

Answer Key & Comprehensive Explanations

Verification and Detailed Review

Q#	CORRECT ANSWER	DETAILED EXPLANATION
1	B) L-Ornithine	L-Ornithine is a non-protein amino acid possessing two amino groups (α and δ). Deamination of the α -amino group provides the C_4N precursor essential for pyrrolidine/tropane ring biosynthesis.
2	B) Pyrrolidine & Piperidine	Tropane is a bicyclic amine consisting of a 5-membered pyrrolidine ring and a 6-membered piperidine ring sharing a common nitrogen atom and bridgehead carbons 1 and 5.
3	B) Tropine: endo / Pseudotropine: exo	Tropan-3 α -ol (Tropine) has the 3-OH group pointing <i>endo</i> (down), which is the preferred moiety in Solanaceae alkaloids. Pseudotropine (tropan-3 β -ol) has the 3-OH group pointing <i>exo</i> (side).
4	B) Acid moiety (Tropic acid)	Tropine (alcohol) is optically inactive because it is symmetrical. Optical activity in Atropine/Hyoscyamine originates from the asymmetric carbon in Tropic acid adjacent to the aromatic ring.
5	B) (-)-Hyoscyamine	In nature, L-hyoscyamine [(-)-hyoscyamine] is produced. During extraction and processing, it readily racemizes into ($\pm$)-hyoscyamine, which is known as Atropine.
6	B) Ecgonine (alcohol moiety)	In Cocaine, the optical activity stems from the alcohol part (Ecgonine), which contains chiral centers, while its acid part (Benzoic acid) is optically inactive. This is the reverse of Hyoscyamine.
7	B) Epoxide bridge at C6-C7	Scopolamine (Hyoscine) contains an epoxide (oxirane) ring spanning carbons 6 and 7 of the tropane alcohol nucleus (Scopine).
8	B) Scopolamine: CNS depressant / Atropine: CNS stimulant	Scopolamine produces CNS depression (sedation, drowsiness, amnesia), whereas Atropine acts as a CNS stimulant at therapeutic doses.
9	B) Transdermal patch behind the ear	Transdermal delivery provides smooth systemic absorption for motion sickness while bypassing severe oral side effects such as dry mouth (xerostomia).
10	C) Erythroxylum coca	Coca leaves come from <i>Erythroxylum coca</i> (Erythroxylaceae), whereas Belladonna, Stramonium, and Henbane belong to Solanaceae.
11	A) Isotropic acid	Dehydration of Tropic acid ($-H_2O$) yields Atropic acid, which upon dimerization yields Isotropic acid (a dicarboxylic acid found in Belladonine).
12		Cocaine blocks dopamine transporters, preventing recycling back into presynaptic neurons. The accumulation of synaptic dopamine overstimulates pleasure circuits.

Q#	CORRECT ANSWER	DETAILED EXPLANATION
	B) Inhibition of dopamine reuptake	
13	B) Ipratropium / Tiotropium bromide	Ipratropium and Tiotropium are quaternary tropane derivatives used as inhaled bronchodilators in COPD and asthma, minimizing systemic anticholinergic effects.
14	B) Atropine esterase enzymatic breakdown	Rabbits and certain birds possess high levels of atropine esterase, which rapidly hydrolyzes the alkaloid into inactive components, rendering them far less susceptible to toxicity.
15	B) To increase volatility for inhalation	Converting cocaine salt to its uncharged free base ("crack") lowers its boiling point and increases volatility, making it suitable for smoking/inhalation and rapid mucosal absorption.