STO-120

Stem Cells

Teacher Information

Summary

Students read about adult and embryonic stem cells. They sequence pictures of the steps used to create an embryonic stem cell line. They use simulated stem cells and growth factors from differentiated cells that could be used to treat diseases.

Core Concepts

- Stem cells are unspecialized cells that have the potential to form new stem cells or to differentiate into more specialized types of cells.
- Embryonic stem cell lines can be created from donated embryos.
- Growth factors can be used to make stem cells differentiate into specialized cell types.

Time Required

Two 40-minute class periods

Kit contains

- *Development Diagram Sheet*
- *Growth Factors (GF) and Stem Cell Differentiation Flow Chart*
- Simulated "Embryonic Stem Cells"
- Simulated "Adult Stem Cells"
- Simulated "Growth Factors" 1, 2, 3, A, B, and C
- 8 Labeled Droppers
- 6 culture cups

Teacher Provides

- Scissors
- Safety goggles

Warning: Choking Hazard

This Science Take-Out kit contains small parts. Do not allow children under the age of seven to have access to any kit components.

Reusing *Stem Cell* kits

Kit components may be refilled and reused. Allow approximately 30 minutes to refill a set of 10 kits. Teachers will need to instruct students on how to handle clean-up and return of the re-usable kit materials. For example, teachers might provide the following information for students:

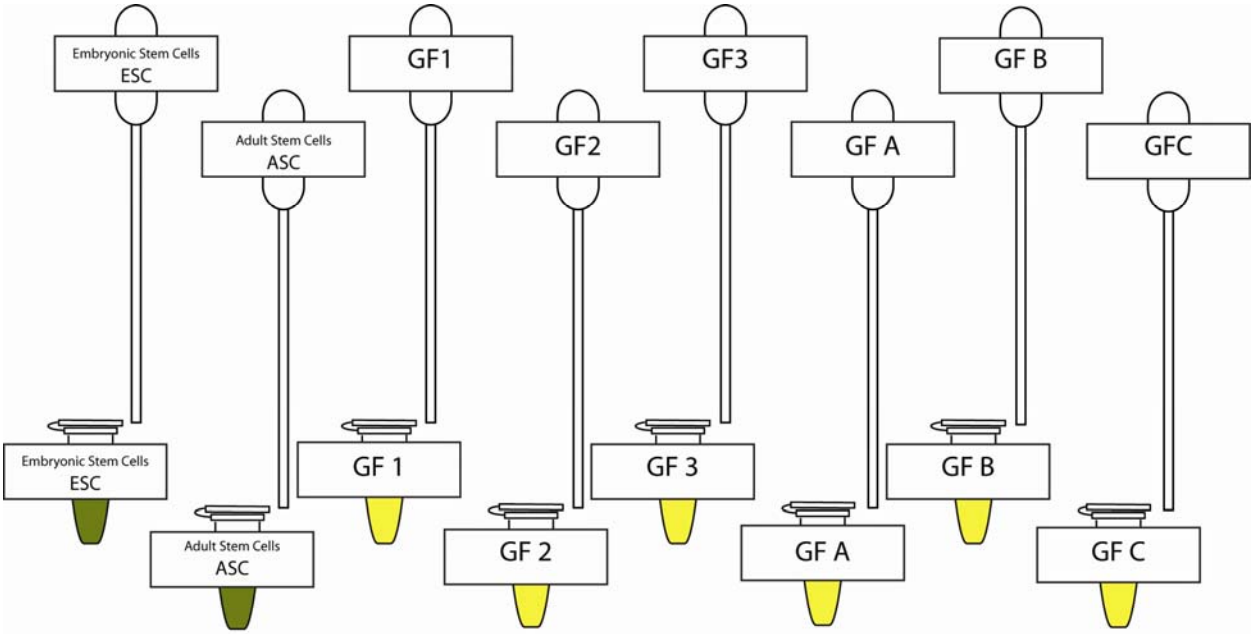
Discard	Rinse with water and dry with paper towel	Return to kit
• Nothing	• All culture cups • All droppers	• All labeled microtubes • All labeled droppers (rinsed) • Culture cups (rinsed) • *Growth Factors (GF) and Stem Cell Differentiation Flow Chart* *

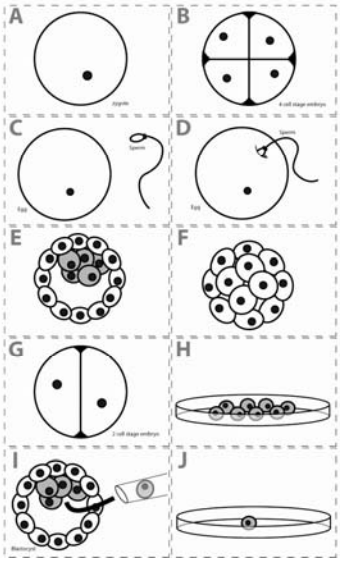
***** Note: Consider laminating printed parts of the kits that will be reused.

Refills for *Stem Cells* kits are available at www.sciencetakeout.com. The **10 Kit Refill Pack** includes the following materials:

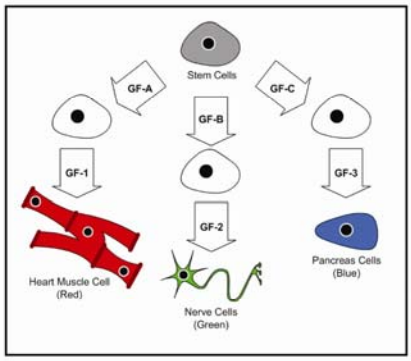
- 1 Quick Guide for refilling kit
- 8 graduated transfer pipets
- 20 ml "Adult Stem Cells"
- 20 ml "Embryonic Stem Cells"
- 5 ml "Growth Factor A"
- 5 ml "Growth Factor B"
- 5 ml "Growth Factor C"
- 5 ml "Growth Factor 1"
- 5 ml "Growth Factor 2"
- 5 ml "Growth Factor 3"
- 10 *Development Diagram Sheets*

Kit Contents Quick Guide





Culture Cups



Read these instructions before using Science Take-Out kits

Parental or Adult Supervision Required

This kit should be used only under the supervision of an adult who is committed to ensuring that the safety precautions below, and in the specific laboratory activity, are followed.

Safety Goggles and Gloves Strongly Recommended

We encourage students to adopt safe lab practices, and wear safety goggles and gloves when performing laboratory activities involving chemicals. Safety goggles and gloves are not provided in Science Take-Out kits. They may be purchased from a local hardware store or pharmacy.

Warning: Choking and Chemical Hazard

Science Take-Out kits contain small parts that could pose a choking hazard and chemicals that could be hazardous if ingested. Do not allow children under the age of seven to have access to any kit components. Material Safety Data Sheets (MSDS) provide specific safety information regarding the chemical contents of the kits. MSDS information for each kit is provided in the accompanying teacher instructions.

Chemicals Used in Science Take-Out Kits

Every effort has been made to reduce the use of hazardous chemicals in Science Take-Out kits. Most kits contain common household chemicals or chemicals that pose little or no risk.

General Safety Precautions

1. Work in a clean, uncluttered area. Cover the work area to protect the work surface.
2. Read and follow all instructions carefully.
3. Pay particular attention to following the specific safety precautions included in the kit activity instructions.
4. Goggles and gloves should be worn while performing experiments using chemicals.
5. Do not use the contents of this kit for any other purpose beyond those described in the kit instructions.
6. Do not leave experiment parts or kits where they could be used inappropriately by others.
7. Never taste or ingest any chemicals provided in the kit - they may be toxic.
8. Do not eat, drink, apply make-up or contact lenses while performing experiments.
9. Wash your hands before and after performing experiments.
10. Chemicals used in Science Take-Out experiments may stain or damage skin, clothing or work surfaces. If spills occur, wash the area immediately and thoroughly.
11. At the end of the experiment, return ALL kit components to the kit plastic bag. Dispose of the plastic bag and contents in your regular household trash.

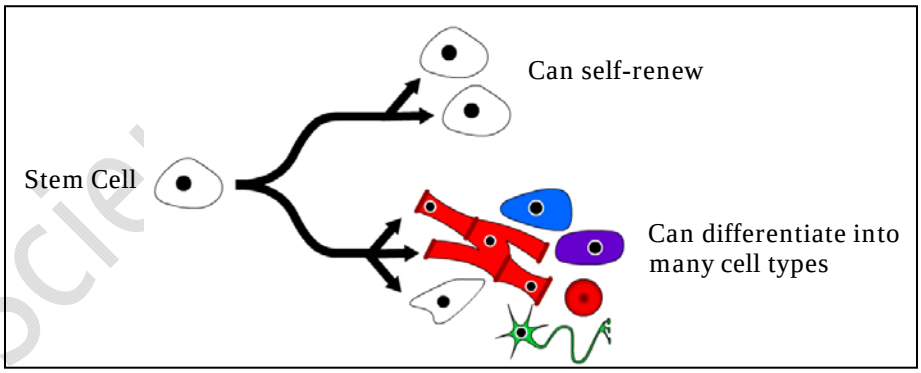
No blood or body fluids from humans or animals are used in Science Take-Out kits. Chemical mixtures are substituted as simulations of these substances.

Stem Cells:

Part 1: What is a Stem Cell?

Stem cells differ from other kinds of cells in the body. When a stem cell divides by mitosis, each new cell has the potential to either remain a stem cell or become another type of cell with a more specialized function. All stem cells—regardless of their source—have three special properties:

1. **Stem cells are unspecialized**. A stem cell does not have any tissue-specific structures that allow it to perform specialized functions. For example, a stem cell cannot work with its neighbors to pump blood through the body (like a heart muscle cell), cannot carry oxygen molecules through the bloodstream (like a red blood cell) or carry impulses (like nerve cells).
2. **Stem cells are capable of dividing and self-renewing continually**. Specialized cells like muscle cells, blood cells, or nerve cells normally do not divide. Stem cells can self-renew by dividing many times to produce millions of stem cells.
3. **Stem cells differentiate into specialized cells**. When unspecialized stem cells give rise to specialized cells, the process is called differentiation. The specialized cells that form from stem cells can be very different from one another, even though they have the same genetic instructions. This is because different genes in stem cells are used (turned on) in different types of cells and are influenced by the cell's environment.



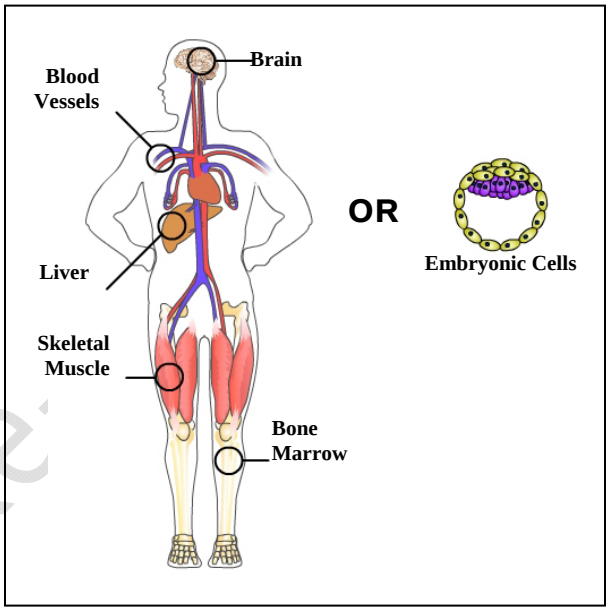
1. Stem cells are unspecialized. What does this mean?

2. Stem cells can self-renew. What does this mean?

3. Stem cells can differentiate. What does this mean?

Stem Cells in the Lab

Scientists are already using stem cells in the laboratory. For example, stem cells are being used to study normal tissue development and to identify the causes of birth defects. Scientists are looking for ways to use stem cells to treat diseases such as diabetes, and heart disease. However, much work remains to be done in the laboratory and the clinic to understand how to use stem cells to treat disease.



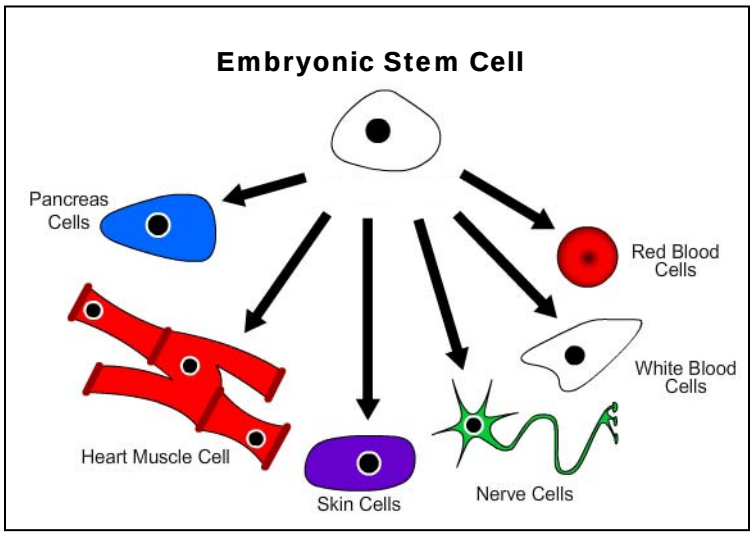
The stem cells that scientists use for laboratory research come from two different sources.

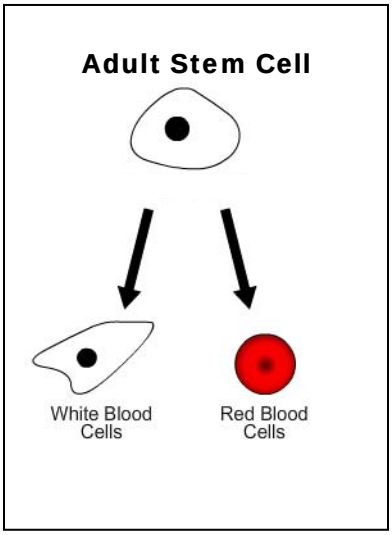
Adult Stem Cells

Some fetal or adult tissues (such as umbilical cord blood, bone marrow, muscle, and brain) contain **adult stem cells** that produce cells to replace ones that are lost through normal wear and tear, injury, or disease. Adult stem cells can be isolated and grown in special conditions in the laboratory. Under proper conditions, adult stem cells can divide but they can only differentiate into a limited number of tissue types.

Embryonic Stem Cells

Embryos contain stem cells that have the remarkable potential to develop into the different cell types in the body. **Embryonic stem cells** can be isolated and grown in special conditions in a laboratory. Under proper conditions, embryonic stem cells can divide and differentiate to form all tissue types in the adult body. However, embryonic stem cells cannot develop into an entire fetus or adult because they cannot form tissues such as the placenta and umbilical cord that provide nourishment to a developing embryo.





4. What are the two types of stem cells?

5. Which type of stem cell is capable of dividing and differentiating into any cell type?

6. Explain why embryonic stem cells cannot be used to make a baby.

7. Why do scientists think it is important to do research using stem cells?

Part 2: Creating Embryonic Stem Cell Lines

Scientists are currently doing research using embryonic stem cell lines. A cell line is a group of cells grown under special conditions in a laboratory. All cells in a specific cell line are genetically identical. In this activity, you will use diagrams to help you understand how an embryonic stem cell line is produced.

1. Your kit contains a *Development Diagram Sheet* with cards that illustrate the steps for making an embryonic stem cell line. Cut along the dotted lines on this sheet to make a set of diagram cards (A–J).

2. Read the information in the brief article below.

In Vitro Fertilization (IVF) to make embryonic stem cells

In vitro fertilization (IVF) offers infertile couples a chance to have a child who is biologically related to them. With IVF, a method of assisted reproduction, a man's sperm and a woman's eggs are combined in a laboratory dish ("in vitro"), where fertilization occurs to form a zygote (fertilized egg). Then the zygote begins to divide by mitosis.

After many mitotic divisions in a laboratory dish, a blastocyst is formed. A blastocyst is a four to five day old embryo made of about 100 cells that each contain DNA from both of the parents. For assisted reproduction, between two and four of the blastocyts may be transferred to the woman's uterus (womb) to implant and hopefully develop into a baby. Extra ("left-over") embryos may be stored for future use or may be donated for use in embryonic stem cell research.

Scientists can use donated blastocysts to create embryonic stem cell lines. To do this, they remove cells from the inner cell mass of a blastocyst and transfer these cells into another laboratory culture dish. The transferred cells then divide by mitosis to form many identical stem cells that can be used for research.

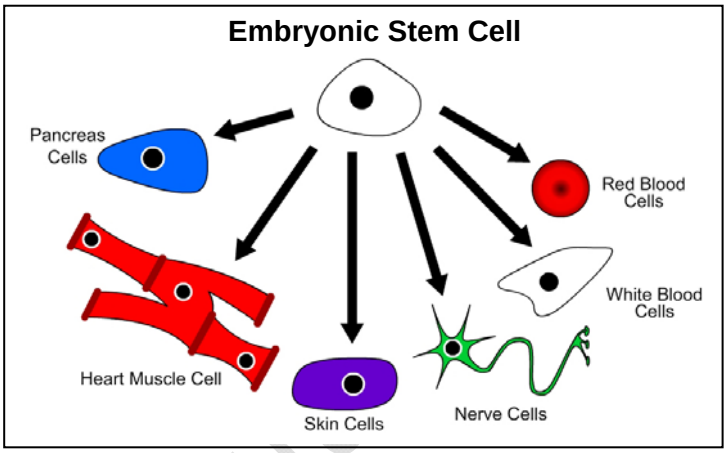
3. Use the information in the reading passage to arrange the diagram cards in the correct sequence to illustrate how *in vitro* fertilization is used to create an embryonic stem cell line.

4. Once you have arranged the cards in the correct sequence, record the order of the cards by writing the letters of the cards in the correct sequence on the lines below.

___ ___ ___ ___ ___ ___ ___ ___ ___ ___

5. Using the cards as a source of information, explain (in your own words) how *in vitro* fertilization is used to produce an embryonic stem cell line.

Part 3: Could Stem Cells Be Used to Treat Disease?



If scientists can make stem cells differentiate into specialized cells, these differentiated cells could then be transplanted into patients to replace cells lost or damaged by disease. In the future, stem cells may be used to treat diseases such as spinal cord injury, diabetes, and heart disease.

To make stem cells differentiate into specialized types of cells, scientists place them in environments that contain signal molecules called growth factors. These growth factors include proteins and other molecules that turn on, or turn off, the expression of specific genes that lead to specific cell structures and functions.

In this simulation you will begin with "cultures" of embryonic and adult stem cells and tubes of growth factors (signal molecules). By selecting a certain sequences of growth factors you may be able to create differentiated cells that could be used to treat different diseases.

A. Using EMBRYONIC stem cells to treat diseases

Imagine you are a scientist who would like to use the embryonic stem cells to produce three types of differentiated cells that could be used to treat three different diseases:

- Muscle cells used to treat heart damage
- Nerve cells used to treat spinal damage
- Pancreas cells used to treat diabetes

Your kit contains a tube of embryonic stem cells and 6 different types of growth factors (GF-A, GF-B, GF-C, GF-1, GF-2 and GF-3). Your job is to decide which growth factors to use to turn the embryonic stem cells into specific types of differentiated cells.

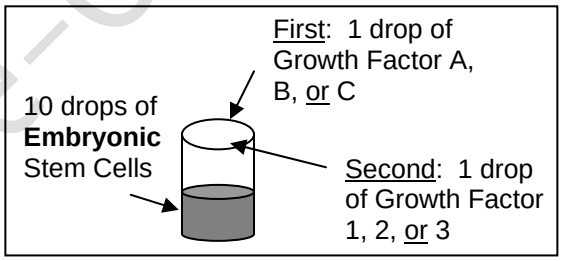
1. Use the information on the *Growth Factors and Stem Cell Differentiation Flow Chart* in your lab kit to complete Column 1, Column 2, and Column 3 of Data Table 1 on the following page. You will complete Column 4 in later steps.

Data Table 1: Using Embryonic Stem Cells to Treat Disease

Type of differentiated cell you are trying to produce from **embryonic** stem cells	**Column 1**	**Column 2**	**Column 3**	**Column 4**
	What growth factor should you add first?	What growth factor should you add second?	What color do you expect to see if the cells differentiated properly?	Did you succeed in turning **embryonic** stem cells into this cell type?
Muscle cells used to treat heart damage				
Nerve cells used to treat spinal cord damage				
Pancreas cells used to treat diabetes				

You will now use the information from your data table to see if you can get embryonic stem cells to differentiate into each of the cell types: muscle cells, nerve cells, and pancreas cells.

2. Use the information from your data table to see if you can get embryonic stem cells to differentiate into **muscle cells** that could be used to treat heart disease.



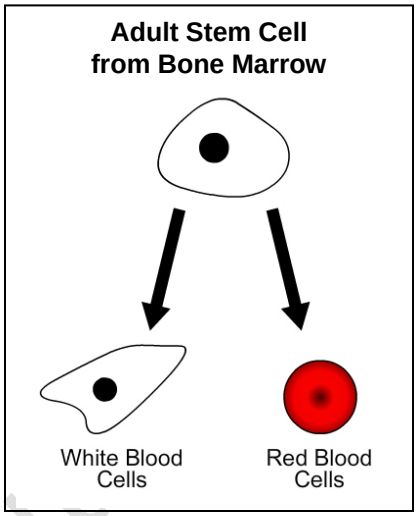
   - Use the "ESC" dropper to add 10 drops of embryonic stem cell culture to a clean small cup.
   - Add one drop of the first growth factor you selected (GF-A, GF-B, or GF-C) then add one drop of the second growth factor (GF-1, GF-2, or GF-3). *Hint: It is easier to see the resulting colors if you put the small cup on a white background.*
   - If you succeeded in turning embryonic stem cells into muscle cells that could be used to treat heart damage, write "Yes" in Column 4 of the appropriate row on Data Table 1. If not, write "No."

3. Use the information from your data table to see if you can get embryonic stem cells to differentiate into **nerve cells** that could be used to treat heart damage.
   - Use the "ESC" dropper to add 10 drops of embryonic stem cell culture to a clean small cup.
   - Add one drop of the first growth factor you selected then add one drop of the second growth factor.
   - If you succeeded in turning embryonic stem cells into nerve cells that could be used to treat spinal cord injuries, write "Yes" in Column 4 of the appropriate row on Data Table 1. If not, write "No."

4. Use the information from your data table to see if you can get embryonic stem cells to differentiate into **pancreas cells** that could be used to treat diabetes.
    - Use the "ESC" dropper to add 10 drops of embryonic stem cell culture to a clean small cup.
    - Add one drop of the first growth factor you selected then add one drop of the second growth factor.
    - If you succeeded in turning embryonic stem cells into pancreas cells that could be used to treat diabetes, write "Yes" in Column 4 of the appropriate row on Data Table 1. If not, write "No."

5. In this part of the lab (Part 3 A), you treated **embryonic** stem cells with growth factors. Summarize the results of your experiment by listing the types of specialized cells that you produced and the types of conditions that these cells could be used to treat.

B. Using ADULT stem cells to treat disease



Bone marrow stem cells usually divide and differentiate to only form red blood cells, white blood cells, or platelets. You wonder if you could use adult stem cells isolated from bone marrow, instead of embryonic stem cells, to treat heart damage, spinal cord injuries, or diabetes.

You want to see if you can add specific growth factors to adult bone marrow stem cells so that the adult bone marrow cells will differentiate into muscle cells, nerve cells, or pancreas cells.

1. Do you think that the information on the *Growth Factors and Stem Cell Differentiation Flow Chart* could be used to make bone marrow stem cells differentiate into muscle cells, nerve cells, and pancreas cells? Explain why or why not.

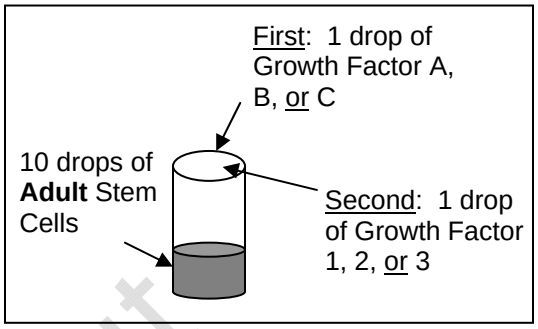
2. Use the information on the *Growth Factors and Stem Cell Differentiation* flow chart in your kit to complete the Columns 1, 2 and 3 on Data Table 2 below.

Data Table 2: Using Adult Stem Cells to Treat Disease

Type of differentiated cell you are trying to produce from **adult** stem cells	**Column 1** What growth factor should you add first?	**Column 2** What growth factor should you add second?	**Column 3** What color do you expect to see if the cells differentiated properly?	**Column 4** Did you succeed in turning **adult** stem cells into this cell type?
Muscle cells used to treat heart damage				
Nerve cells used to treat spinal cord damage				
Pancreas cells used to treat diabetes				

3. You will now use the tube of adult stem cells (ASC) in your kit, the growth factors, and the information from your data table to see if you can get adult stem cells to differentiate into each of the cell types: muscle cells, nerve cells, and pancreas cells.
   For each cell type, remember to:

   - Use the "ASC" dropper to add 10 drops of adult stem cell culture (ASC) to a clean small cup.
   - Add one drop of the first growth factor you selected then add one drop of the second growth factor.
   - If you succeeded in turning adult stem cells into each of the cell types, write "Yes" in Column 4 of the appropriate row on Data Table 1. If not, write "No."



4. In this part of the lab (Part 3 B), you treated **adult** stem cells with growth factors. Summarize the results of your experiment by listing the types of specialized cells that you produced and the types of health conditions that these cells could be used to treat.

5. Based on the results of your experiments with embryonic and adult stem cells, why do you think scientists feel it is important to be able to do research using **embryonic** stem cells?

Human embryonic stem cell research is controversial because the current technology requires destruction of embryos. Opponents of embryonic stem cell research argue that a human embryo is a human life that should not be destroyed. Supporters of embryonic stem cell research argue that this research should be pursued because embryonic stem cells are more likely to result in treatments for a variety of diseases. They also note that excess embryos created for in vitro fertilization could be donated with consent and used for the research.

6. Explain why opponents of stem cell research think that scientists SHOULD NOT be allowed to do research using **embryonic** stem cells.

7. Explain why supporters of stem cell research think that scientists SHOULD be allowed to do research using **embryonic** stem cells.

MATERIAL SAFETY DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name (as printed on the label): "Embryonic Stem Cells" (simulated)

Product identity: 0.1% bromothymol blue solution

Distributor: Science Take-Out, LLC. PO Box 205, Pittsford, NY 14534

Telephone number for information: (866)260-0501 Medical emergency phone number (Chemtrec): (800) 424-9300

Date of this MSDS: 7/6/09

2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients	CAS Numbers	% Weight/Volume	TLV Units
Bromothymol blue sodium salt	34722-90-2	0.1%	None established
Water	7732-18-5	99.9%	None established

3. HAZARDS IDENTIFICATION – for all pH buffer products

EMERGENCY OVERVIEW
Do not ingest. Avoid skin and eye contact. Avoid exposure to vapor or mists.

Potential Health Effects EYES: May cause irritation. SKIN: May cause slight irritation. INHALATION: n/a
INGESTION: May cause gastrointestinal discomfort

4. FIRST AID MEASURES

EYES - Flush with water for at least 15 minutes, raising and lowering eyelids occasionally. Get medical attention if irritation persists.

SKIN - Thoroughly wash exposed area for at least 15 minutes. Remove contaminated clothing. Launder contaminated clothing before reuse. Get medical attention if irritation persists.

INGESTION - Do not induce vomiting. If swallowed, if conscious, give plenty of water immediately and call a physician or poison control center. Never give anything by mouth to an unconscious person.

5. FIRE FIGHTING MEASURES

NFPA Rating: Health: 1 (slight) Fire: 0 Reactivity: 0
Extinguisher Media: Any means suitable for extinguishing surrounding fire
Firefighting Procedures: Firefighters should wear full protective equipment and NIOSH approved self-contained breathing apparatus.
Unusual Fire and Explosion Hazards: None

6. SPILL OR LEAK PROCEDURES

Ventilate area of spill. Clean-up personnel should wear proper protective equipment and clothing. Mop up, or absorb material with suitable absorbent and containerize for disposal.

7. HANDLING AND STORAGE

Store in a cool dry place. Handle using safe laboratory practices.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory Protection: None required
Ventilation: Local Exhaust: Preferred
Protective Gloves: Natural rubber, Neoprene, PVC or equivalent.
Eye Protection: Splash proof chemical safety goggles should be worn.
Other Protective Clothing or Equipment: Lab coat, apron, eye wash, safety shower.

9. PHYSICAL AND CHEMICAL PROPERTIES

Melting Point: <2°C
Vapor Pressure: Ca 50 @ 20°C
Specific Gravity (H_2O=1): ~1
Evaporation Rate: ~ same as water
Appearance and Odor: Green liquid

Boiling Point: >98°C
Vapor Density: ~ same as water
Percent Volatile by Volume: information not available
Solubility in Water: soluble

10. STABILITY AND REACTIVITY

Stability: Stable
Materials to Avoid: none known
Hazardous Decomposition Products: none
Reactive under what conditions: none known

11. TOXICOLOGICAL INFORMATION

Toxicity (rat) LD_{50}
Acute oral toxicity = information not available
Acute toxicity from vapor = information not available

Effects of Overexposure:
Acute: Irritation of eyes/skin
Chronic: Irritation of eyes/skin
Target Organs: Eyes, skin.
Primary Route(s) of Entry: Ingestion

12. ECOLOGICAL INFORMATION No data available

13. DISPOSAL CONSIDERATIONS
Waste Disposal Methods: Dispose in accordance with all applicable Federal, State and Local regulations. Always contact a permitted waste disposer (TSD) to assure compliance.

14. TRANSPORTATION INFORMATION No data available

15. REGULATORY INFORMATION No data available

16. ADDITIONAL INFORMATION

The information provided in this Material Safety Data Sheet represents data from the manufacturer and/or vendor and is accurate to the best of our knowledge. By providing this information, Science Take-Out LLC makes no guarantee or warranty, expressed or implied, concerning the safe use, storage, handling, precautions, and/or disposal of the products covered or the accuracy of the information contained in this fact sheet. It is the responsibility of the user to comply with local, state, and federal laws and regulations concerning the safe use, storage, handling, precautions, and/or disposal of products covered in this fact sheet.

MATERIAL SAFETY DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name (as printed on the label): "Adult Stem Cells" (simulated)

Product identity: Yellow food coloring – 0.01% Inorganic salts – 99.99%

Manufacturer: Science Take-Out, LLC
P.O. Box 205
Pittsford, NY 14534

Telephone number for information: (585)764-5400
Preparation date of this MSDS: 10/5/08
Medical emergency phone number (Chemtrec): (800) 424-9300

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2. COMPOSITION/INFORMATION ON INGREDIENTS
This product contains no hazardous materials as defied by the OSHA Hazards Communications Standard
Chemical Ingredients: Food coloring (0.01%); Inorganic salts (99.00%)
Chemical Name: N/A CAS Number: N/A
Formula: N/A Synonyms: N/A
Principle Hazardous Components: No Data TLV and PEL units: No Data
OSHA-PEL 10ppm (TWA): No Data

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3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW
Avoid skin and eye contact.

Potential Health Effects EYES: May cause irritation. SKIN: May cause irritation.

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4. FIRST AID MEASURES EYES - Flush with water for at least 15 minutes, raising and lowering eyelids occasionally. Get medical attention if irritation persists.
SKIN - Thoroughly wash exposed area.

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5. FIRE FIGHTING MEASURES No data available

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6. SPILL OR LEAK PROCEDURES
Wear proper eye and skin protection. Mop/wipe spill area. Rinse with water.

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7. HANDLING AND STORAGE Avoid eye and skin contact

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8. EXPOSURE CONTROLS/PERSONAL PROTECTION
Respiratory Protection: N/A Ventilation: N/A
Protective Gloves: Natural rubber, Neoprene, PVC or equivalent.
Eye Protection: Splash proof chemical safety goggles should be worn.
Other Protective Clothing or Equipment: None

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9. PHYSICAL AND CHEMICAL PROPERTIES
Molecular Weight: No data Melting Point: N/A
Boiling Point: No data Vapor Pressure: No data
Vapor Density (Air=1): No data Specific Gravity (H_2O=1): No data

Percent Volatile by Volume: No data Evaporation Rate (BuAc=1): No data
Solubility in Water: Soluble Appearance and Odor: Yellow liquid

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10. STABILITY AND REACTIVITY
Stability: Stable Conditions to Avoid: No data
Incompatibility (Materials to Avoid): None Hazardous Decomposition Products: No D
Hazardous Polymerization: Will not occur

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11. TOXICOLOGICAL INFORMATION
Toxicity Data: No data Effects of Overexposure: See section 3
Target Organs: Eyes and skin Primary Route(s) of Entry: Eye or skin contact.
Conditions Aggravated by Overexposure: See section 3

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12. ECOLOGICAL INFORMATION No data

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13. DISPOSAL CONSIDERATIONS Can be disposed of in the trash or down the sink.

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14. TRANSPORTATION INFORMATION D.O.T. SHIPPING NAME: N/A

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15. REGULATORY INFORMATION N/A

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16. ADDITIONAL INFORMATION
The information provided in this Material Safety Data Sheet represents data from the manufacturer and/or vendor and is accurate to the best of our knowledge. By providing this information, Science Take-Out LLC makes no guarantee or warranty, expressed or implied, concerning the safe use, storage, handling, precautions, and/or disposal of the products covered or the accuracy of the information contained in this fact sheet. It is the responsibility of the user to comply with local, state, and federal laws and regulations concerning the safe use, storage, handling, precautions, and/or disposal of products covered in this fact sheet

MATERIAL SAFETY DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name (as printed on the label): "Growth Factor A", "Growth Factor B" and "Growth Factor C" (simulated)

Product identity: 0.05% methyl red solution

Distributor: Science Take-Out, LLC. PO Box 205, Pittsford, NY 14534

Telephone number for information: (866)260-0501 Medical emergency phone number (Chemtrec): (800) 424-9300

Date of this MSDS: 7/6/09

2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients	CAS Numbers	% Weight/Volume	TLV Units
Methyl red	63451-28-5	0.05%	None established
Water	7732-18-5	99.9%	None established

3. HAZARDS IDENTIFICATION – for all pH buffer products

EMERGENCY OVERVIEW
Do not ingest. Avoid skin and eye contact. Avoid exposure to vapor or mists.

Potential Health Effects EYES: May cause irritation. SKIN: May cause slight irritation. INHALATION: n/a
INGESTION: May cause gastrointestinal discomfort

4. FIRST AID MEASURES

EYES - Flush with water for at least 15 minutes, raising and lowering eyelids occasionally. Get medical attention if irritation persists.

SKIN - Thoroughly wash exposed area for at least 15 minutes. Remove contaminated clothing. Launder contaminated clothing before reuse. Get medical attention if irritation persists.

INGESTION - Do not induce vomiting. If swallowed, if conscious, give plenty of water immediately and call a physician or poison control center. Never give anything by mouth to an unconscious person.

5. FIRE FIGHTING MEASURES

NFPA Rating: Health: 1 (slight) Fire: 0 Reactivity: 0
Extinguisher Media: Any means suitable for extinguishing surrounding fire
Firefighting Procedures: Firefighters should wear full protective equipment and NIOSH approved self-contained breathing apparatus.
Unusual Fire and Explosion Hazards: None

6. SPILL OR LEAK PROCEDURES

Ventilate area of spill. Clean-up personnel should wear proper protective equipment and clothing. Mop up, or absorb material with suitable absorbent and containerize for disposal.

7. HANDLING AND STORAGE

Store in a cool dry place. Handle using safe laboratory practices.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory Protection: None required
Ventilation: Local Exhaust: Preferred
Protective Gloves: Natural rubber, Neoprene, PVC or equivalent.
Eye Protection: Splash proof chemical safety goggles should be worn.
Other Protective Clothing or Equipment: Lab coat, apron, eye wash, safety shower.

9. PHYSICAL AND CHEMICAL PROPERTIES

Melting Point: <2°C
Vapor Pressure: Ca 50 @ 20°C
Specific Gravity (H_2O=1): ~1
Evaporation Rate: ~ same as water
Appearance and Odor: Green liquid

Boiling Point: >98°C
Vapor Density: ~ same as water
Percent Volatile by Volume: information not available
Solubility in Water: soluble

10. STABILITY AND REACTIVITY

Stability: Stable
Materials to Avoid: none known
Hazardous Decomposition Products: none
Reactive under what conditions: none known

11. TOXICOLOGICAL INFORMATION

Toxicity (rat) LD_{50}
Acute oral toxicity = information not available
Acute toxicity from vapor = information not available

Effects of Overexposure:
Acute: Irritation of eyes/skin
Chronic: Irritation of eyes/skin
Target Organs: Eyes, skin.
Primary Route(s) of Entry: Ingestion

12. ECOLOGICAL INFORMATION No data available

13. DISPOSAL CONSIDERATIONS
Waste Disposal Methods: Dispose in accordance with all applicable Federal, State and Local regulations. Always contact a permitted waste disposer (TSD) to assure compliance.

14. TRANSPORTATION INFORMATION No data available

15. REGULATORY INFORMATION No data available

16. ADDITIONAL INFORMATION

The information provided in this Material Safety Data Sheet represents data from the manufacturer and/or vendor and is accurate to the best of our knowledge. By providing this information, Science Take-Out LLC makes no guarantee or warranty, expressed or implied, concerning the safe use, storage, handling, precautions, and/or disposal of the products covered or the accuracy of the information contained in this fact sheet. It is the responsibility of the user to comply with local, state, and federal laws and regulations concerning the safe use, storage, handling, precautions, and/or disposal of products covered in this fact sheet.

MATERIAL SAFETY DATA SHEET

1. PRODUCT AND COMPANY IDENTIFICATION

Label on Tube	Contents
Growth Factor 1	Buffer pH 3 + yellow food coloring
Growth Factor 2	Buffer pH 7 + yellow food coloring
Growth Factor 3	Buffer pH 10 + yellow food coloring

Distributor: Science Take-Out, LLC. PO Box 205, Pittsford, NY 14534
Telephone number for information: (585)764-5400 Medical emergency phone number (Chemtrec): (800) 424-9300
Date of this MSDS: 9/29/09

2. COMPOSITION/INFORMATION ON INGREDIENTS

Product	Ingredients	CAS Numbers	% Weight/Volume (balance is water)
pH 3 buffer	Sulphamic acid Potassium biphthalate	5329-14-16 877-24-7	0.10% 0.35%
pH 7 buffer	Potassium phosphate monobasic Sodium phosphate dibasic	7778-77-0 7558-79-4	0.15% 0.30%
pH 10 buffer	Sodium carbonate Sodium bicarbonate	497-19-8 144-55-8	0.25% 0.15%

For all the ingredients OSHA PEL: TWA – none estab. STEL – none estab.
ACGIH TLV: TWA – none estab. STEL – none estab.
NIOSH REL: TWA – none estab. STEL – none estab.
NIOSH ILDH: none estab.

3. HAZARDS IDENTIFICATION – for all pH buffer products

EMERGENCY OVERVIEW
Do not ingest. Avoid skin and eye contact. Avoid exposure to vapor or mists.

Potential Health Effects EYES: May cause irritation. SKIN: May cause irritation. INHALATION: n/a
INGESTION: May cause gastrointestinal discomfort and mouth burns .

4. FIRST AID MEASURES – for all pH buffer products

EYES - Flush with water for at least 15 minutes, raising and lowering eyelids occasionally. Get medical attention if irritation persists.

SKIN - Thoroughly wash exposed area for at least 15 minutes. Remove contaminated clothing. Launder contaminated clothing before reuse. Get medical attention if irritation persists.

INGESTION - Do not induce vomiting. If swallowed, if conscious, give plenty of water immediately and call a physician or poison control center. Never give anything by mouth to an unconscious person.

5. FIRE FIGHTING MEASURES – for all pH buffer products

NFPA Rating: Health: 1 Fire: 0 Reactivity: 0
Extinguisher Media: Any means suitable for extinguishing surrounding fire
Special Firefighting Procedures: Firefighters should wear full protective equipment and NIOSH approved self-contained breathing apparatus.
Unusual Fire and Explosion Hazards: No data available

6. SPILL OR LEAK PROCEDURES – for all pH buffer products

Ventilate area of spill. Clean-up personnel should wear proper protective equipment and clothing. Absorb material with suitable absorbent and containerize for disposal.

7. HANDLING AND STORAGE – for all pH buffer products

Store in a cool dry place. This Material is not considered hazardous. Handle using safe laboratory practices.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION – for all pH buffer products

Respiratory Protection: n/a
Ventilation: Local Exhaust: Preferred
Mechanical(General): Acceptable
Special: No
Other: No
Protective Gloves: Natural rubber, Neoprene, PVC or equivalent.
Eye Protection: Splash proof chemical safety goggles should be worn.
Other Protective Clothing or Equipment: Lab coat, apron, eye wash, safety shower.

9. PHYSICAL AND CHEMICAL PROPERTIES – for all pH buffer products

Melting Point: ~0°C Boiling Point: ~100°C
Vapor Pressure: information not available Vapor Density: information not available
Specific Gravity (H_2O=1): ~1 Percent Volatile by Volume: >99
Evaporation Rate: information not available Solubility in Water: soluble
Appearance and Odor: Clear colorless liquid

10. STABILITY AND REACTIVITY – for all pH buffer products

Stability: Stable Materials to Avoid: strong acids and bases
Hazardous Decomposition Products: none known Hazardous Polymerization: will not occur

11. TOXICOLOGICAL INFORMATION

Ingredient	Toxicity (oral-rat) LD_{50}
Sulphamic acid	3160 mg/kg
Potassium biphthalate	3200 mg/kg
Sodium phosphate dibasic	17 g/kg
Potassium phosphate monobasic	7100 mg/kg
Sodium carbonate	4090 mg/kg
Sodium bicarbonate	4220 mg.kg

Effects of Overexposure (for all pH buffers):
Acute: Essentially non-hazardous. Possible irritation of eyes/skin/stomach
Chronic: None known.
Conditions aggravated/Target organs: none known
Target Organs: Eyes, skin, and gastrointestinal tract.
Primary Route(s) of Entry: Ingestion or skin contact.

12. ECOLOGICAL INFORMATION – for all pH buffer products No ecological data available

13. DISPOSAL CONSIDERATIONS – for all pH buffer products

Waste Disposal Methods: Dispose in accordance with all applicable Federal, State and Local regulations. Always contact a permitted waste disposer (TSD) to assure compliance.

14. TRANSPORTATION INFORMATION D.O.T. SHIPPING NAME: Not regulated

15. REGULATORY INFORMATION – for all pH buffer products

EPA regulations: RCRA Hazardous waste number (40 CFR 261.33) – not listed
RCRS Hazardous waste classification (40 CFR 261) – not classified
SARA Toxic Chemical (40 CFR 372.65) – not listed
SARA EHS (Extremely Hazardous Substance (40 CFR 355) – not listed
OSHA regulations: Air Contaminant (29 CFR 1910.1000) – not listed

16. ADDITIONAL INFORMATION

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or warranty, expressed or implied, concerning the safe use, storage, handling, precautions, and/or disposal of the products covered or the accuracy of the information contained in this fact sheet. It is the responsibility of the user to comply with local, state, and federal laws and regulations concerning the safe use, storage, handling, precautions, and/or disposal of products covered in this fact sheet.