Opium is a highly addictive drug derived from the opium poppy flower. Opium and other opiates such as oxycontin, vicodin, and morphine are used as analgesic drugs. Another drug derived from opium is heroin. These opiates attach to natural occurring “opiate receptors” in the brain or other neurons. The brain works through neurons communicating with each other by releasing signaling chemicals called neurotransmitters. These chemicals attach to receptors on nearby neurons the way a key fits a lock. There are three major areas that are affected by opiates:

- The brainstem, which controls functions like breathing and heartbeat. Opiates may affect this part of the body by slowing breathing or reducing coughing.
- The limbic system, which controls emotions. Opiates may act on this part of the body to create feelings of pleasure or relaxation.
- The spinal cord, which sends messages from the brain to the rest of the body, and vice versa. In this part of the body, opiates work to reduce pain.

The opiate receptor was initially hard to find because it was only a tiny percentage of brain tissue. Researchers got around the problem by using radioactive naloxone, a synthetic opiate with a strong attraction to the receptor. The human brain naturally uses endorphins that bind to these receptor sites and help control and regulate body systems.

Long-term use of morphine in palliative care and management of chronic pain cannot be managed without the possible development of drug tolerance or physical dependence. Many techniques of drug treatment exist, including pharmacologically based treatments with naloxone.

Knowing that naloxone blocks the analgesic effects of opiates, researchers hypothesized that naloxone drug acts by binding tightly to brain opiate receptors without activating them. The data table at the right shows the effects of different drugs that were tested to see if they blocked naloxone binding.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Opiate</th>
<th>Lowest concentration that blocked naloxone binding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphine</td>
<td>Yes</td>
<td>$6 \times 10^{-9} \text{ M}$</td>
</tr>
<tr>
<td>Methadone</td>
<td>Yes</td>
<td>$2 \times 10^{-8} \text{ M}$</td>
</tr>
<tr>
<td>Levorphanol</td>
<td>Yes</td>
<td>$2 \times 10^{-9} \text{ M}$</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>No</td>
<td>No effect at $10^{-4} \text{ M}$</td>
</tr>
<tr>
<td>Atrophine</td>
<td>No</td>
<td>No effect at $10^{-4} \text{ M}$</td>
</tr>
<tr>
<td>Serotonin</td>
<td>No</td>
<td>No effect at $10^{-4} \text{ M}$</td>
</tr>
</tbody>
</table>
Interpret the Data:

1. Compare the concentrations of the first three drugs listed in the table above. Which concentration is the highest? How much higher is the highest from the next highest?
2. Would the bottom three drugs on the table block naloxone binding at a concentration of $10^{-5}$ M? Explain why or why not.
3. Which drugs blocked naloxone binding in this experiment?
4. What does it say about the receptors in the brain for naloxone?
5. When this experiment was repeated using tissue from mammalian intestinal muscle rather than brains, they found no naloxone binding. What does this say about mammalian muscle tissue?