Civics Group	Index Number	Name (use BLOCK LETTERS)

H1

ST ANDREW'S JUNIOR COLLEGE
2022 JC2 Weighted Assessment 1

H1 BIOLOGY **8876**

STRUCTURED QUESTIONS

45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagram, graph or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
All working for numerical answers must be shown.

Conceptual error (C)	Data Quoting (D)	Expression (E)	Misreading the question (Q)

For Examiner's Use	
STQ 1	/14
STQ 2	/12
Total	**/26**

This document consists of 6 printed pages.

[Turn over

QUESTION 1

BRCA 1 and BRCA2 are tumour suppressor genes which code for tumour suppressor proteins associated with DNA repair. Women with harmful mutations in either *BRCA1* or *BRCA2* are five times more likely to develop breast cancer and 10-30 times more likely to develop ovarian cancer than women without any BRCA mutations. Fig. 1.1 shows the progression of breast cancer.

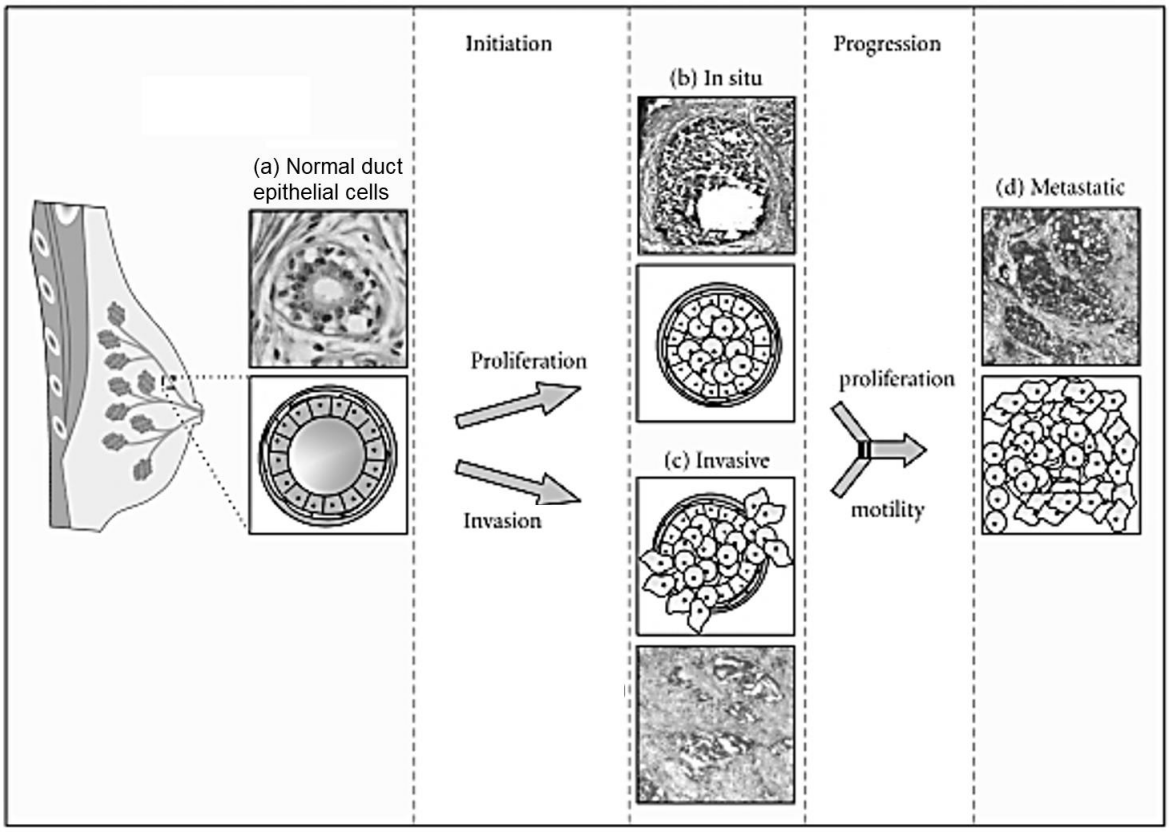

Fig. 1.1

(a) (i) Describe and explain how the multi-step process of cancer development relates to the information given as well as Fig 1.1.

…… [6]

1 Accumulation of many mutations, including BRCA 1 and BRCA2
2 lead to **excessive proliferation** of the duct epithelial cells
3 Activation of telomerase gene enables cells to **divide indefinitely**.
4 Further mutations can lead to loss of contact inhibition/density-dependent inhibition which leads to **tissue invasion**.
5 Ref. Formation of benign tumour.
6 Loss of anchorage-dependent inhibition leads to metastasis/motility.
7 At this point, the tumour is considered malignant.

(ii) Compare between cancerous breast duct epithelial cells and normal epithelial stem cells.

…… [4]

Similarities:
1 Both are unspecialised and undifferentiated.
2 Both can replicate indefinitely / both have telomerase activity.

Differences [any 2]:

	Cancerous epithelial cell	Stem epithelial cell
Ability to differentiate	Do not differentiate into other cell types.	Differentiate into duct epithelial cells.
Cell division	Undergo uncontrolled cell division.	Undergo normal cell division.
Anchorage-dependent inhibition	Do not exhibit anchorage-dependent inhibition. /density-dependent /contact-dependent	Exhibit anchorage-dependent inhibition. /density-dependent /contact-dependent

(b) Fig. 1.2 shows the various types of cells that are found in the human skin. Cells in the spinous layer, granular layer and stratum corneum provides a barrier protection against pathogens in the external environment. Stem cells in the basal layer will divide and differentiate into committed progenitors, which can only divide a limited number of times to give rise to cells in the layers above it. Only 2-7% of the cells in the basal layer are stem cells.

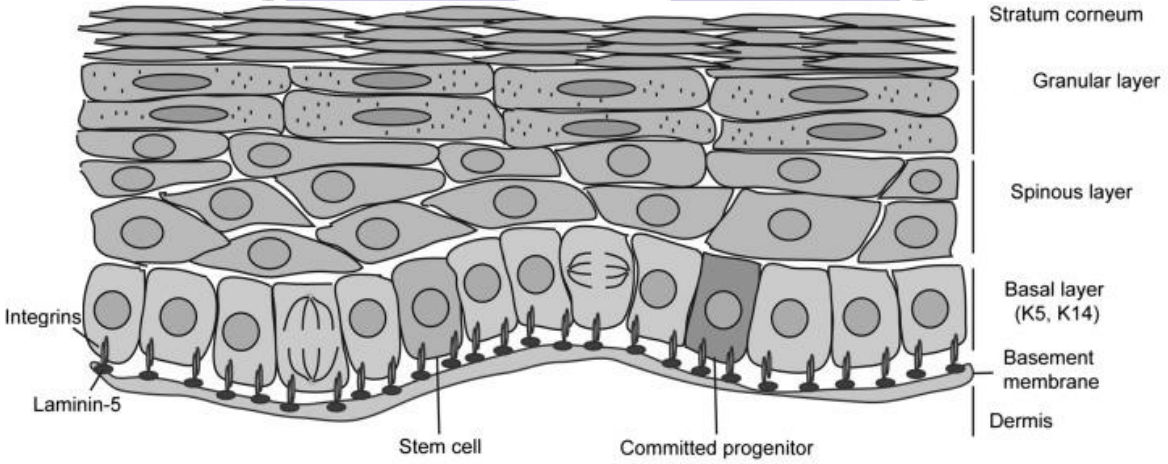

Fig. 1.2

(i) Describe the differences between the skin stem cell and the committed progenitor cell.

…… [2]

1 Skin stem cells are capable of **self renewal** / has **telomerase** while committed progenitors cells do not have/lower self-renewal ability / no telomerase.

2 Skin stem cells have **higher** potency level than committed progenitor cells. (note: both may be multipotent. But committed progenitor cells are more limited in the types of cells they can differentiate into)

Human induced pluripotent stem cells (hiPSCs) have been recognized as a possible source of cells for skin tissue engineering. They have the potential to greatly benefit patients with large areas of burned skin or skin defects. Fig. 1.3 shows an outline of the production if hiPSCs and its use in treating burn victims.

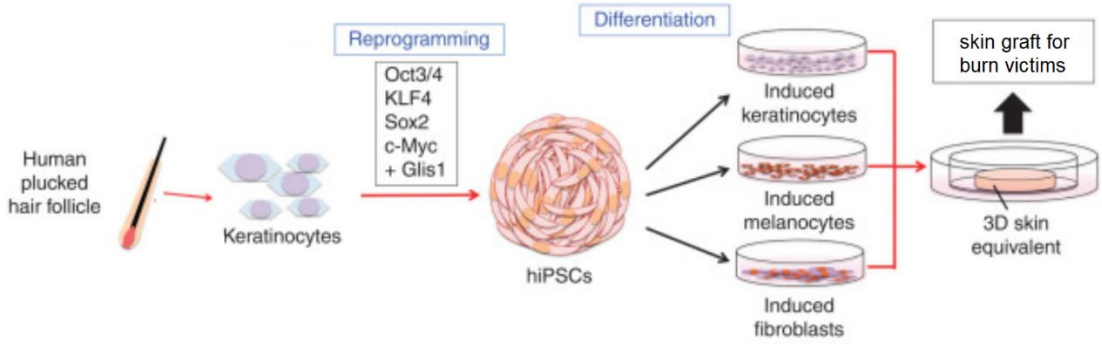

Fig. 1.3

(ii) Suggest two advantages of using hiPSCs over the use of other types of treatment for burn victims.

…… [2]

1 No tissue rejection because the patient's own cells are used to produce the iPSCs, compared with using a donor's stem cells.
2 Fewer ethical concerns because no human blastocysts were destroyed in the process, compared with the use of human embryonic stem cells.
3 Non-invasive as you just need to pluck a hair from the patient, compared to grafting skin from another part of the patient's body.
4 No need to find a matching donor.

[Total: 14]

QUESTION 2

In a species of pea plants, the plants can produce smooth seed pods or constricted seed pods with seeds ranging from two to four seeds each. Fig. 2.1 shows the appearance of some seed pods that can be observed.

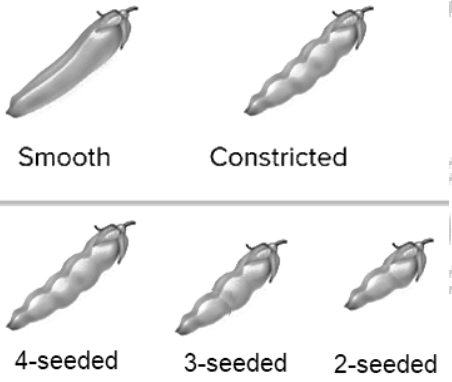

Fig. 2.1

A pure-breeding plant with 4-seeded constricted pods was crossed with a pure-breeding plant with 2-seeded smooth pods. All the F_1 generation had 3-seeded constricted pods. The F_1 generation were selfed to produce F_2 generation.

(a) Draw a genetic diagram to show the selfing of the F_1 generation.

…….. [4]

F_1 phenotype: 3-seeded constricted pods X 3-seeded constricted pods

F_1 genotype: CcS^FS^f CcS^FS^f

F_1 gametes: (circled) CS^F CS^f cS^F cS^f (circled) CS^F CS^f cS^F cS^f

	CS^F	CS^f	cS^F	cS^f
CS^F	CCS^FS^F 4-seeded constricted pod	CCS^FS^f 3-seeded constricted pod	CcS^FS^F 4-seeded constricted pod	CcS^FS^f 3-seeded constricted pod
CS^f	CCS^FS^s 3-seeded constricted pod	CCS^fS^f 2-seeded constricted pod	CcS^FS^f 3-seeded constricted pod	CcS^fS^f 2-seeded constricted pod
cS^F	CcS^FS^F 4-seeded constricted pod	CcS^FS^f 3-seeded constricted pod	ccS^FS^F 4-seeded smooth pod	ccS^FS^f 3-seeded smooth pod
cS^f	CcS^FS^f 3-seeded constricted pod	CcS^fS^f 2-seeded constricted pod	ccS^FS^f 3-seeded smooth pod	ccS^fS^f 2-seeded smooth pod

F_2 phenotypic ratio: 3 4-seeded constricted pod : 6 3-seeded constricted pod : 3 2-seeded constricted pod : 1 4-seeded smooth pod : 2 3-seeded smooth pod : 1 2-seeded smooth pod.

Mark scheme:
1 F_1 phenotype match with genotype (use of superscript)
2 Gametes (circled)
3 Punnet square/F_2 genotypes
4 F_2 genotypes matched with phenotypes + F_2 phenotypic ratio

(b) An F_2 generation plant with 3-seeded constricted pod was selected at random to be test crossed. Considering all possible scenarios, what is the probability of producing plants with 3-seeded constricted pods? Show your working using genetic diagrams.

…….. [6]

Test crossing CCS^FS^f:

F_2 phenotype: 3-seeded constricted pods X 2-seeded smooth pods

F_2 genotype: CCS^FS^f ccS^fS^f

F_2 gametes: (circled) CS^F CS^f (circled) cS^f

F_3 genotypes: CcS^FS^f CcS^fS^f

F_3 phenotypic ratio: 1 3-seeded constricted pod : 1 2-seeded constricted pod

Probability of producing 3-seeded constricted pod = ½

Test crossing CcS^FS^f:

F_2 phenotype: 3-seeded constricted pods X 2-seeded smooth pods

F_2 genotype: CcS^FS^f ccS^fS^f

F_2 gametes: (circled) CS^F CS^f cS^F cS^f (circled) cS^f

F_3 genotypes:

	CS^F	CS^f	cS^F	cS^f
cS^f	CcS^FS^f 3-seeded constricted pod	CcS^fS^f 2-seeded constricted pod	ccS^FS^f 3-seeded smooth pod	ccS^fS^f 2-seeded smooth pod

F_3 phenotypic ratio: 1 3-seeded constricted pod : 1 2-seeded constricted pod : 1 3-seeded smooth pod : 1 2-seeded smooth pod

Probability of producing 3-seeded constricted pod = ¼

Mark scheme

1 F_2 gametes (circled) (for 1st scenario)
2 F_3 genotypes matched with phenotypes (for 1st scenario)
3 F_3 phenotypic ratio (for 1st scenario)

4 F_2 gametes (circled) (for 2nd scenario)
5 F_3 genotypes matched with phenotypes (for 2nd scenario)
6 F_3 phenotypic ratio (for 2nd scenario)

[Max 5 marks for genetic crosses]

7 Overall probability = ½ x ½ + ½ x ¼

$= \frac{3}{8}$