2A2B HUMAN BIOLOGY

EXTENDED RESPONSE – STEM CELLS AND TISSUE ENGINEERING

Name: Answer key Teacher: _____ Due: _____ /32

One of the most recent advancements in medical technology has been the use of stem cell cloning to provide the raw material required for tissue engineering. The applications of this range from blood vessel replacement and skin, bone and tendon repair, to the treatment of degenerative nerve diseases.

- Write the question number before each answer.
- Write answers in own words.
- Use your 'useful terms in science' handout to help you answer the questions correctly.
- Staple your written or typed answers to the back of this booklet when handing in.

1. **State** which type of stem cell is more versatile; pluripotent stem cells or multipotent stem cells, and **explain** why. (2 marks)

2. **List** two currently accepted and routinely practiced stem cell therapies. (2 marks)

3. **Outline** two benefits of using a tissue engineered skin product, such as Apligraf, to treat wounds that require grafts. (2 marks)

4. 'Creating human embryonic stem cells destroys a life' is a common belief in society. Respond to this statement by **describing** three advantages and three disadvantages of using embryonic stem cells for research. (6 marks)

5. Embryonic stem cells are capable of self-renewal and are quite prolific in the lab (many cells can be made). **Explain** why is this appealing to scientists. (1 mark)

6. **Describe** the benefits of using stem calls to study diseases and to test the effects of new drugs. (2 marks)

7. In regards to how the stem cells are obtained, **explain** which stem cell type you would feel most comfortable using if you required the assistance of stem cells to cure a disease. **Explain** your choice. (2 marks)

1. **State** which type of stem cell is more versatile; pluripotent stem cells or multipotent stem cells, and **explain** why. (2 marks)

Pluripotent (1)
They can form into any cell of the body. (1) OR they can make copies of themselves (self renew)

2. **List** two currently accepted and routinely practiced stem cell therapies. (2 marks)

Bone marrow transplants (1)

Cord blood transplants (1)

3. **Outline** two benefits of using a tissue engineered skin product, such as Apligraf, to treat wounds that require grafts. (2 marks)

- ***FDA Approved:***
  Apligraf® is an FDA approved product that has been evaluated in multiple controlled clinical studies and is proven to be effective, safe, and to accelerate healing. Many wound care products cannot make such claims.

- ***Superior healing compared to basic wound care:***
  Apligraf® heals more wounds (30% to 50% more) and heals them faster (in 1/3 less time).

- ***Active vs. passive wound healing:***
  Many wound therapies are designed to passively manage the wound. Apligraf® plays a more active role by delivering to the wound living cells, proteins produced by the cells, and collagen, which are important for healing as growth factors, cells, and proteins directly to the wound.

- ***A living therapy similar to our own skin:***
  Apligraf® is the only living cell based treatment containing two different types of skin cells combined with collagen, and is close in structure to natural human skin.

- ***Easy:***
  Apligraf® typically requires no daily maintenance. Dressings are usually changed once a week by your doctor or nurse, depending on your wound type.

ANY TWO (2)

4. 'Creating human embryonic stem cells destroys a life' is a common belief in society. Respond to this statement by **describing** three advantages and three disadvantages of using embryonic stem cells for research. (6 marks)

Advantage	Disadvantage
Are pluripotent and can form into any type of cell in the body	Patient may reject cells because they are not from own body
Unused embryos can be donated for research	Embryo is destroyed (loss of potential life)
Can be grown in large numbers in the laboratory (self renewing)	Can carry risk of cancer if not treated properly before transferred into patient.
Can be frozen and stored indefinitely whilst retaining viability	

ANY THREE (3) ANY THREE (3)

5. Embryonic stem cells are capable of self-renewal and are quite prolific in the lab (many cells can be made). **Explain** why is this appealing to scientists. (1 mark)

Because they only need a small number of embryonic stem cells to make a culture. (1)

6. **Describe** the benefits of using stem calls to study diseases and to test the effects of new drugs. (2 marks)

Reduces the need to use other animals (1)
(Other animals have different genes to us and express different proteins, which may not react the same way to drugs as humans do.) (1)

7. In regards to how the stem cells are obtained, **explain** which stem cell type you would feel most comfortable using if you required the assistance of stem cells to cure a disease. **Explain** your choice. (2 marks)

Various answers.

Either embryonic stem cells or adult stem cells.

Using the timeline on the following page, answer the questions below.

1. When was the first bone marrow transplant performed and in which country? (1 mark)

1956, USA

2. Would the scientists who performed this transplant have necessarily known which cells in the blood helped cure the patient? Explain. (2 marks)

Not necessarily. Canadian scientists Till & McCulloch only proved the existence of stem cells in bone marrow in 1961

3. When were embryonic stem cells discovered? (1 mark)

1981

4. How long after starting bone marrow transplants was cord blood transfusions used to treat disease of the blood? (1 mark)

32 years.

5. How long did it take for scientists to publish work on human embryonic stem cells (hESCs) after embryonic stem cells were first derived from mice? (1 mark)

17 years

6. What is the significance of Dolly the sheep? (2 marks)

First mammal cloned from an adult (somatic) cell.

7. Locate on the time line all references to Somatic Cell Nuclear Transfer (SCNT) and answer the following questions.

a) When did scientists first publish findings on SCNT and in which organism? (1 mark)

2000 in mice

b) How long after Dolly the sheep were the first successful SCNT produced in humans? (1 mark)

Never.

8. What are MSCs? (1 mark)

Mesenchymal stem cells

a) Are MSCs embryonic stem cells or tissue stem cells? (1 mark)

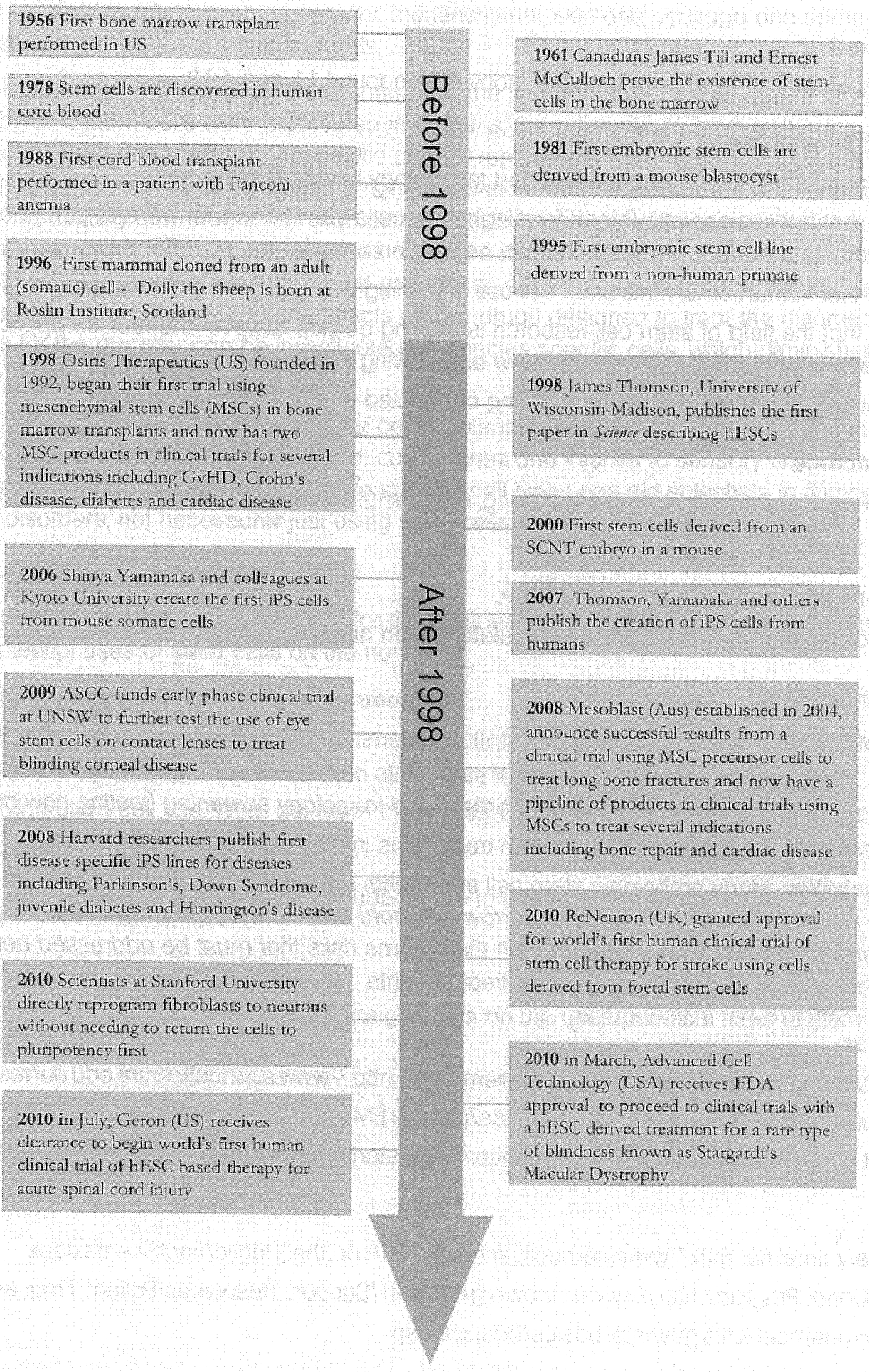
Tissue stem cells.

b) Name three disorders on which scientists are trialing their use? (1 mark)

Crohns disease, diabetes, cardiac disease bone repair

9. When did scientists first report the approval to start a clinical trial with human embryonic stem cells and for what purpose? (2 marks)

- 2010 - clinical trial working on a rare type of blindness (stargardt's macular dystrophy).
- 2010 - Clinical trial using neural cells to treat spinal cord injury.


Before 1998
After 1998
1956 First bone marrow transplant performed in US
1961 Canadians James Till and Ernest McCulloch prove the existence of stem cells in the bone marrow
1978 Stem cells are discovered in human cord blood
1981 First embryonic stem cells are derived from a mouse blastocyst
1988 First cord blood transplant performed in a patient with Fanconi anemia
1995 First embryonic stem cell line derived from a non-human primate
1996 First mammal cloned from an adult (somatic) cell - Dolly the sheep is born at Roslin Institute, Scotland
1998 Osiris Therapeutics (US) founded in 1992, began their first trial using mesenchymal stem cells (MSCs) in bone marrow transplants and now has two MSC products in clinical trials for several indications including GvHD, Crohn's disease, diabetes and cardiac disease
1998 James Thomson, University of Wisconsin-Madison, publishes the first paper in Science describing hESCs
2000 First stem cells derived from an SCNT embryo in a mouse
2006 Shinya Yamanaka and colleagues at Kyoto University create the first iPS cells from mouse somatic cells
2007 Thomson, Yamanaka and others publish the creation of iPS cells from humans
2009 ASCC funds early phase clinical trial at UNSW to further test the use of eye stem cells on contact lenses to treat blinding corneal disease
2008 Mesoblast (Aus) established in 2004, announce successful results from a clinical trial using MSC precursor cells to treat long bone fractures and now have a pipeline of products in clinical trials using MSCs to treat several indications including bone repair and cardiac disease
2008 Harvard researchers publish first disease specific iPS lines for diseases including Parkinson's, Down Syndrome, juvenile diabetes and Huntington's disease
2010 ReNeuron (UK) granted approval for world's first human clinical trial of stem cell therapy for stroke using cells derived from foetal stem cells
2010 Scientists at Stanford University directly reprogram fibroblasts to neurons without needing to return the cells to pluripotency first
2010 in March, Advanced Cell Technology (USA) receives FDA approval to proceed to clinical trials with a hESC derived treatment for a rare type of blindness known as Stargardt's Macular Dystrophy
2010 in July, Geron (US) receives clearance to begin world's first human clinical trial of hESC based therapy for acute spinal cord injury