Printed Packet Work for Week of 4/6-4/10

1. **Assignment #1:** Read and complete questions in textbook: pages 480-483

   Then complete this quiz:

Textbook Reading Quiz (Unit 7, Explore 4) (1st quiz for week of 4/6-4/10)

1. First name

2. Last name

3. Period (just put the number)

4. Stem cells are a unique type of body cell that can _____ to form a variety of specialized cell types.

- differentiate
- fuse

5. A stem cell can either divide into two new stem cells or it can divide to produce one stem cell and one specialized cell, such as a(n):

- undifferentiated cell
- identical cell
- neuron

6. New advancements in science have allowed researchers to convert human skin cells to embryonic stem cells. This requires altering segments of DNA called:

- proteins
- genes
- organelles

7. When these segments of DNA are expressed, the cell produces _____, which carries out specific functions within the cell.

- proteins
- genes
- organelles

8. Explain the relationship between embryonic cell layers, gene expression, proteins, and cell differentiation.

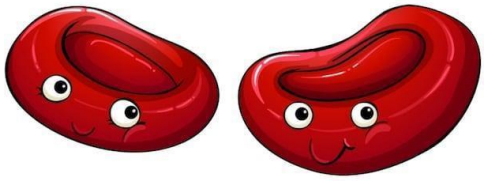
9. Explain why stem cells are of great interest to researchers studying therapies for human diseases.

2. **Assignment #2:** Read and complete the next 4 pages on Specialized Cells

SPECIALIZED CELLS

A specialized cell has a special **STRUCTURE** so that it can perform a specific **FUNCTION** .

Your body has many different kinds of cells, but they all work together. Each type of specialized cell is a particular shape and size that help it perform its special function.



Red blood cells have rounded edges that allow them to flow easily through blood vessels. They also do not contain a nucleus, which gives them more room for hemoglobin- which helps transport oxygen.

Fat cells can swell up with fat in order to store energy for the body.

Skin cells are flat and grow in layers to cover and protect the body.

Bone cells contain structures to store calcium and also to make the cell rigid and strong in order to support the weight of our bodies.

Inner ear cells have tiny little hairs that stick out from the top of the cell to detect small vibrations in the air that we can interpret as sound.

Skeletal muscle cells are connected to bones and can contract to allow movement.

Cardiac muscle cells have a single nucleus and are connected in a way that allows them to contract quickly and repeatedly.

Smooth muscle cells are short and work under involuntary control.

Nerve cells are long and thin, with lots of whisker-like projections, allowing them to pick up and send electrical signals quickly throughout the entire body.

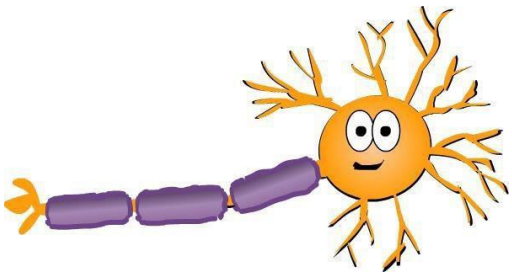
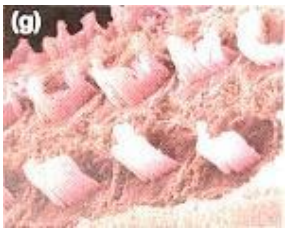
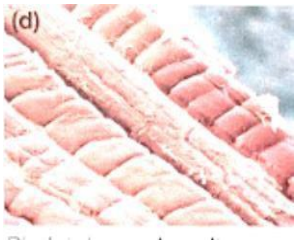
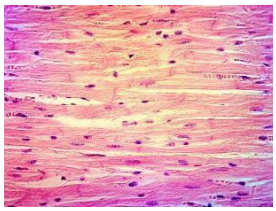
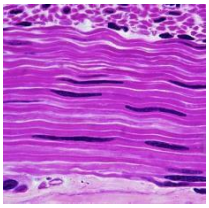


	Photo	**How does the Shape/Structure help with its Job/Function?**	*An example of* **<u>where</u>** *you might find it in the body:*
Red Blood Cell	 Red blood cells deliver oxygen and remove carbon dioxide.		
Fat Cell	 Fat cells store energy in the form of fat.		
Skin Cell	 Skin cells cover the body and reduce water loss.		
Bone Cells	 Bone cells store calcium and build new bone.		

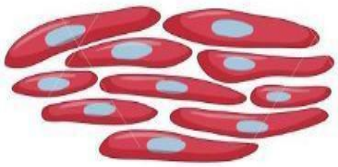
Inner Ear Hair Cells	 Hair cells in the inner ear detect sound vibrations.		
Skeletal Muscle Cells	 Skeletal muscle cells contract to allow movement.		
Cardiac Muscle Cells	 Cardiac muscle cells are involuntarily controlled to make the heart beat rhythmically.		
Smooth Muscle Cells	 Smooth muscle cells line many organs such as the esophagus and intestines and are under involuntary control. Help move food along the digestive system.		
Nerve Cells	 Nerve cells conduct electrical impulses and coordinate activity.		

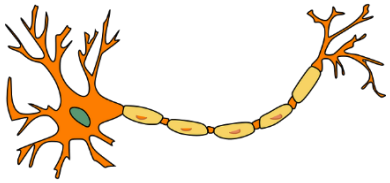
Help the Lab Technician!

Oh no! Someone has delivered a package of slides to your lab, but forgot to label them. Label each of the following slides using the word bank below, and match the function of each type of cell to the picture.

Word Bank

Red Blood	**Nerve**	**Skin**	**Fat**
Bone	**Inner Ear Hair**	**Skeletal Muscle**	**Smooth Muscle**

Cell type: _____ 	**Function:**
Cell type: _____ 	**Function:**
Cell type: _____ 	**Function:**
Cell type: _____ 	**Function:**

Cell type: _____ 	**Function:**
Cell type: _____ 	**Function:**
Cell type: _____ 	**Function:**
Cell type: _____ 	**Function:**

Functions

A: store calcium and provide support to the body
B: you can voluntarily tell it to contract/relax to allow limbs to move
C: involuntarily contracts the inner organs
D: deliver oxygen to cells and remove carbon dioxide **E**: covers the body to protect it and prevent water loss **F**: sends messages from the body to the brain and back **G**: can swell up and store energy
H: detect vibrations and allow us to hear

3. **Assignment #3**: Read the transcripts from the video located in the left column. Write any questions, sketches, or notes that will help you learn the material. After you are done with that, take the quiz.

Suggested Script Annotation Key:

Highlight or underline key content information that is new to me. Go back and research this if possible or ask me via email.

Put a ? = Thought of a question! After making the question mark, write your question in right margin.

Video Script typed out Note: The script from the video has been typed out for you below. Therefore, you do not need access to the video online.	**Questions and Sketches** We learn from questions! After you make a question mark in the text, write your question out in this space next to it. Like to doodle? If you come up with something that helps you remember a concept, sketch it next to the text here!
"We've mentioned a lot about specialized cells. Specialized plant cells. Specialized animal cells. So many kinds of specialized cells…it's going to get a bit crowded here. But have you ever wondered how cells become specialized? How does a neuron or a muscle cell have the structure and function they have? Can you imagine if they had to switch jobs for a day? That wouldn't go so well. They're so specialized for the function they perform. Well this video is going to talk about how cells differentiate into other cells, which basically means, how cells become specialized. Remember that many multicellular organisms like a plant or a human come from a fertilized egg cell. So as a human, you started as a fertilized egg. Otherwise known as a zygote! A zygote that divided to make more and more cells. Oh look, this zygote has developed into a morula. It divides to make more and more cells. Oh look, it's a blastocyst now. The problem is that if the cells just divided, as in mitosis, that would make identical cells. Mitosis is great for growth so dividing is definitely going to happen. But that's not going to result in different specialized cells with different specialized functions, because mitosis results in identical cells. There's something else that will be happening for that. *Continued on next page ->*	

We're going to pause in the blastocyst stage. The blastocyst contains stem cells, and those stem cells are amazing. See, they're not differentiated yet. They're not specialized. They are like blank slates. They don't have a special structure. They don't have any special job. They can become any type of body cell.

Now a reminder that most body cells in your body contain all of your DNA. Therefore, neurons and muscle cells in your body don't have different DNA; they use different parts of the DNA. Genes are regulated which means they can be turned on and off. That's important to understand, because that's a big part of how these stem cells are going to specialize.

Stem cells will activate certain areas of the DNA in their process of differentiating into certain types of cells. Transcription factors are major key players here. They're typically---but not always---proteins, and they determine which areas of the DNA code will get transcribed into mRNA. This can eventually be used to make specific proteins that can impact what a cell will look like and what a cell will do. This means transcription factors have a major role in determining which genes are expressed in a cell, because a cell that is going to become a skin cell is going to have different areas of genes expressed than a cell that is going to be a stomach cell.

There are internal and external cues for stem cells which can involve these transcription factors. An example of an internal cue could be transcription factors present in the cytoplasm of the original starting zygote cell---which will eventually be present in the cells that originate from it. The specific location of the stem cell within the developing embryo can matter, because the transcription factors available in different areas of the developing embryo can differ in quantity and type, impacting what a stem cell differentiates into. External cues could involve cell signaling from other cells next to it or even environmental effects like temperature. There's still a lot of research in this area, and we can't wait to see what scientists discover about this in the next decade.

Continue on next page →

Stem cells are the unspecialized, undifferentiated cells that can become other cells in your body. Not all stem cells are found in a developing embryo. Stem cells can also be found in your body as well like your muscle, skin, liver, or bone marrow just to name a few. These are often called somatic stem cells.

To give some relevance to this, it's likely you have heard of bone marrow transplants before. Bone marrow transplants involve transplanting a portion of healthy bone marrow, which contains bone marrow stem cells, with the idea that those donor stem cells can help regenerate different types of blood cells since bone marrow is like a blood cell making machine! It contains stem cells that differentiate into different types of blood cells.

Many- but not all- of the somatic stem cells that are found in your body are considered to be multipotent. That means they can become many types of body cells but not as many as the embryonic stem cells.

So, after talking about these stem cells, why the heavy focus on the stem cells right now in research? Well one reason is that these cells have the ability to differentiate into other cells, and therefore they could be used to helped regenerate organs or tissues that are damaged from a disease or an accident. There are two important issues to consider, however. One is the ethical issue, especially if considering embryonic stems cells. The ethical issue is significant, because the extraction of embryonic stem cells results in the demise of the embryo. A point consistently debated is the potential benefits offered in stem cell research versus the onset of personhood of human embryos. A second issue is that organ or tissue developed from stem cells that didn't come from that person will carry the risk of organ or tissue rejection as you can get in donated organs or tissue.

Continued on next page →

But there may be something promising! Some research shows that somatic stem cells from your own body may actually be able to develop into more types of cells than what people first thought. In fact, it was discovered that some somatic stem cells can be induced to go back into a pluripotent state. Yes, they're what we call induced pluripotent stem cells!

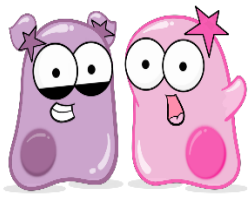
This means a person's own stem cells potentially could be induced into a pluripotent state, with the potential that they could differentiate into tissues or organs that the person may need. Theoretically, this could be an alternative to waiting for an organ or tissue donor as well as decrease chances for organ/tissue rejection since the organ or tissue would have originated from the person's own cells. We encourage you to keep up with the topic of stem cells to stay educated on this topic. All of our understanding of these undifferentiated cells is likely to advance in the near future.

Well that's it for the Amoeba Sisters, and we remind you to stay curious!"

Check your work!

Did you:

- Mark content information that you already know? Y / N
- Mark content information that is new? Y / N
- Did you write down your questions on the right margin? Y / N
- Underline vocabulary terms? Y / N



Assignment #3 Quiz:

How Cells Become Specialized Amoeba Sisters Quiz (3rd quiz for week 4/6-4/10)

1. First name

2. Last name

3. Period (just the number)

4. What is a zygote?

5. Why is a blastocyst so important to cells becoming specialized?

6. Do neurons and muscle cells (or any other types of body cells) have different DNA?

- yes
- no

7. What does "genes are regulated" mean?

8. Why is "gene regulation" important?

9. _____ determine which area of the DNA code will be used to make proteins.

- Zygotes
- Scientists
- Transcription factors
- Specialized cells

10. Give some examples of internal cues for stem cells to start specializing.

11. Give some examples of external cues for stem cells to start specializing.

12 .Now, put it all together. Summarize in a paragraph, how cells become specialized.

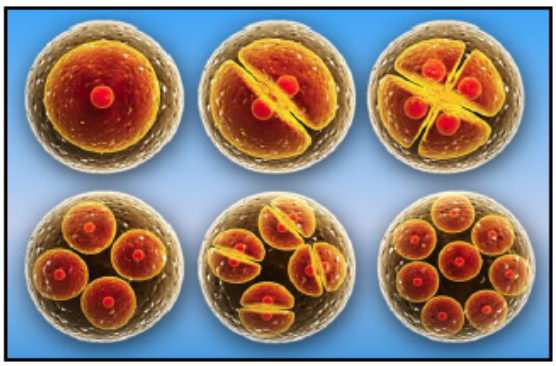
4. **Assignment #4:** Read the following article about Stem Cells. Then, answer the questions at the end.

STEM CELL SCIENCE

(1) Stem cells have been a hot area of research for over the last three decades and researchers have been making very interesting medical advances recently. Let's look at the fundamentals of stem cell science before we get into the newest research. There are three different types of stem cells: embryonic stem cells, adult stem cells and induced-pluripotent stem cells (IPSCs), though all share common traits. First, all can divide for long periods of time. Second, stem cells are not specialized, meaning that they have not become a specific type of cell yet (e.g. neurons and skeletal muscle cells are specific and specialized cells). Third, they have plasticity, so they are capable of becoming more than one cell type.

(2) Embryonic stem cells were first isolated in human embryos in 1998. Stem cells are used in the research of diseases, like cancer and birth defects, as well as drug research and medical treatments where stem cells can be used to make new tissues. However, obtaining these stem cells is the most controversial part of stem cell research as they are harvested from embryos which are destroyed in the process.

(3) Embryos are obtained by using the unused embryos from IVF (*in vitro* fertilization) treatments. IVF helps infertile couples have a child. In this process, several eggs are harvested from a woman and mixed with the sperm taken from her partner. If fertilization results and produces embryos, often only one or two embryos are transplanted back into the woman's uterus. The couple can consent for the unneeded and leftover embryos to be either destroyed or used for stem cell research. Those against human embryonic stem cell research argue that using and destroying embryos shows a lack of respect for the value and dignity of life. For those who are for human embryonic stem cell research, they argue that the embryos were going to be discarded so they would never have become human beings. They also argue that embryos do not have the rights of personhood. Using adult stem cells would seem like the solution to this ethical dilemma, as they can be obtained from a consenting adult without the need for embryos. If so, why not just use adult stem cells? It is because adult stem cells are much less plastic than embryonic stem cells.



(4) Embryonic stem cells obtained from early embryos are totipotent, which literally means "totally powerful". They have the ability to become any cell type in the body and any one of these cells, in isolation, can form an entire human. Four days after fertilization the cells divide into a blastocyst with two cell layers. The surrounding layer forms the placenta and the inner layer are the stem cells that form the tissues of the fetus. At this point, stem cells are no longer totipotent. Though they can still form any and all the tissues of the body, they have lost the ability to form an entire individual if removed from the embryo, thus instead of being totipotent, they are now considered pluripotent. As an embryo continues to develop, the pluripotent stem cells increasingly lose their plasticity.

(5) As adult stem cells are even less plastic than pluripotent stem cells, they are called multipotent stem cells. This means they only have the ability to become a small and limited selection of related cell types. A good example are the multipotent stem cells found in your bone marrow, called a hemocytoblasts. These divide throughout your lifetime to make white and red blood cells. The purpose of adult stem cells is to maintain and repair existing adult tissues. Adult stem cell research bypasses the controversy over destroying embryos, but it also limits research because the plasticity of adult stem cells is reduced.

(6) A third type of stem cell was developed in 2006 to help overcome the embryo controversy and supply more stem cells for researchers. These are induced-pluripotent stem cells (IPSCs). They come from specialized adult somatic cells (not gametes), which are

STEM CELL SCIENCE

reprogrammed, "induced", to act and behave like pluripotent embryonic stem cells. When stem cells begin to specialize, certain genes turn off so that only the genes needed for a specific cell type stay active. The IPSCs are reprogrammed by reactivating the genes that have been switched off.

(7) In addition to skipping over the moral dilemma of using embryos, IPSCs also allow for the custom tailoring of stem cell therapies to individual patients. This removes the risk of immune system rejection. For example, if your liver is damaged and you need a new liver, you would have to get a liver transplant. This means you will have to wait for a liver donor whose cells are a match for yours so that your immune system doesn't reject the transplanted organ. However, if healthy cells of your own body are harvested and turned into IPSCs, these IPSCs in turn can be made into liver cells that form liver tissue that can be transplanted back into you. You will not need to wait for a compatible donor and you will not reject transplanted tissue from our own cells. Though using IPSCs for tissue regeneration is just beginning, there is hope that this type of treatment will become a common reality in the near future.

(8) Another benefit is for drug testing. Many drugs tested on non-human animals harm and kill them. This is often considered a cruel but necessary step in early drug testing, however, testing on human tissues made from IPSCs is a very good alternative. The response of human cells provides more accurate results than using non-human animals and no one is harmed.

Article Questions

1) What are three characteristics of a stem cell?

2) What is the ethical controversy over using human embryonic stem cells for research?

3) How are most embryos obtained?

4) What is the difference between a totipotent stem cell and a pluripotent stem cell?

5) What is the difference between a pluripotent stem cell and a multipotent stem cell?

6) What does IPSCs stand for and what are they?

7) Name two potential uses of using IPSCs?

5. **<u>Assignment #5</u>**: Now, you will tie together all the information from the lessons in this assessment.

   Week 1 Assessment (4/6-4/10)

   1. All body cells have the same DNA but not all cells have the same structure and function. Explain why and how this happens. Be sure to include compare and contrast two different body cells structure and function in your answer.

   2. List some specifics that would happen to the organ/body/etc if the two cell types you listed above did have the exact same structure and function?