

# Memory Aids

## Three Key Learning Principles

What good is learning if you don't remember what you learn? There are ways to make learning easier, faster, and more lasting. Here are three important principles.

### **1. Motivation**

When it comes to learning, motivation is everything. It is in **your** interest to make yourself interested in all learning assignments. Being bored doesn't punish your teacher or the author of your materials you are supposed to learn. You would be **punishing yourself**. You will find that with most any subject matter, the more you motivate yourself to delve into it, the more interesting it becomes for you! In addition, the more motivated you are to learn, the greater the chance that your grades will improve!

### **2. Intense Focus**

With any subject matter, you learn easier, faster, and better if you become totally immersed as well as motivated. When immersed in your subject matter, you quickly lose yourself in the learning material. Being immersed in your subject allows you to shut out distractions that otherwise might disrupt the encoding of the information and cementing it into memory. As scientists have demonstrated in multiple experiments, multi-tasking is the **archenemy of learning!**

### **3. Deliberate Practice**

We all know that repeating learned information helps us to remember it. However, rote memorization, where you repeat something repeatedly without thinking about it, is the worst of all memorizing tactics. Rote memorization takes too long to create or encode what you are trying to learn, so that with this method you may soon forget

Study takes time, but **effective** study takes much less time if you will "study smart." To "study smart," you need to practice recalling in a deliberate way the information learned. To study smart, think about the strategies and tactics you need to be using to master a learning challenge. Be aware of any need to change strategies and tactics that are not working well for you. Don't just "look over" the information. Quiz yourself in ways that force memory retrieval. Ask yourself questions and answer them. Think about the information in different ways, in other contexts. Think about how the information relates to what you thought you **already** knew and what is new about it that you need to incorporate into your knowledge arsenal. Thinking about information in these different ways is a far more important method for learning than is rote memory.

The best memory technique is to **think about** what you are trying to memorize. When you are learning, ask yourself questions and then try to generate your own answers. For example, ask questions about the information like:

- What has special meaning for me?
- What is missing that would be useful to know?
- What do I not understand?
- Where can I get this explained better?
- How can I apply this information to what I already know, to other parts of the course, to other courses, and to different kinds of problems?
- What new ideas does this give me?

The reasoning processes required for answering questions like these are excellent tools for highly-effective memory rehearsal.

## Seven Common Memorization Techniques

The most basic feature of effective memory enhancing techniques (mnemonics) is the association of what you are learning (the new) with what you already know (the old). Unfortunately, this association process does not always occur automatically. That is why it helps to know and use specific tactics designed to promote the creation of these associations.

Below we explain seven mnemonics that you can use to promote effective memorization. We will walk you through how you can use these techniques right now to help you remember the content in this current instructional module.

### Seven Memorization Techniques

<p><b>Common-Sense Thinking:</b> Every new bit of information has meaning. Thinking about that meaning improves your understanding and may give you new ideas. In the process, you are also memorizing.</p> <p><b>Acronym:</b> Use the first letter of each word to create one set of letters, forming an acronym. Ex: U.S.A. for United States of America.</p> <p><b>Acrostic:</b> Use the first letter of each word of a concept or item you are trying to remember to create a string of words. Ex: <u>A</u>ll <u>C</u>ows <u>E</u>at <u>G</u>rass (the white keys on a piano)</p> <p><b>Categorization:</b> Group similar items together. Remembering any item in a category often will help you recall the others in that same category.</p>	<p><b>Subject-Object-Verb (SOV):</b> Imagine a picture of someone or something doing something to a target or object.</p> <p><b>Memory Palace:</b> Visualize (create a mental picture for) each item you want to remember and mentally place that item’s image on or in a place with which you are familiar (like objects in your room, parts of your bicycle, etc.)</p> <p><b>Story Chain:</b> Imagine a picture for each item you want to remember and mentally place it into a story that you make up.</p>
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As you begin to review these techniques, it is useful to know that while each of these seven techniques can be applied using words or language, the most effective approach is often to convert words into mental images. Once you create your own mental images, memorization of the concepts you are trying to learn (remember) becomes easier and more reliable—even fun! We have summarized these seven techniques in the table below and described how each works. Once you have reviewed these techniques, we will guide you step-by-step through ways you can apply them to this instructional module.

We know that some of these tactics may seem dumb or a little silly, but often the dumber and sillier they are, the more powerfully they promote memorization. Memory Palace and Story Chain techniques are in fact the most powerful of the seven memorization techniques. Successful “memory athletes” use them to compete in international contests designed to see who can memorize the most in the shortest amount of time. With Memory Palace, for example, contest winners have been able to memorize the sequence of four shuffled decks of cards in less than three minutes! Without these techniques or tactics, their memorization ability would be no better than your own.

Two other advantages of these memory aid techniques are not so obvious. One advantage is that these techniques exercise and develop your creativity. You must imagine mental pictures that work for you. Secondly, you must think about the item being memorized in order to construct the memory aid and we already know that thinking is great memory rehearsal.

Below, we will provide ideas for ways you can use one of these seven mnemonic techniques for each memory task in this learning module. For each given memory task, choose the technique that seems to work best for you and that best fits the task. You don’t have to use the words or sample images we use here. These are simply examples. Make up your own scheme based on what is easiest for you to remember and what works best for you.

Once you construct a mnemonic for a given learning task, force yourself to recall it three or four times the first day. Repeat that recall once a day for the next four or five days. Remember: forced recall is essential to effective memorization. And, recall is most powerful if you say it aloud, write it down, or draw it.

**Source:** the eBook, *Better Grades, Less Effort*

## **Items to Be Memorized: Cell Biology**

### **Using Common-Sense Thinking**

You can get off to a good start by first thinking about the functions a cell must accomplish. Here are a few examples to consider.

- Cells of most tissues benefit from reproducing, as they must do to replace old, worn-out cells (like skin). This should make you think about genes and DNA and RNA in the nucleus.

- Animals must eat and their cells must make energy from what they eat. This should help you think of mitochondria.
- Plants do not eat, but instead trap energy from the sun. This should help you think of chloroplasts.
- All cells must make proteins. This should help you think of endoplasmic reticulum, ribosomes and their RNA, and the Golgi apparatus that puts the final touch on newly made proteins.
- Cells need storage areas. This should help to think of vesicles.
- Cells need waste disposal and recycling. This should help you think of lysosomes.

Below are more specific examples of ways that thinking can reduce the need for memorization:

**Name four features of plant cells not found in animal cells.** Cell wall, chloroplast, larger vacuoles, no lysosomes.

You can use reason to help you remember two of these four:

- Plants have to a special wall to protect them since they do not have skin.
- They must have chloroplasts in order to perform photosynthesis.

Here is another approach: Create an overlapping two-circle Venn diagram. In the circle on the left, label it “Plants” and list all the organelles for plants. In the circle on the right, label it “Animals” and list all the organelles for animals. In the overlap area, write in the names for features that occur in both plants and animals. Finally, use a highlighter to indicate the four that are unique to plants.

**What is turgor pressure and how does it relate to plant cells?** Filling a cell with water helps fill the space and keeps the cell from collapsing and the plant from drooping. If you know what the word “turgid” means, you could use reason to our question.

If you don’t know what “turgor” means, start by asking yourself what the word “turgid” means. It might help you to think of a turnip, which is a rigid or hard vegetable. Now, imagine one of your houseplants. Suppose you forget to water it for a couple of weeks. How does its appearance change? It droops from lack of water, and so they droop or sag, making the plant appear limp (thus not turgid).

**Name five components that occur in both eukaryotic and prokaryotic cells.** DNA, cytoplasm, ribosomes, plasma membrane. Now, reason through the answer. You already know that cells have a membrane holding things in. You also know that cells have to make proteins, so think of the organelles that make proteins (DNA, ribosomes, Golgi apparatus). These organelles do not float around in empty space; maybe that will help you think of cytoplasm.

**What is the relationship of cells, tissues, and organs?** Tissues are made up of cells and organs contain one or more tissues. Use reason to find the answer. Think about an organ, like your stomach. You know it has more than one kind of tissue (smooth muscle, gland cells, and nerves). From basic cell theory, you learned that all tissue contains a collection of similar cells.

### Acronym

To answer the question "What is that circular dark spot inside a nucleus?" think of the spot as being a loud speaker that is broadcasting a story about what goes on inside the nucleus. Think of the radio network NPR:

#### NPR

N (nucleolus), P (proteins), R (ribsomes).

### Acrostic

If somebody asks you how the idea of cells arose, you might devise an acrostic to help you remember. For instance, you could think of cells as a magical discovery. That could then remind you of Harry Potter and how Harry waves his magic wand and makes chocolate candy.

Use this visual image to help you remember that it was Hooke who had the idea of cells. Hooke used a microscope to look at cork and saw that it contained many similar enclosed units that he called "cells." Now think of Hooke waving a magic wand and declaring: "Eureka, here are cells!" You could then use this acrostic:

#### *Harry Makes Chocolate Candy*

(Hooke, Microscope, Cork, Cells)

### Categorization

To help you see the "big picture" about organelles, you could group together those that have similar functions within a cell. To illustrate this, we've created the table below and grouped organelles by function: physical support, synthesis of compounds, and direct biochemical reactions.

Physical Support	Make Compounds	Biochemical Reactions
Cytosol	Endoplasmic reticulum	Mitochondria
Cytoskeleton	Ribosomes	Lysosomes
	Golgi apparatus	Vesicles

## Memory Palace

To remember the names of the organelles, you can use either Memory Palace or Story Chain. In either case, you need an imagined mental picture for each organelle. For Memory Palace, here are some examples of mental images you might create:

**Cytoskeleton:** tubules, filaments that support a cell's shape and guide movement of cell components. *Imagine a human skeleton.*

**Lysosomes:** membrane-bound spheres that contain enzymes that break down many kinds of biomolecules; a recycle center; fluid-filled bags of digestive chemicals. *Imagine a bag of lye, with LYE (for lysosomes) marked on the side of the bag. Imagine the lye digesting away parts of the bag, causing spillage.*

**Mitochondria:** make energy; power-plant of the cell. *Imagine mite insects (mitochondria) jumping up and down with great energy.*

**Vesicle:** contains liquids surrounded by a lipid bilayer. Involved in metabolism, transport, buoyancy control, and temporary storage of food and enzymes. They can also act as chemical reaction chambers. *Imagine the small vessel like a boat (vessel sounds like vesicle) floating on the sea and carrying cargo from one place to another.*

**Endoplasmic Reticulum:** interconnected network of flattened, membrane-enclosed sacs or tube-like structures that transport compounds within the cell. Smooth ER: has no ribosomes, processes substances like lipids (*Imagine a basketball net; reticulum means net-like*). *See yourself throwing hamburgers instead of basketballs at the net.*

**Ribosomes:** make proteins which are then delivered to Golgi apparatus for finishing touches. *Imagine barbecue ribs.*

**Golgi:** flattened membranes that modify proteins and help distribute them within the cell *Imagine gold ("Gol" might make you think of gold). Imagine an ordinary hamburger that suddenly turns to gold color.*

**Membrane:** allows for the movement of people, materials, and messages. *Imagine plastic Saran wrap on top of a bowl. Imagine turning the bowl upside down and only a little of the bowl contents seep through.*

Now to place these images in your Memory Palace, pick the location to serve as a "palace." If, for example, you use your classroom, moving left to right as you look from your desk to the front of the room, you might see:\*

*The teacher's desk.* Imagine a skeleton (cytoskeleton) sitting behind the desk. See the skeleton lift the desk (support) and move it around the room (guiding movement of cell components).

*The blackboard.* Imagine banging on the board with a bag (lysosome) that breaks up the words written on the board.

*The U.S. flag.* Imagine a swarm of mites (mitochondria) running all over the flag, making it wave vigorously as if it had energy.

*The first student desk on the left.* Imagine a toy boat (vessel.... vesicle) sitting on top of the desk. The boat stores cargo and floats up and down on the desk top.

*The second student desk on the left.* Imagine a basketball net covering the desk (endoplasmic reticulum), with the nodes of the net being barbecue ribs (ribosomes) instead of string knots.

*The last student desk on the left.* Imagine a plate of barbecue ribs (ribosomes) on the desk and the ribs are shape-shifting (morphing) into miniature teenagers (proTEENS ... proteins).

*The back wall of the classroom.* Imagine gold bars (Golgi apparatus) being seized by the proTEENS from the previous image and the gold makes the teens glitter and look more impressive (enhancement of proteins).

*The door to the classroom.* Imagine the door being wrapped in Saran wrap (plasma membranes) so that large objects, like students, can't enter or exit.

\*Of course, you have to vary the objects to match what your own classroom actually looks like.

## Story Chain

To help you remember the names of all the major organelles, you might construct a mental-image story like the one below:

Imagine a basketball player as only a skeleton (“cytoskeleton”) running down the court, which is lined like a football field with lime (lye ... “lysosome”). All down the field are swarms of mites (mites ... “mitochondria”). Hear in your mind’s ear the crunching of bugs as the skeleton rattles its way down the court past each line marker and leaps for a jump shot, throwing a toy boat (vessel ... “vesicle”) into the net. (The net is reticular or “Endoplasmic Reticulum”; knots represent “rough ER”; string is the “smooth ER.”) The boat won’t fall through right away, because the bottom of the net is covered with Saran wrap (plastic sheet is the “membrane”). The wrap finally breaks and the team wins. The coach gives the skeleton player a gold bar (gold for “Golgi”), which magically causes flesh to appear between the ribs (rib for “ribosomes.”)

If you created and visualized images like these in your mind’s eye, this information will be hard for forget. Keep these same image representations, or whichever ones you chose, and use them for the next step of memorizing what each organelle does. Note: You could have used the Memory Palace technique in this example, but it is probably best reserved for very long lists of 15 or more items. Story chains seem to work best for short lists. In the above example, there are only eight items. An acrostic could also work, but it is hard to construct a sentence where almost every word begins with a consonant.

## Subject-object-verb (SOV)

To help you remember the function of each organelle, the examples below might help:

**Cytoskeleton:** tubules, filaments that support a cell's shape and guide movement of cell components. *Imagine the skeleton using straw tubes to lift weights.*

**Lysosomes:** membrane-bound spheres that contain enzymes that can break down many kinds of biomolecules; a recycle center; fluid-filled bags of digestive chemicals. *Imagine that bags placed on each line marker break one at a time, releasing small particles.*

**Mitochondria:** make energy; power-plant of the cell. *Imagine the mites (mitochondria) jumping up and down with lots of energy.*

**Vesicle:** contain liquids surrounded by a lipid bilayer. Involved in metabolism, transport, buoyancy control, and temporary storage of food and enzymes. They can also act as chemical reaction chambers. *Imagine the small boat (vesicle) is a barge holding lots of cargo. Some of the cargo falls off, representing that vesicles may release secretions.*

In secretory cells, the vesicles often migrate to fuse with the plasma membrane and release their contents outside the cell. *Imagine your barge floating into a membrane wall at the edge of the river where it releases some of its cargo.*

**Endoplasmic Reticulum:** interconnected network of flattened, membrane-enclosed sacs or tube-like structures that transport compounds within the cell.

- Smooth ER: has no ribosomes, processes substances like lipids. *Imagine the strings of the net dripping oil.*
- Rough ER: studded with ribosomes that make proteins. *Imagine the knots as tiny protein steaks.*

**Membrane:** allows for the movement of people, materials, and messages. *Imagine things moving through the Saran wrap.*

**Golgi:** flattened membranes that modify proteins and help distribute them within the cell. *Imagine the gold bar sitting on top of a raw steak. As the bar is squashed flat, the steak is cooked and becomes ready to eat.*

**Ribosomes:** make proteins which are then delivered to Golgi apparatus for finishing touches. *Imagine that the barbecue ribs (protein) you are eating have a sauce poured on them from a gold (Golgi) bottle.*

**Three basic ideas in cell theory:** (1) Cells are the basic building blocks of life, (2) all organisms are made of one or more cells and (3) all cells come from existing cells. *Imagine a brick multiplying into multiple bricks, each one of which you use to make a brick wall.*



**To remember the two types of cells and how they differ:** Prokaryotic, eukaryotic. Memorize the prefix meanings because you will need that later. “Pro” means coming beforehand or in advance of, as in **procedure** comes before results, or **prosecution** comes before conviction, etc. “Eu” means completed, better or good. Thus **euphoric** means to feel good, **euology** means saying something good about the deceased and **euphemistic** means sounding better than it really is. Prokaryotic cells do not have bound organelles. *Imagine seeing a cell under a microscope which you can't see its organelles because there are no membrane boundaries to indicate where they are. Reason that eukaryotics would be better (“eu”) because things are organized so that you can see them with a microscope.*

**To remember what cytosol is:** Jell-O-like fluid that fills cells. “Cyt” should make you think of cell, as in cytology or cytoplasm. “Sol” should make you think of solution or liquid-like. Imagine a cell with nothing inside it other than a Jell-O-like fluid. *Imagine a cell jiggling like a bowl of Jell-O.*

**To remember what chromatin is:** Mass of DNA and associated proteins that make up the chromosomes. Chromatin might make you think of a chrome car bumper. You also need an image to represent proteins, like a steak or hamburger. An image for DNA might be the twisted ladder appearance of the double helix. *Now mentally see your car driving into a Sonic Drive-In restaurant; the server brings your hamburger out on a twisted ladder and places it on the bumper instead of in your car.*

**What is a chloroplast and what does it do?** Plant organelle that traps light to make energy. *Chlorophyll gum is green. Let the gum represent a chloroplast. Imagine chewing the chlorophyll gum while you sleep. You wake up, yawn, the morning light hits your mouth and the gum, and you leap out of the bed with energy.*

**Summarize the molecular structure of the plasma membrane.** Lipid bilayer with proteins embedded in it. *Imagine one row of stick-figure people standing in a line. Each stick figure has a head and two legs with feet. Directly below them is another line of similar stick figures but they are upside down and their feet are touching the feet of those in the top line, like a mirror image (representing lipid bilayer). Next visualize corks (representing proteins) bobbing and floating from one stick figure to another.*

## Wrapping UP

Now you see examples of how you can use the seven memory techniques to help you remember important information. You don't have to use these specific examples. Create associations that work best for you. We suggest you make a list of these seven techniques and use them throughout this module (and those that follow too!).