1. ai. Oestrogen and progesterone 1m x 2

aii. The level of FSH is low. 1m

aiii. FSH stimulates follicle development. 1m
After ovulation, high levels of oestrogen and progesterone together inhibit FSH secretion. 1m
This prevents the maturation of another follicle and ensures only one ovum is released in each cycle. 1m
This allows a higher survival chance of the foetus if fertilization occurs. 1m

aiv. High levels of oestrogen and progesterone together inhibit FSH and luteinising hormone (LH) secretion. 1m
This prevents follicle development and ovulation. 1m
No ova are released into the oviducts for fertilization. 1m

bi. X: 55 x 98 = 5.390
Y: 127 x 146 = 18.542
Q: 76 x 70 = 5.32
R: 148 x 105 = 15.54 2m

bii. Sam has a greater stroke volume / can pump more blood in each heartbeat. /
Cardiac output depends upon both the stroke volume and heart rate / equals to stroke volume multiplied by heart rate. /
Cardiac muscles of Sam are larger in size due to regular training. /
Ventricles of Sam can contract more powerfully. (any 2)
1m x 2

biii. During exercise, muscle use up a lot of glucose to produce energy, causing blood glucose level to decrease. 1m
when blood glucose level decrease, it will be detected by Sam's pancreas and reduce the production of insulin. 1m
The liver will then convert less glucose into glycogen, the blood glucose level therefore increase/ be restored. 1m
Since David is a diabetic, his pancreas cannot produce insulin
All of the insulin in his body come from regular injection. 1m
During exercise, his blood glucose level will decrease while the insulin level cannot be reduced, 1m
the liver will convert the same amount of glucose into glycogen, causing a low blood glucose level, therefore David will faint. 1m

#Not acceptable answer:
Fail to respond to insulin.
No insulin > no glycogen storage

2.

ai Beetle banks reduce crop yield as no crops can be grown in them. /
Beetle banks may harbour some pest species. /
Beetle banks allow weeds / diseases to spread through the crops. /
Plants growing in the beetle banks compete with the crops for resources, e.g. water and nutrients. /
Beetle banks restrict the use of machinery. (any 3) 1m x 3

aii Any two methods with explanation:

Use biological control agents. 1m
Introduce the species that feeds on / infects the pests. 1m

Use insecticides / pesticides. 1m
Repeatedly spray the insecticides / pesticides which kill the pests by poisoning them. 1m

Grow genetically modified crops. 1m
Some genes are introduced into the crops for pest resistance. For example, GMO crops can produce toxin to kill the pests that feed on them. 1m

aiii They can select sampling points at random positions / regularly. 1m
They can use pitfall traps / nets to trap the beetles. 1m
They can use key to identify the species of the beetles. 1m
Repeated sampling is required. 1m
(or other reasonable answers)

2.

bi Bacteria content in lower stream is higher than upper stream. Since, Bacteria grow rapidly as the sewage contains organic matters. / Sewage contains bacteria. 1m

bii Oxygen in the water is used up by the bacteria for growth and decomposition of organic matters. 1m
The fish die of suffocation. 1m
Toxic substances may also produced by the bacteria during the decomposition of organic matters, which kill the fish. 1m

biii Decomposition of organic matters produces nutrients (phosphates, ammonium compounds and nitrates) for the growth of algae. 1m
The dense surface growth of algae prevents sunlight from penetrating deep into the water. Aquatic plants cannot get enough sunlight for photosynthesis and they may die. 1m
The algae use up the oxygen in the water at night. The aquatic organisms may die of suffocation. 1m
When the algae die, they are decomposed by bacteria which further consume the oxygen in water. The aquatic organisms may die of suffocation. 1m

biv Set up of a sewage treatment works to reduce the harmful substances in sewage before it is discharged into the river.
(or other reasonable answers) 1m

3.

ai A known volume of culture is transferred to a known volume of sterile culture medium. 1m
This process is repeated to give series of culltures of progressively higher dilution. 1m

aii The number of cells in the original culture is too great to count. 1m

aiii Rate of growth = (420 - 200) x 10^3 cm^{-3} / 4 hrs 1m
= 55 x 10^3 cm^{-3} hr^{-1} 1m

aiv During the lag phase (0 to 2 hours), the number of bacterial cells increases very slowly as the cells are in a period of adaptation / enzyme production for glucose metabolism. 1m

During the exponential phase (2 to 2.5 hours), the cells divide rapidly / the population increases exponentially as the supply of glucose is adequate. 1m

During the second lag phase (2.5 to 5 hours), the number of bacterial cells levels off as glucose runs out. 1m

The bacteria produce enzymes (lactase) to break down lactose to glucose so as to support growth during the second exponential phase (5 to 7 hours). 1m

During the stationary phase (7 to 10 hours), the growth rate slows down / population levels off as nutrients begin to run out and metabolic waste accumulates. 1m

3.

bi(1) Antibiotics may have been used to treat cattle so their milk may contain antibiotics. 1m
The antibiotics may inhibit the growth of/kill the bacteria in the starter culture. 1m

bi(2) The pathogenic bacteria may compete with the bacteria in the starter culture. 1m
They will contaminate the yogurt made and cause diseases in humans upon consumption. 1m

bii High temperatures would denature enzymes and kill the bacteria, 1m
Cooling the milk provides an optimum temperature for the maximum bacterial growth / for the enzymes to work best. 1m

biii The bacteria may carry out anaerobic respiration, 1m
which converts lactose in milk into lactic acid. 1m

biv The incubation time would be shortened 1m
as the higher temperature increases the growth rate/ metabolic rate of the bacteria. 1m

4.

ai The genes of interest are first inserted into a virus. 1m
The virus carrying the genes is then allowed to infect the cells thereby introducing the genes into the cells. 1m

aii Stems cell are undifferentiated / unspecialized cells 1m
Therefore, capable of developing into different types of cells in the body. 1m

aiii Different factors or conditions affect the process of differentiation. 1m
Therefore, different genes can be switched on or off, producing different type of cells. 1m

aiv The use of iPS cells may be less controversial than using embryonic stem cells as embryos are not sacrificed. 1m
Mature cells can be obtained more easily. 1m

av The iPS cells are produced from mature cells of the patients 1m
so that no immune response will be triggered. 1m

4

bi The base sequence of the short single-stranded DNA is complementary to (part of) the defective gene. 1m

bii Heating separates the double helix of DNA into two pieces of single-stranded DNA. 1m
The bases are exposed for the binding of the short single-stranded DNA. 1m

biii The short single-stranded DNA can be labelled with a radioactive or fluorescent marker. 1m

biv The statement is correct. 1m
Dominant normal allele is not masked by the recessive defective allele. / Removal / inactivation of the defective allele is not required. 1m

bv The therapeutic effect of somatic cell gene therapy is lost when the normal gene degrades 1m
or when the cells with the normal gene die. 1m

bvi Viral vectors may gain the ability to cause diseases during modification. /Viral vectors may cause severe immune reactions. /The insertion of new genes may affect the expression of existing genes / The insertion of new genes may cause cancer. / The new genes may be wrongly transported into non-target cells. (any 2) 1m x 2