Full Name:	Civics group:	Index no.:	Date:
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Core Idea 1: Cells and Biomolecules of Life Stem Cells Tutorial 12

MCQ

1	2	3	4	5	6	7	
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1 Which of the following shows the correct developmental potency of the following stem cells?

	Zygotic stem cells	Embryonic stem cells	Myeloid stem cells	Neural stem cells
Α	Pluripotent	Totipotent	Multipotent	Unipotent
В	Totipotent	Pluripotent	Multipotent	Unipotent
С	Pluripotent	Totipotent	Pluripotent	Multipotent
D	Totipotent	Pluripotent	Multipotent	Multipotent

- 2 Which of the following best illustrates totipotency?
 - A A somatic cell isolated from a root tip develops into a normal adult plant.
 - B Stem cells are able to divide indefinitely.
 - **C** Mesenchymal stem cells can differentiate into an extensive range of cell types, including bone cells, cartilage cells, muscle cells and fat cells.
 - **D** The replacement of the nucleus of an unfertilised egg with that of a pancreatic cell converts the egg into a pancreatic cell.
- **3** Which of the following statements is/are true regarding zygotic stem cells and cancer cells?
 - **1** Both are able to move from one location to another.
 - 2 Both are able to divide by mitotic division.
 - **3** Both are specialised cells and capable to differentiate further.
 - 4 Both are capable of indefinite replication.
 - A 2 only
 - **B** 1 and 3 only
 - **C** 2 and 4 only
 - **D** 1, 2 and 4 only

- 4 What is the role of stem cells with regard to the function of adult tissues and organs?
 - A Stem cells are fully differentiated cells that reside under the surface of epithelial tissue, in position to take over the function of the tissue when the overlying cells become damaged or worn out.
 - **B** Stem cells are embryonic stem cells that persist in the adult, and can give rise to all of the cell types in the body.
 - **C** Stem cells are differentiated cells that have yet to express the genes and produce proteins characteristic of their differentiated state, and do so when needed for repair of tissues and organs
 - D Stem cells are undifferentiated cells that divide asymmetrically, giving rise to one daughter cell that remains a stem cell and one daughter that will differentiate to replace damaged and worn out cells in the adult tissue or organ.

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5 Stem cells are found in many tissues that require frequent cell replacement such as the skin, the intestine and the blood.

However, within their own environments, a bone marrow cell cannot be induced to produce a skin cell and a skin cell cannot be induced to produce a blood cell.

Which statement explains this?

- A Different stem cells have only the genes required for their particular cell line.
- **B** Genes not required for the differentiation of a particular cell line are methylated.
- **C** Binding of repressor molecules prevents the expression of genes not required for a particular cell line.
- **D** Expression of genes not required for a particular cell line is controlled at translational level.
- 6 All the following statements about stem cells are true except
 - A Cord blood stem cells will only give rise to blood cells.
 - **B** Cord blood from the newborn is a source of adult stem cells.
 - **C** Adult somatic cells can be reprogrammed to behave like embryonic stem cells.
 - **D** Cord blood stem cells are pluripotent.
- 7 Which of the following is a valid ethical concern on the use of stem cells?
 - **A** Use of adult stem cells could result in the formation of new organism.
 - **B** Totipotent stem cells should be recommended as they are in huge abundance.
 - **C** Skin stem cells usage should be prohibited as they are limited in quantities
 - D Embryonic stem cells retrieval results in the destruction of human embryos.

STRUCTURED QUESTIONS

QUESTION 1

(a) Describe the features of myeloid and lymphoid stem cells and discuss their use in the treatment of leukemia.

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(b) Describe the differences between stem cells and cancer cells
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MYP LLAND UP
[3]
[TOTAL: 9]

QUESTION 2 [Worked example – Ans at the back]

Describe the features of zygotic and embryonic stem cells that distinguish them from each other.

	[4]
	[TOTAL: 4]

QUESTION 3

The response of the human body to tissue damage depends on the types of tissues involved. Epithelial tissue, liver tissue and cardiac muscle tissue each respond differently to damage.

- Epithelial tissue in the lungs contain stem cells.
- Liver tissue contains cells that can divide when stimulated.
- Cardiac muscle tissue contains cells that cannot divide at all. Damage is permanent and is associated with scar tissue formation.

Researchers hope to repair heart tissue damaged by heart attacks. Cellular therapy using stem cells offer ways to replace damaged cardiac muscle tissue.

Some fully differentiated cells from the patient can be reprogrammed into stem cells in tissue culture as seen in Fig. 3.1. Such cells are called induced pluripotent stem cells (iPSCs).



Fig. 3.1

(a) Outline two advantages of using induced pluripotent stem cells (iPSCs) in a patient suffering from a heart attack, to generate cardiac muscle for treatment.

In experiments with mice, it was discovered that the introduction of four specific genes that code for transcription factors would reprogramme fully differentiated cells to iPSCs.

(b) Suggest how the insertion of genes coding for transcription factors can cause a differentiated cell to become pluripotent.

There is evidence to suggest that the introduction of the four genes has caused an increase in the production of telomerase in the fully differentiated cells.

(c) Explain how telomerase may contribute to the re-programming of mouse skin cells into stem cells.



Scientists investigated the use of iPSCs to treat type I diabetes in mice. The scientists reprogrammed skin cells to form iPSCs. They inserted a normal copy of the insulin gene into the cells to correct the gene mutation. The scientists then stimulated the *in vitro* differentiation of iPSCs into pancreatic stem cells.

The scientists set up three experimental groups:

- Group A 30 mice with type I diabetes received pancreatic stem cell transplants derived from iPSCs.
- Group **B** 30 mice with type I diabetes were left untreated.
- Group **C** 30 mice without diabetes were left untreated.

The scientists measured the fasting blood glucose concentration of all the mice on a weekly basis for 12 weeks.



The results the scientists obtained are shown in Fig. 3.2



(d) Using all the information provided, discuss the effectiveness of iPSCs to treat type I diabetes in humans.



(e) Suggest one advantage of using stem cell therapy in treating type I diabetes.



QUESTION 4

A cybrid (cytoplasmic hybrid cell) is produced as shown in Fig. 4.1.





(a) The DNA of such a cybrid is 99.6% human. The remaining 0.4% of the DNA is in the cytoplasm. Explain the presence of the 0.4% DNA in the cytoplasm.
[1]
(b) Suggest an explanation to why the UK regulations do not allow blastocysts used in research to be developed beyond 14 days.
[1]
[1]
(c) Some people argued that it is unethical to allow the production of cybrids and its use in treatment.
State whether you agree or disagree that this is unethical and explain why you reached this decision.
Choose a stand first.
[2]
[Total. 4]
ROAR
UP AND ON

QUESTION 2 ANSWER

Feature	Zygotic stem cells	Embryonic stem cells
Source of	Derived from the cells of the	Derives from the inner cell mass
cells	morula	of the blastocyst
Potency	Totipotent – they can divide and	Pluripotent – they can divide and
	then their progenitor cells can	then their progenitor cells can
	differentiate into any cell type	differentiate into any cell type
		except extra-embryonic tissues
		such placenta, chorion, amniotic
		sac etc.
Normal	Divide via mitosis and	Divide via mitosis and
function	differentiate to form a	differentiate into specialised
	blastocyst that eventually forms	tissues to form specific organs
	the whole organism	of the organis <mark>m</mark>
Use in	Not used in therapy;	Use in therapy <mark>;</mark>
therapy	Difficult to harvest due to the	Easier to harvest from the
	small number of cells in the	blastocyst and have
	morula (~16) and their rapid	approximately the same
	division to form a blastocyst (~2-	differentiation potential as zygotic
	3 days)	stem cells.



ACTIVITY – CORD BLOOD DONATION

Cord blood banks are facilities that store cord blood derived from the umbilical cord during delivery. These are either run by the government (e.g. Singapore Cord Blood Bank) or by private companies (e.g. Cordlife).

Pregnant women are approached by cord-blood banks to decide whether they want to store the cord blood of their baby for the immediate family's use for a fee or donate it to the public cord-blood bank or for research free of charge.

Task 1 (to be done before tutorial)

Imagine you are pregnant/your wife is pregnant with your first child. You are approached by the Singapore Cord Blood Bank. The agent provides you 2 resources: **#1 Brochure** explaining benefits of cord blood in therapy, Public Donation and Family Banking of cord blood and **#2 Fee schedule** for Family banking. You may also choose to not donate/store the cord blood in which case it is discarded after the baby's delivery.

Using the information provided in the brochure and fee schedule and, **your own research** about cord blood banking, take a stance on whether you want to donate/store and if you do then would you opt for Public Donation or Family Banking. Describe at least 3 reasons to support your stance. Complete the box below:



Task 2 (In class activity) – Divide the class into smaller groups based on their stance and discuss the reasons behind their stance in class.



Resource #1 page 3 – FAQs about cord blood storage

Frequently Asked Questions

1. What is cord blood?

Cord blood is rich in blood stem cells, and is usually disposed after a baby's birth. If successfully stored, it can be used to treat blood cancers and disorders.

2. What is Community Cord Blood Banking?

SCBB Community Cord Blood Banking is an ethical approach to cord blood banking which provides parents with clear and balanced information to educate and enable parents to make an informed decision, with full autonomy of choice. It includes both public donation as well as family banking services. Public banking (also known as Cord Blood Donation) remains SCBB's core mission and focus.

3. What is the difference between family banking offered by SCBB and other private banks?

The key difference is that parents can choose to donate their cord blood in future, subject to the donation criteria, if they decide not to continue with family storage. This will potentially increase the public inventory, to save the lives of more patients. with blood cancer or disorder.

4. What is the storage duration for SCBB family banking?

SCBB offers an initial storage period of five years. Depending on the growth and well-being of the child in the first five years, parents can then decide if they would like to continue storage.



" The birth of a child is such a wonderful moment. Make it even more special by giving the gift of life to another person in need! Donate your baby's cord blood!

Mandy Loh (2-time Cord Blood Donor)

66

cord blood when we know that it could help save someone's life. 99



Jannathnisha Binte Mohideen Pitchay (4-time Cord Blood Donor)



Laboratory

c/o KK Women's & Children's Hospital 100 Bukit Timah Road, Women's Tower Basement 1, Unit 0B60A, Singapore 229899

Management Office 37 Jalan Pemimpin #04-14 Mapex

Singapore 577177



Resource #2 - Fee Schedule from

Singapore Cord Blood Bank for Family Banking

Fee Schedule

21 years

A. Cord Blood Banking Service

Cord Blood Banking Service :
Direct Family

Babies in this pregnancy	:	One	🗆 Twins

Storage Period

Annual	5 Years

Randaa	Direct Family				
Service	Annual	5 Years	21 Years		
Cord Blood Banking Fee	\$1,100				
Storage Fee	\$250	\$1,250	\$5,250		
Storage Fee Discount*	NA	10%	26%		
Total Fee	\$1,350	\$2,225	\$4,985		

*Additional discount of 10% applies if either one or both parents are working in healthcare

B. Additional Tests Yes (Select below) □ No

Newborn Screening – Hemoglobinopathy \$75.00

Evaluation of inherited blood disorders like sickle cell disease and thalassemia

Human Leucocyte Antigen (HLA) Typing...... \$175.00

HLA typing is a genetic test performed to determine tissue type of a person. This data will be used to perform matching of donor and recipient during transplantation.

- The Service Fee stated are in Singapore Dollars (S\$) and are exclusive of and shall be subjected to payment of goods and services tax ("GST") imposed under the prevailing legislation which shall be payable by Client. The applicable GST shall be incorporated in the total amount in SCBB's invoice.
- The Client shall pay the Service Fee and any applicable fee for additional tests to SCBB within thirty (30) days1 from the date of invoice
- If the banking services is extended for twin pregnancy, the Total Fee shall be multiplied by . two

Client's Signature

Date

Client's Name

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It is wasteful to discard

¹ Credit terms may not be applicable if the payment is by Child Development Account.