Name: _____ Date: _____

# Student Exploration: Drug Dosage

**Vocabulary:** controlled release, dosage, drug, overdose, target organ

**Prior Knowledge Question** (Do this BEFORE using the Gizmo.)

Suppose you take aspirin for a headache. What happens after you swallow the pill?

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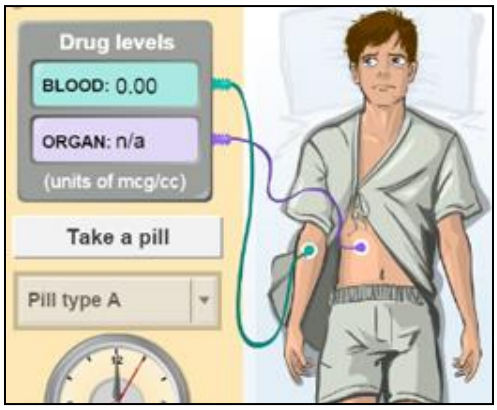
**Gizmo Warm-up**

A **drug** is a substance that causes changes in how your body functions. When you swallow a pill, the pill dissolves in your digestive system and the drug is absorbed into your bloodstream. Many drugs are designed to affect specific **target organs**.




The *Drug Dosage* Gizmo allows you to monitor the concentration of drugs in the bloodstream and target organ of a patient. To begin, check that **Pill Type A** is selected. Pill A is a general painkiller similar to aspirin. Click **Play** (▶) and press the **Take Pill** button.

1. Click **Pause** (⏸) after about 10 minutes of simulated time. In the **Drug levels** panel, observe the concentration of drug in the blood. The unit of concentration is micrograms per cubic centimeter (mcg/cc).

   Has any drug entered the bloodstream after 10 minutes? _____

2. Change the **simulation speed** to 2, and press **Play**. Click **Pause** when the **BLOOD** value starts to increase. How long does it take for the drug to reach the blood? _____

3. Click **Play**, and then click **Pause** when the patient starts to smile. Approximately what concentration of drug is needed to relieve the patient's pain? _____

| **Activity A:**<br>**Dosage** | Get the Gizmo ready:<br>• Click **Reset** ( ).<br>• Check that **Pill Type A** is selected. |  |
|---|---|---|

**Question: The dosage of a drug is the quantity of drug that is taken in a given time period. How can you determine the ideal dosage of a drug?**

1. Observe: Click **Play** and press the **Take Pill** button. Set the **simulation speed** to 20, and click **Pause** after eight simulated hours have passed. Select the GRAPH tab.

   A. What was the maximum blood concentration of the drug? _____

   B. What is the general shape of the graph? _____

   _____

   C. Why do you think the graph has the shape it has? _____

   _____

   _____

   D. Most drugs are eliminated from the bloodstream by the kidneys and pass out of the body in urine. How does this fact explain the shape of the graph?

   _____

   _____

2. Experiment: Click **Reset**. Set the **simulation speed** to 2. Click **Play**, and click **Take Pill** two times quickly. Watch the facial expressions of the patient for about one simulated hour.

   What do you notice? _____

   The patient frowns when the blood concentration of the drug is too low or too high. Ingesting too much of a drug can result in a dangerous **overdose**.

3. Gather data: Click **Reset**. Click **Play**, and then click **Take Pill** twice as you did before.

   While the blood concentration is decreasing, click **Pause** when the patient starts to smile. Record the blood concentration and time below. Click **Play**, and then click **Pause** and record when the patient stops smiling. (Adjust the **simulation speed** if necessary.)

   Maximum recommended concentration: _____ Time: _____

   Minimum recommended concentration: _____ Time: _____

**(Activity A continued on next page)**

**Activity A (continued from previous page)**

4. Calculate: How long does it take for the blood concentration to go from the maximum recommended value to the minimum recommended value? _____

5. Predict: How often do you think the patient should take a pill? _____

6. Test: Click **Reset**. Run a simulation with this dosage schedule for at least five pills, and then click **Pause**. Observe the results of your dosage schedule on the GRAPH tab.

   A. What was the maximum blood concentration of the drug? _____

   B. What was the minimum blood concentration of the drug? _____

   C. Based on the graph, was the dosage too high, too low, or just right? Explain.

   _____

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7. Record: Click the **camera** (📷) icon to take a snapshot of your graph. Right-click the image, click Copy Image, and paste the image in a blank document. You will turn in this document with this worksheet. Label the image with the pill type and dosage schedule.

8. Revise and repeat: Continue to experiment until you have determined the ideal dosage schedule for this patient. Remember, an overdose is more dangerous than an under-dose!

   What is the ideal dosage schedule for pill A? _____

9. Record: Take a snapshot of the "ideal" graph and add it to your document. Label the image with the pill type and dosage schedule.

10. Think and discuss: Why is it important to determine the correct dosage schedule for a drug?

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| **Activity B:**<br>**Controlled release** | Get the Gizmo ready:<br>• Click **Reset**.<br>• Select **Pill Type B**. |  |
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**Question: How is the dosage of a longer-lasting pill determined?**

1. Observe: Click **Play** and press **Take Pill**. Set the **simulation speed** to 20, and click **Pause** after 8 hours. Select the GRAPH tab.

   A. What is the maximum blood concentration of the drug in pill B? _____

   B. What is the shape of the graph? _____

   _____

2. Explain: Pill B uses a technology called **controlled release**. It has a coating that slows the release of the drug. How does this fact explain the shape of the graph?

   _____

   _____

3. Experiment: Use the Gizmo to determine the maximum and minimum blood concentrations of the drug in pill B that result in a smiling patient. What are they?

   Maximum recommended concentration: _____ Time: _____

   Minimum recommended concentration: _____ Time: _____

4. Predict: How often do you think a patient should take pill B? _____

5. Test: Click **Reset**. Run a simulation with this dosage schedule for at least five pills, and then click **Pause**. Observe the results of your dosage schedule on the GRAPH tab.

   A. What was the maximum blood concentration of the drug? _____

   B. What was the minimum blood concentration of the drug? _____

   C. Based on the graph, was the dosage too high, too low, or just right? Explain.

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**(Activity B continued on next page)**

**Activity B (continued from previous page)**

6. Record: Take a snapshot of your graph, and paste the image in a blank document. Label the image with the pill type and dosage schedule.

7. Revise and repeat: Continue to experiment until you have determined the ideal dosage schedule for this patient. Remember, an overdose is more dangerous than an under-dose!

   What is the ideal dosage schedule for pill B? _____

   Take a snapshot of the ideal graph and add it to your document. Label the image with the pill type and dosage schedule.

8. Apply: Why would it be dangerous to chew up a controlled-release pill rather than swallowing it? _____

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9. Think and discuss: What are some of the possible advantages of controlled-release pills?

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| **Activity C:**<br>**Target organs** | Get the Gizmo ready:<br>• Click **Reset**.<br>• Select **Pill Type C**. |  |
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**Introduction:** Most drugs are designed to interact with a specific organ, or target organ. For example, a headache medication might be targeted toward nerve cells in the brain.

**Question: How are dosage schedules determined for drugs that target particular organs?**

1. Observe: Click **Play** and press **Take Pill**. Set the **simulation speed** to 20, and click **Pause** after 8 hours. Select the GRAPH tab.

   A. What is the maximum blood concentration of the drug in pill C? _____

   B. What is the maximum organ concentration of the drug in pill C? _____

   C. How does the organ graph compare to the blood graph? _____

   _____

   _____

2. Experiment: Use the Gizmo to determine the maximum and minimum organ concentrations of the drug in pill C that result in a smiling patient. What are they?

   Maximum recommended concentration: _____ Time: _____

   Minimum recommended concentration: _____ Time: _____

3. Predict: How often do you think a patient should take pill C, and how many pills should the patient take each time? _____

4. Test: Click **Reset**. Run a simulation with this dosage schedule for at least five pills, and then click **Pause**. Observe the results of your dosage schedule on the GRAPH tab.

   A. What was the maximum organ concentration of the drug? _____

   B. What was the minimum organ concentration of the drug? _____

   C. Based on the graph, was the dosage too high, too low, or just right? Explain.

   _____

   _____

**(Activity C continued on next page)**

**Activity C (continued from previous page)**

5. Record: Take a snapshot of your graph, and paste the image in a blank document. Label the image with the pill type and dosage schedule.

6. Revise and repeat: Continue to experiment until you have determined the ideal dosage schedule for this patient. Remember, an overdose is more dangerous than an under-dose!

   What is the ideal dosage schedule for pill C? _____

7. Record: Take a snapshot of the "ideal" graph and add it to your document. Label the image with the pill type and dosage schedule. You will turn in this document with this worksheet.

8. Think and discuss: Why isn't it enough to know only the blood concentration for a drug that affects a target organ? _____

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9. On your own: Explore the effects of pill D on the patient.

   A. How would you describe pill D? Explain how you know. _____

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      _____

      _____

      _____

   B. What is the ideal dosage schedule for pill D? _____

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