**SECTION A.** Answer each question in this section by writing the letter corresponding to the best answer on the line provided (2 points each; 60 points total)

1. **The drug illustrated below:**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl</td>
<td>H</td>
<td>N</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>C-N-</td>
<td>CH2C-O-</td>
<td>CO2CH2CH3</td>
</tr>
<tr>
<td>II</td>
<td>III</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I. Cannot pass into the CNS because it is 100% ionized at all pH values  
II. Has a short half-life because of rapid hydrolysis of the ester  
III. Is a preferred analgesic during labor

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

**Answer**

2. **The drug illustrated below is:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CH3CH2CH2-</td>
<td>CH3CH2OC</td>
</tr>
<tr>
<td>H2N</td>
<td>H</td>
</tr>
<tr>
<td>C-O-</td>
<td>C-O-</td>
</tr>
<tr>
<td>H</td>
<td>CH2CH2N-</td>
</tr>
<tr>
<td>Cl</td>
<td>Cl</td>
</tr>
</tbody>
</table>

I. Is a topical anesthetic available over the counter in lozenge form for treating sore throats  
II. Is a salicylate NSAID  
III. Is used for corneal anesthesia during cataract surgery

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

**Answer**

3. **The drug illustrated below:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CH3CH2OC</td>
<td>H</td>
</tr>
<tr>
<td>CH3</td>
<td>Cl</td>
</tr>
<tr>
<td>N-CH2CH2C-C=N</td>
<td></td>
</tr>
</tbody>
</table>

I. Is given together with atropine to treat diarrhea  
II. Undergoes hydrolysis to give an acid that retains antidiarrheal activity  
III. Can cause euphoria and is potentially addicting when administered without atropine

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

**Answer**
4. **The drug illustrated below:**

   ![Chemical Structure]

   I  Is effective as an anesthetic when administered topically on skin and mucous membranes  
   II Is not water-soluble enough to be administered by injection  
   III Is acetaminophen  

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

   **Answer**  

5. **The compound illustrated below:**

   ![Chemical Structure]

   I  Is the common precursor to prostaglandins, leukotrienes, prostacyclins, and thromboxanes  
   II Is bound to cell membranes and released by phospholipase A₂  
   III Is an eicosanoid  

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

   **Answer**  

6. **The drug illustrated below:**

   ![Chemical Structure]

   I  Acetylates COX and blocks thromboxane A₂ formation  
   II Is used for treating inflammation  
   III Undergoes hydrolysis to form two molecules of salicylic acid  

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

   **Answer**  

7. **The drug illustrated below:**

   ![Chemical Structure]

   I  Is a potent μ-agonist used to treat pain  
   II Is used orally as a cough suppressant  
   III Is a long-acting μ-antagonist which is given by injection to reverse respiratory depression resulting from an opioid overdose

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

   **Answer**  

8. **The drug illustrated below:**

<table>
<thead>
<tr>
<th>CH₃CH₂CH₂</th>
<th>O</th>
<th>CH₃CH₂CH₂</th>
<th>N-S</th>
<th>CO₂H</th>
<th>CH₃CH₂CH₂</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**I** Inhibits the synthesis of uric acid  
**II** Inhibits the migration of leukocytes into an inflamed joint during an acute attack of gout  
**III** Increases the excretion of uric acid

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III  

**Answer** ______

9. **The drug illustrated below:**

<table>
<thead>
<tr>
<th>CH₂</th>
<th>N⁺</th>
<th>H⁺</th>
<th>OH⁻</th>
<th>CO₂⁻</th>
<th>CO₂⁻</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**I** Is sold over-the-counter as a cough suppressant  
**II** Is used to treat pain  
**III** Is an antagonist at μ-receptors and an agonist at κ-receptors

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III  

**Answer** ______

10. **The drug illustrated below:**

<table>
<thead>
<tr>
<th>CH₃CO₂H</th>
<th>CO₂H</th>
<th>CO₂H</th>
<th>CO₂H</th>
<th>NCH₃</th>
<th>H⁺</th>
<th>H⁺</th>
<th>H⁺</th>
<th>H⁺</th>
<th>H⁺</th>
<th>H⁺</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**I** Is highly lipophilic and readily enters the CNS  
**II** Is rapidly metabolized to salicylic acid and so is effective in treating fever  
**III** Does not readily enter the CNS because it is highly charged at physiologic pH

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III  

**Answer** ______

11. **The drug illustrated below:**

<table>
<thead>
<tr>
<th>CH₃</th>
<th>NCH₃</th>
<th>CO₂CH₃</th>
<th>CO₂CH₃</th>
<th>O</th>
<th>CO₂CH₃</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**I** Is a topical anesthetic used on mucous membranes  
**II** Has vasoconstrictive properties  
**III** Is psychologically-addicting

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III  

**Answer** ______
12. **The drug illustrated below:**

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Drug Molecule" /></td>
<td>Is used to treat diarrhea by inhibiting peristalsis</td>
<td>Is used as an anesthetic during minor surgical procedures</td>
<td>Is highly addicting</td>
</tr>
</tbody>
</table>

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III

**Answer**

13. **The drug illustrated below:**

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Drug Molecule" /></td>
<td>Is an analog of PGE	extsubscript{1}</td>
<td>Inhibits gastric acid secretion and increases bicarbonate and mucous production in the gastric mucosa</td>
<td>Is rapidly metabolized at the 16-position to a ketone</td>
</tr>
</tbody>
</table>

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III

**Answer**

14. **The drug illustrated below:**

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Drug Molecule" /></td>
<td>Is a schedule II drug with high addiction potential</td>
<td>Is a potent μ-antagonist</td>
<td>Is sold over-the-counter as a cough suppressant</td>
</tr>
</tbody>
</table>

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III

**Answer**
15. **The drug illustrated below:**

![Chemical structure](image)

I. Is used to treat inflammation, pain, and fever  
II. Selectively inhibits COX-II  
III. Has fewer GI side effects as compared to aspirin  

a) I only  

b) III only  

c) I and II only  

d) II and III only  

e) I, II, and III  

**Answer**

---

16. **The drug illustrated below:**

![Chemical structure](image)

I. Is used orally to treat moderate pain  
II. Is an agonist at κ-receptors and a weak antagonist at μ-receptors  
III. Is mixed with naloxone in the oral preparation to prevent its abuse by injection with tripelennamine  

a) I only  

b) III only  

c) I and II only  

d) II and III only  

e) I, II, and III  

**Answer**

---

17. **The drug illustrated below:**

![Chemical structure](image)

I. Inhibits COX  
II. Is used to treat arthritis  
III. Contains only one basic nitrogen  

a) I only  

b) III only  

c) I and II only  

d) II and III only  

e) I, II, and III  

**Answer**

---

18. **The drug illustrated below:**

![Chemical structure](image)

I. Undergoes rapid metabolic hydrolysis of the amide bond  
II. Is sometimes used as a cardiac depressant during cardiac surgery  
III. Can be converted into a hydrochloride salt for use as an injectible anesthetic  

a) I only  

b) III only  

c) I and II only  

d) II and III only  

e) I, II, and III  

**Answer**

---
19. **The drug illustrated below:**

<table>
<thead>
<tr>
<th>I</th>
<th>Transfers an acetyl group to COX in platelets which irreversibly inhibits COX and blocks thromboxane A&lt;sub&gt;2&lt;/sub&gt; formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Inhibits PGE&lt;sub&gt;2&lt;/sub&gt; and prostacyclin formation in the gastric mucosa leading to irritation of the stomach</td>
</tr>
<tr>
<td>III</td>
<td>Should not be used by children under 16 years of age who experience flu-like symptoms</td>
</tr>
</tbody>
</table>

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III  

**Answer**

20. **The drug illustrated below:**

<table>
<thead>
<tr>
<th>I</th>
<th>Cannot be used as an anesthetic because the nitrogen is charged</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Is a powerful analgesic agent</td>
</tr>
<tr>
<td>III</td>
<td>Is sometimes used as an anesthetic during surgery</td>
</tr>
</tbody>
</table>

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III  

**Answer**

21. **The compound illustrated below:**

<table>
<thead>
<tr>
<th>I</th>
<th>Can cause methemoglobinemia at high doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Can be used as an antidote for cyanide poisoning at high doses</td>
</tr>
<tr>
<td>III</td>
<td>Can be used to treat methemoglobinemia at low doses</td>
</tr>
</tbody>
</table>

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III  

**Answer**

22. **The drug illustrated below:**

<table>
<thead>
<tr>
<th>I</th>
<th>Is used over-the-counter to treat diarrhea</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Is a μ-antagonist</td>
</tr>
<tr>
<td>III</td>
<td>Is used for the controlled withdrawal of patients addicted to opioids</td>
</tr>
</tbody>
</table>

a) I only  
b) III only  
c) I and II only  
d) II and III only  
e) I, II, and III  

**Answer**
23. The drug illustrated below:

- **I**: Is non-acidic and does not cause stomach upset
- **II**: Is a pro-drug
- **III**: Is used to treat arthritis

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

   Answer

24. The drug illustrated below:

- **I**: Is a propiophenone derivative
- **II**: Is used for corneal anesthesia during cataract surgery
- **III**: Undergoes metabolic hydrolysis to 4-butoxybenzoic acid

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

   Answer

25. The drug illustrated below:

- **I**: Is a derivative of the amino acid cysteine
- **II**: Is used as an antidote for an overdose of acetaminophen
- **III**: Is used to reduce fever and treat inflammation

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

   Answer

26. The drug illustrated below:

- **I**: Has no known medicinal use
- **II**: Has good oral bioavailability
- **III**: Is used to treat moderate pain and cough

   a) I only  
   b) III only  
   c) I and II only  
   d) II and III only  
   e) I, II, and III

   Answer
27. The drug illustrated below:

```
O
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
H3CO
```

I Belongs to the same class of NSAIDS as ibuprofen
II Might be expected to cause gastric distress
III Belongs to the same class of NSAIDS as aspirin

a) I only
b) III only
c) I and II only
d) II and III only
e) I, II, and III

Answer

28. The compound illustrated below:

```
   O
  |   |
 N   H
  |   |
O  CH3
```

I Is a derivative of morphine
II Is highly lipophilic and readily crosses the blood-brain barrier to cause euphoria
III Is widely prescribed by dentists to treat pain after root canal procedures

a) I only
b) III only
c) I and II only
d) II and III only
e) I, II, and III

Answer

29. The drug illustrated below:

```
       CO2H
  O   |   |
H2CO
```

I Is metabolized mainly in the liver to 5-aminosalicyclic acid
II Is used for treating an upset stomach
III Is metabolized mainly in the large intestine to 5-aminosalicyclic acid

a) I only
b) III only
c) I and II only
d) II and III only
e) I, II, and III

Answer

30. The drug illustrated below:

```
H3CO
```

I Is shown as the (S)-enantiomer
II Has a long half life and can be administered every 12 hours for treating pain and inflammation
III Is shown as the (R)-enantiomer

a) I only
b) III only
c) I and II only
d) II and III only
e) I, II, and III

Answer
Section B. On the line to the right of each of the following structures write the letter corresponding to its generic name (shown at bottom of page). (10 Points).

A. Olsalazine
B. Flurbiprofen
C. Proparacaine
D. Oxycodone
E. Colchicine
F. Acetaminophen
G. Tramadol
H. Ropivacaine
I. Naloxone
J. Ibuprofen
K. Procaine
L. Oxymorphone
M. Bupivacaine
N. Codeine
O. Lidocaine
Section C. For each of the following answer the questions pertaining to the metabolism of the drugs shown in the boxes. You will be awarded 1 point for each correct metabolite and will lose 1 point for each incorrect metabolite. (10 Points).

1. On the line, write the letter(s) corresponding to all likely phase I metabolic pathways for the drug shown in the box below.

\[ \text{drug structure} \]

- A
- B
- C
- D
- E

[Diagram of metabolic pathways with lettered options A through E]
2. On the line, write the letter(s) corresponding to all likely phase I metabolic pathways for the drug shown in the box below.
3. On the line, write the letter(s) corresponding to all likely phase I metabolic pathways for the drug shown in the box below.
Section E. For each of the following systematic names, **draw the correct chemical structure, including stereochemistry** wherever indicated. Partial credit will be given but you will lose points for incorrect chemical symbols, hydrogens missing from heteroatoms, hydrogens missing from carbons labeled C, and for having too many bonds to an atom. (20 Points).

1. 2-(Diethylamino)ethyl 4-amino-3-butoxybenzoate monohydrochloride

2. Morphinan-3-ol, 17-(cyclobutylmethyl)-8-methyl-6-methylene-, (8β)-

3. Benzoic acid, 2-[[3-(trifluoromethyl)phenyl]amino]-, 2-(2-hydroxyethoxy)ethyl ester

4. Acetamide, N-[1-[2-(4-ethyl-4,5-dihydro-5-oxo-1H-tetrazol-1-yl)ethyl]-3-methyl-4-piperidinyl]-N-(2-fluorophenyl)-2-methoxy-