I. How much sleep do we need and why do we sleep?

Humans sleep on average about one third of their lives. It has been suggested that sleep may serve several functions. One is a **restorative** process and the other is an **adaptive** process. The **restorative** process simply means that sleep may fulfill the need to restore and recover energy. Body systems may be repaired and the body brought back into a state of restored energy to function on a daily basis. People who lack sleep often feel tired and are irritable. The **adaptive** process suggests that sleep may help to protect the species from predation. During the dark night it is difficult to see and therefore difficult for some animals to hunt. Sleep functions as a time to rest and save energy while avoiding being eaten. There are other theories as well that suggest sleep is a time when *learning is reinforced* and becomes part of our memory. Others theorize that sleep is a time when the *brain develops and emotions are discharged*. Scientists are still pondering the benefits of sleep.

II. Phases of Sleep

Scientists who study sleep have identified two phases of sleep. The first phase is called **non-rapid eye movement (NREM)** sleep. As you can see in Figure 5, REM and NREM Phases of Sleep below, NREM sleep is divided into four stages. The second phase is called **rapid eye movement (REM)** sleep. REM sleep is associated with dreaming and paralysis of body muscles (except for the eye and diaphragm muscles). Humans alternate between these two phases of sleep throughout the night. REM sleep alternates with NREM sleep approximately every 90 minutes. A person with normal sleep usually has four to five cycles of REM and NREM sleep during a night. Figure 1, REM and NREM Phases of Sleep below shows how a typical eight-hour sleep cycle might look in graphical form. Figure 6, Four Stages of NREM Sleep Distinguished by EEG Patterns below shows the four stages of NREM sleep distinguishable by brain waves recorded on an EEG.
As you can see in Figures 1 and 2, NREM sleep is divided into four stages. Sleep scientists can tell which stage a person is in by looking at brain waves. Brain waves are normal changes in the electrical activity of our brains and they can be measured using electrodes. You can easily observe how brain waves differ in each stage by looking at Figure 6.

Now, what is happening in each of the four stages?

- **Stage 1 sleep (drowsiness):**
  We drift in and out of sleep for about 5 to 10 minutes and can be awakened easily. Our eyes move very slowly and muscle activity slows.

- **Stage 2 (light sleep):**
  Our eye movements stop and our brain waves become slower, with occasional bursts of rapid waves called sleep spindles. Our heart rate slows and body temperature decreases.

- **Stage 3 (deep sleep):**
  In stage 3 sleep extremely slow brain waves called delta waves begin to appear, interspersed with smaller, faster waves. It is very difficult to wake someone during stages 3 and 4, which together are called deep sleep.

- **Stage 4 (deep sleep):**
  By Stage 4 the brain produces delta waves almost exclusively. There is no eye movement or muscle activity. People awakened during deep sleep do not adjust immediately and often feel groggy and disoriented for several minutes after they wake up. Some children experience bedwetting, night terrors, or sleepwalking during deep sleep.

When we are in REM sleep, breathing becomes rapid, irregular and shallow. Our eyes move and jerk rapidly in various directions and our limb muscles become temporarily paralyzed. Our heart rate increases, blood pressure rises and people dream during this phase.
III. What’s Your Whole Body Doing While You’re Sleeping?

Since sleep is a time to rest and restore energy and since all body systems require energy, they are all affected by sleep. This is a good example of how our organ systems are interrelated in our bodies. Table 1 shows how our organ systems are affected by sleep. For the sake of simplicity, only the organ system primarily involved in each activity is listed. Keep in mind that every life process (activity) requires the cooperation of two or more organ systems.

### Table 1. How Your Organ Systems are Linked to Sleep

<table>
<thead>
<tr>
<th>Physiological Process*</th>
<th>During NREM</th>
<th>During REM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brain Activity (Nervous System)</strong></td>
<td>decreases from wakefulness</td>
<td>increases in motor and sensory areas, while other areas are similar to NREM</td>
</tr>
<tr>
<td><strong>Heart Rate (Circulatory System)</strong></td>
<td>slows from wakefulness</td>
<td>increases and varies compared with NREM</td>
</tr>
<tr>
<td><strong>Blood Pressure (Circulatory System)</strong></td>
<td>decreases from wakefulness</td>
<td>increases (up to 30 percent) and varies from NREM</td>
</tr>
<tr>
<td><strong>Blood Flow to Brain (Circulatory System)</strong></td>
<td>does not change from wakefulness in most regions</td>
<td>increases by 50 to 200 percent from NREM, depending on brain region</td>
</tr>
<tr>
<td><strong>Breathing Rate (Respiratory System)</strong></td>
<td>decreases from wakefulness</td>
<td>increases and varies from NREM, but may show brief stoppages (apnea); coughing suppressed</td>
</tr>
<tr>
<td><strong>Breathing Airway Resistance (Respiratory System)</strong></td>
<td>increases from wakefulness</td>
<td>increases and varies from wakefulness</td>
</tr>
<tr>
<td><strong>Body Temperature</strong></td>
<td>regulated at lower set point than when awake; shivering starts at lower temperature than when awake</td>
<td>not regulated; no shivering or sweating; temperature drifts toward that of surroundings</td>
</tr>
<tr>
<td><strong>Hormone Secretion (Endocrine System)</strong></td>
<td>several sleep-dependent hormones are released</td>
<td>several sleep-dependent hormones are released</td>
</tr>
<tr>
<td><strong>Urine Concentration (Excretory System)</strong></td>
<td>increases (due to reduction of filtration, plasma flow and excretion of sodium, chloride, potassium, and calcium ions)</td>
<td>increases (due to reduction of filtration, plasma flow and excretion of sodium, chloride, potassium, and calcium ions)</td>
</tr>
<tr>
<td><strong>Digestive Acid Production (Digestive System)</strong></td>
<td>decreases in people with normal digestive systems</td>
<td>decreases in people with normal digestive systems</td>
</tr>
<tr>
<td><strong>Swallowing (Digestive System)</strong></td>
<td>decreases</td>
<td>decreases</td>
</tr>
</tbody>
</table>
I. How much sleep do we need and why do we sleep?

1. On average, how much time do humans spend sleeping?

2. List four benefits we get from sleep:
   a. __________________________________________________________________________
   b. __________________________________________________________________________
   c. __________________________________________________________________________
   d. __________________________________________________________________________

Figure 1a The Amount of Sleep Required Throughout the Human Lifespan


Figure revised by authors since publication.

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3. According to the graph in Figure 1a, how much sleep is needed by a thirteen-year old child? ________________________________

4. According to the graph in Figure 1a, how much sleep is required by a baby who is three days old? ________________________________

5. According to the graph in Figure 1a, what happens to the amount of sleep needed as we get older? ________________________________

6. According to the graph in Figure 1a, how does the amount of REM sleep compare between a baby 3 days old and a person 50 years old? ________________________________

7. What proportion of sleep do 50 – 70 year-old people require when compared to 1 – 15 day-old babies? ________________________________

8. Why do you think we might need less sleep as we get older? ________________________________

9. From looking at the trend in the Figure 1a graph, if people aged 86 – 100 years were added, what do you think would happen to the amount of sleep they need? (Explain why you think this) ________________________________

II. Phases of Sleep

1. Use section II, Figure 1: REM and NREM Phases of Sleep in the Student Activity handout and Table 1 Colors below to color-coded Figure 5 on the following page.

<table>
<thead>
<tr>
<th>Phase of Sleep</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>REM (R)</td>
<td>Blue Green (Teal)</td>
</tr>
<tr>
<td>NREM</td>
<td></td>
</tr>
<tr>
<td>Stage 1 (1)</td>
<td>Red</td>
</tr>
<tr>
<td>Stage 2 (2)</td>
<td>Purple</td>
</tr>
<tr>
<td>Stage 3 (3)</td>
<td>Green</td>
</tr>
<tr>
<td>Stage 4 (4)</td>
<td>Blue</td>
</tr>
<tr>
<td>Awake Line (A)</td>
<td>Yellow</td>
</tr>
</tbody>
</table>
1. From looking at Figure 2 above, REM sleep seems to occur between which two stages of sleep? ________________________________
______________________________________________________________________________
______________________________________________________________________________

2. List three things that happen during REM sleep. ________________________________
______________________________________________________________________________

3. From what you learned previously about the purpose of sleep, what purpose do you think dreaming serves during REM sleep? ________________________________
______________________________________________________________________________

4. How often do humans change from REM to NREM sleep in an 8 hour sleep period? _____
______________________________________________________________________________

5. From what you learned about measurement of sleep, how could you tell if a person was in REM or NREM sleep? ________________________________
______________________________________________________________________________
______________________________________________________________________________

6. According to Section II, Figure 2: Four Stages of NREM Sleep Distinguished by Brain Patterns in the Student Activity Page, how can you determine which stage of NREM sleep a person is in at any given time? ________________________________
______________________________________________________________________________
7. Describe how the brain waves of Stage 4 NREM sleep differ from those of Stage 1 NREM sleep. __________________________________________________
   ___________________________________________________________________

8. What trend do you see in the brain wave patterns in Section II, Four Stages of NREM Sleep Distinguished by Brain Patterns in the Student Activity Page? ________________________________________________________________
   ___________________________________________________________________

III. WHAT’S YOUR WHOLE BODY DOING WHILE YOU’RE SLEEPING?

For the following activity, you will need to refer to Table 1, How Your Organ Systems are Linked to Sleep on the Student Activity Page. Your job will be to use the information in Table 1, How Your Organ Systems are Linked to Sleep and the Figure 1. Chart What Happens to Your Organ Systems When You Sleep? that follows to make a graphic representation showing what happens to each body function when you sleep. You will draw arrows on Figure 1 to show whether each body function increases or decreases during REM and NREM sleep. Read each instruction and check it off when completed.

☐ You will need two (red and blue) colored pencils or markers. Use the red marker for all information related to REM sleep and the blue marker for all information related to NREM sleep.

☐ For REM Sleep: Draw a red arrow above the center bar and pointing up for any activity that increases
   Draw a red arrow below the center bar and pointing down for any activity that decreases

☐ For NREM Sleep: Draw a blue arrow above the center bar and pointing up for any activity that increases
   Draw a blue arrow below the center bar and pointing down for any activity that decreases

☐ Look at Brain Activity in Table 1 How Your Organ Systems are Linked to Sleep. You see that brain activity decreases during NREM sleep. This means you will draw a blue arrow to indicate that this is NREM sleep. You will start the arrow at the center bar in the first square labeled Brain Activity on Figure 1 below. Draw the arrow with the point down since brain activity decreases. Make the arrow go to the end of the graph (12 boxes in length) and make it wide enough to fill the box. Color it in with the blue marker or pencil.

☐ Now look at Brain Activity for REM sleep in Section III, Table 2 How Your Organ Systems are Linked to Sleep. You will see that it increases during REM sleep. This means you will draw a red arrow for REM sleep and it will point up since brain activity increases during REM sleep. Be sure to make the arrow begin at the center bar, starting with the second column for Brain Activity. Make the arrow wide enough to fill the column and long enough to reach the top of the column.

☐ Repeat this procedure for each of the Physiological Processes listed in Section III, Table 1 on you Student Activity Page.
<table>
<thead>
<tr>
<th>DECREASE</th>
<th>INCREASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>REM Sleep</td>
<td>NREM Sleep</td>
</tr>
<tr>
<td>Brain Activity</td>
<td>Heart Rate</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Flow to Brain</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>Respiratory Resistance</td>
</tr>
<tr>
<td>Body Temperature</td>
<td>Thermoregulation</td>
</tr>
<tr>
<td>Hormone Secretion</td>
<td>Steroid ADH</td>
</tr>
<tr>
<td>Swallowing</td>
<td>Salivating</td>
</tr>
<tr>
<td>Positively Aging®/M.O.R.E.</td>
<td>2012® The University of Texas Health Science Center at San Antonio</td>
</tr>
</tbody>
</table>
Chart Summary Statement

Now that you have completed the chart showing what happens to the organ systems in your body as you sleep, write a summary statement about the graph. In general terms, what is happening to most of the systems in your body during REM sleep when compared to NREM sleep?

____________________________________________________________________
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