

OCR A-LEVEL BIOLOGY B • H422

BIOLOGY



EXAM QUESTION PACK

3.1.2 THE DEVELOPING INDIVIDUAL: MEIOSIS, GROWTH AND DEVELOPMENT

SCORE

/90

PERCENTAGE

%

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- 1 Bardet-Biedl syndrome (BBS) is a human genetic disorder. One of the main symptoms is child-onset loss of vision.

Abnormalities of cilia are known to be related to a wide range of disease symptoms including those commonly seen in BBS patients. It is now accepted that mutated *BBS* genes affect microtubules and the normal functioning of cilia.

In the early childhood of individuals with BBS, deterioration of cone cells in the retina occurs, leading to poor visual acuity and colour blindness.

- (i) Using your knowledge of the internal structure of photoreceptor cells, suggest why mutated *BBS* genes lead to deterioration of cone cells and poor visual acuity.

[2]

- (ii) Explain how cone cells enable humans to distinguish colour.

[3]

(iii) Obesity, syndactyly, diabetes and kidney failure are other symptoms associated with BBS.

Suggest why BBS is described as a syndrome.

[1]

(iv) State the mechanism that prevents syndactyly occurring in healthy individuals.

[1]

2 A pregnant woman has been advised to increase her daily intake of protein by 15% to 53 g.

Which of the options, **A** to **D**, is her normal daily intake of protein?

A 28 g

B 8 g

C 46 g

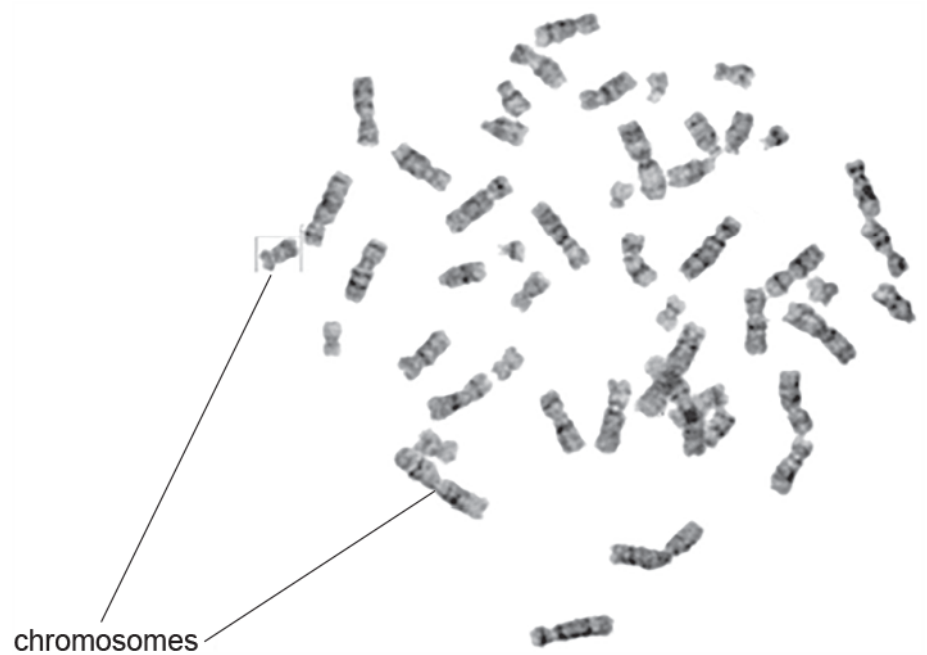
D 38 g

Your answer

[1]

3(a) Karyotyping is a technique used to produce images of chromosomes extracted from fetal cells.

An example is shown below.



Karyotyping involves many stages.

Complete the table giving reasons for each of the stages used in producing the karyotype image.

Stage	Reason
ultrasound scan	
addition of colchicine	
addition of a fluorescent stain	

[3]

(b) Describe the final stages of this technique which are needed to produce a karyogram from the image.

[2]

(c) A 25 year old woman is fifteen weeks pregnant. It is her second pregnancy and she has been advised to have amniocentesis to extract fetal cells for karyotyping.

(i) Suggest why karyotyping may have been advised in this case.

[2]

(ii) Explain why amniocentesis was the preferred method of extracting fetal cells.

[2]

4 A population of cells was isolated from an anther of a plant and viewed under a light microscope. The population comprised 254 cells, of which 118 were in interphase, 72 were in meiosis I and 64 were in meiosis II.

(i) Calculate the percentage of cells undergoing **reduction** division in the cell population.

percentage of cells = ... % [2]

(ii) Explain how specific events in meiosis give rise to genetic variation. State the **phase** of meiosis in which each event takes place.

----- [2]

5(a) This question is about the female reproductive system and pregnancy.

(i) Name the part of the reproductive system in which fertilisation occurs.

-----[1]

(ii) Fertilisation in humans involves a series of biological events that result in the formation of a zygote.

Some events in fertilisation are summarised in statements A to F below.

A	digestion of zona pellucida
B	completion of meiosis II
C	passage of sperm cell through follicular cells
D	nuclear fusion
E	digestion of plasma membrane of secondary oocyte
F	exocytosis of acrosome contents

Place the letters A to F representing the event statements into the correct order below.
Statement E has been done for you.

E

[2]

(b)

(i) Pregnancy testing involves the use of antibodies. The antigen-binding site of an antibody recognises its antigen.

Describe the structure of the antigen-binding site.

-----[2]

(ii) The diagram in Fig. 31.1 shows a pregnancy test strip.

During the test, urine is deposited onto the sample pad and it migrates along the strip until it passes the control region.

Three regions of the strip that contain antibodies at the start of the test are labelled **A** to **C**.

The antibodies in region **A**, the antibody-antigen binding region, have a coloured dye attached that is visible by eye.

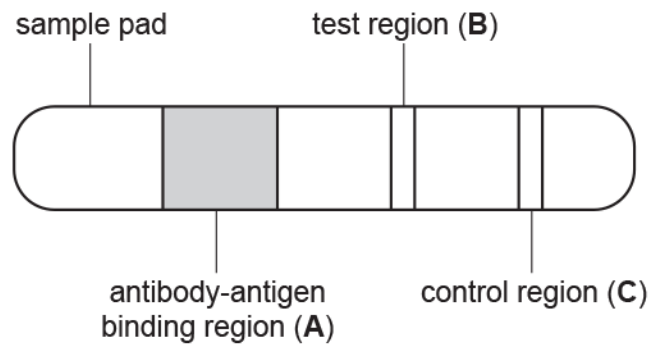


Fig. 31.1

Outline the role of the antibodies in each region of the test strip, **A** to **C**, in Fig. 31.1.

region A

.....

region B

.....

region C

.....

[3]

6 Head circumference (HC) is a key indicator of fetal size and is estimated from two ultrasound measurements:

- biparietal diameter (BPD)
- occipitofrontal diameter (OFD).

$$HC = 1.62 \times (BPD + OFD)$$

The table below shows BPD and OFD measurements from a fetus.

Measurement	Length (mm)
BPD	76 ± 4.2
OFD	98 ± 6.5

Which of the options, A to D, is the percentage uncertainty for the HC measurement of this fetus?

- A 6.1
- B 10.7
- C 12.2
- D 37.0

Your answer

[1]

7(a) Meiosis is the nuclear division that forms gametes.

(i) Explain why meiosis is referred to as a **reduction** division.

----- [1]

(ii) Errors in meiosis can lead to chromosome mutations.

State the name of an event in meiosis that leads to chromosome mutations.

----- [1]

(iii) State the name of one syndrome caused by a chromosome mutation.

----- [1]

(iv) Some cancers that develop later in life are caused by chromosome mutation.

Suggest why these cancers are unlikely to be the result of errors in meiosis.

----- [1]

(b) * Events before conception and during pregnancy can have a significant effect on the health of a baby.

Recently, scientists found there is only a small correlation between light alcohol consumption and small birth weight.

They found no evidence for a link between light-to-moderate alcohol consumption and the more serious effects of fetal alcohol syndrome, which can be caused when a mother drinks alcohol heavily during pregnancy.

Using this information and your own knowledge about the effects of alcohol on fetal development, evaluate this advice from the NHS website:

The Chief Medical Officers for the UK recommend that if you're pregnant or planning to become pregnant, the safest approach is not to drink alcohol at all.

Blank lined paper for writing.

8 A sample of cells can be collected from a fetus to test for genetic disorders such as cystic fibrosis.

(i) Chorionic villus sampling (CVS) and amniocentesis are two methods of obtaining fetal cells.

State the **source** of fetal cells that are obtained through these methods.

CVS -----

Amniocentesis -----

[1]

(ii) The sample of fetal cells can be used to produce a karyotype for genetic analysis.

Explain why karyotyping can **not** be used to detect cystic fibrosis.

----- [1]

9 Which of the options, **A** to **D**, is a molecule that requires vitamin C for its synthesis?

A collagen

B deoxyribonucleic acid

C haemoglobin

D rhodopsin

Your answer

[1]

10 Meiosis II pauses in the secondary oocyte and is only completed if fertilisation occurs.

Which of the options, **A** to **D**, is a description of the **last** meiotic stage prior to fertilisation?

- A** Homologous chromosomes align to the equator of the oocyte.
- B** Homologous chromosomes migrate to opposite poles of the oocyte.
- C** Single chromosomes align to the equator of the oocyte.
- D** Sister chromatids migrate to opposite poles of the oocyte.

Your answer

[1]

11(a) Fig. 1 is a fetal growth chart showing how biparietal diameter (BPD) increases during gestation.

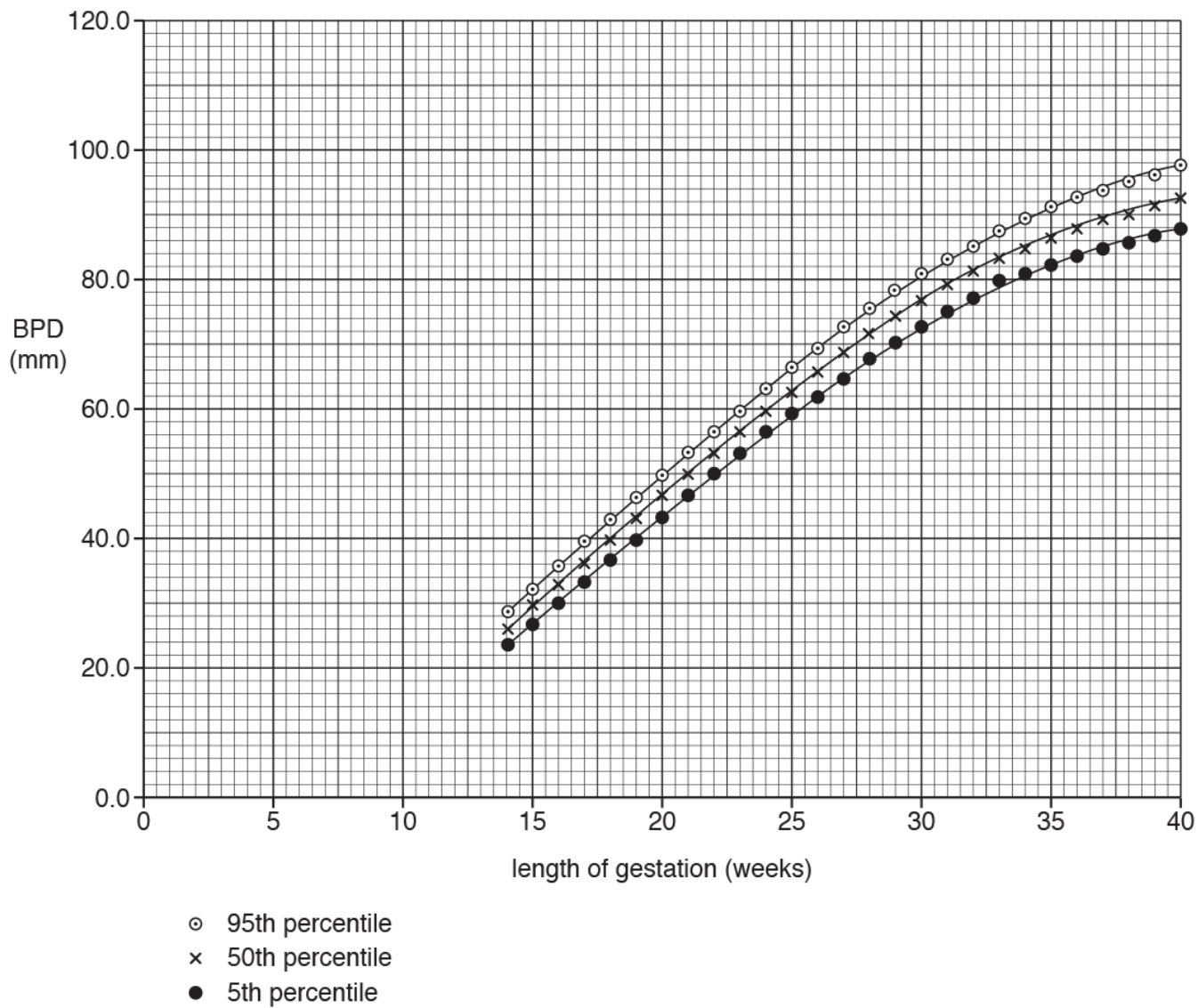


Fig. 1

Calculate the rate of growth at 30 weeks' gestation for the data shown in the uppermost curve (95th percentile). Show your working.

Answer = ... [2]

(b) Three sets of data are shown in Fig. 1.

How can the **three sets of data** be used together to monitor the health of a growing fetus?

----- [1]

(c) The measurements for BPD in Fig. 1 were taken using ultrasound.

Evaluate the usefulness of ultrasound in measuring fetal growth.

----- [2]

12

Oogenesis occurs in the ovaries of female mammals, resulting in the production of gametes.

(i) Name the type of nuclear division that results in the production of **secondary** oocytes from **primary** oocytes during oogenesis.

----- [1]

(ii) Complete the table below to indicate the stage and type of nuclear division in which the events being described occur.

Event	Type of nuclear division	Stage in nuclear division
Chromosomes line up on the equator; there is no association between homologous chromosomes.		
Homologous chromosomes form bivalents.		
Homologous chromosomes separate and are pulled to opposite poles.		
Crossing over occurs.		

[4]

- 13 In spermatogenesis, crossing over of the chromatids of homologous chromosomes gives rise to genetic variation.

Which of the options, **A** to **D**, is the cell type in which crossing over occurs?

- A** primary spermatocyte
- B** secondary spermatocyte
- C** spermatogonium
- D** spermatid

Your answer

[1]

14 A karyotype of a person with a genetic disorder is shown below.



Which of the options, **A** to **D**, correctly identifies the genetic disorder shown in the karyotype?

- A Down's syndrome
- B Klinefelter's syndrome
- C Nail-patella syndrome
- D Turner's syndrome

Your answer

[1]

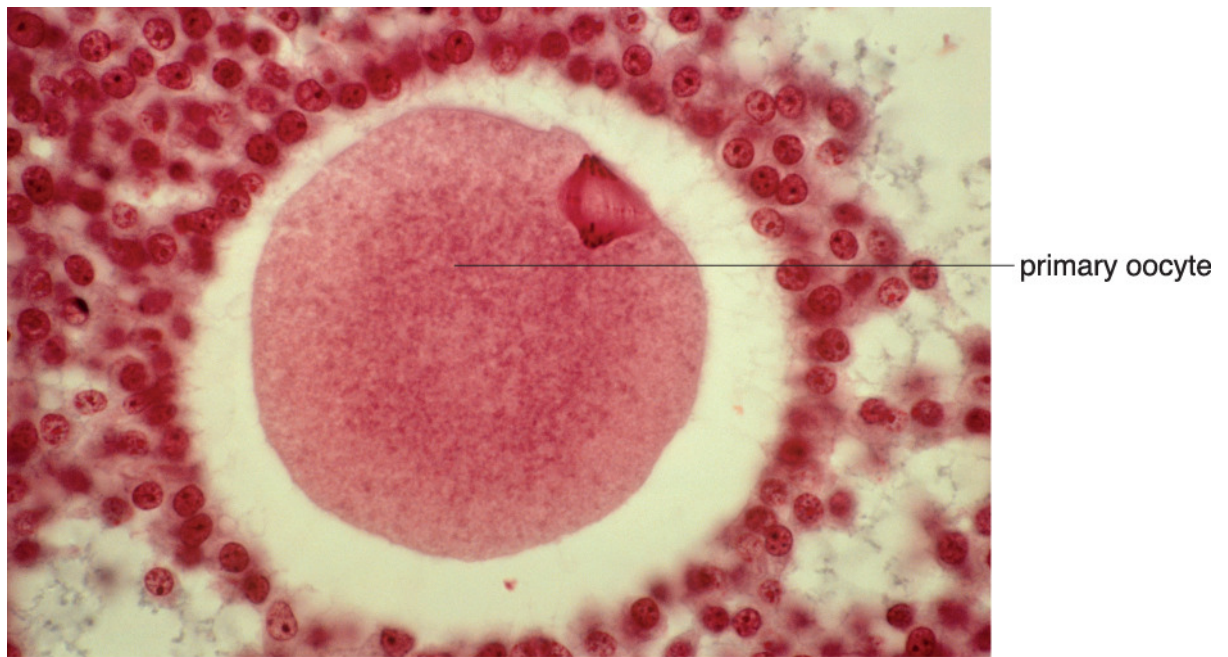


Fig. 2.1

(i) Name the type of nuclear division occurring in a primary oocyte.

-----[1]

(ii) Name the phase of division shown in Fig. 2.1.

-----[1]

Explain why nicotine in cigarette smoke is harmful to a developing fetus.

[3]

A study was conducted to determine the effect of cigarette smoke on CRL in mice.

- group **A** was exposed to environmental cigarette smoke daily
- group **B** was exposed to clean air only.

The mean CRL measurement for each litter is shown in Table 34.

Mouse litter	CRL (mm)	
	Group A	Group B
1	28.2	28.4
2	28.5	28.9
3	27.5	29.4
4	27.9	29.3
5	28.4	27.9
6	27.8	28.5
Mean ($\bar{X}$)	28.1	
Standard deviation (S)	0.38	0.58

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- (i) Calculate the mean CRL for the mice of all litters in group B.

Answer mm [1]

- (ii) The unpaired Student's t-test is an appropriate statistical test to analyse the data in Table 34.

Calculate the test statistic (t) using the formula shown below.

$$t = \frac{|\bar{x}_A - \bar{x}_B|}{\sqrt{\frac{S_A^2}{n_A} + \frac{S_B^2}{n_B}}}$$

Show your working.

Answer [2]

- (iii) At a 95% confidence level, the critical value for t is 2.23.

Using this information and your calculated value for t , what can be concluded from the data in Table 34?

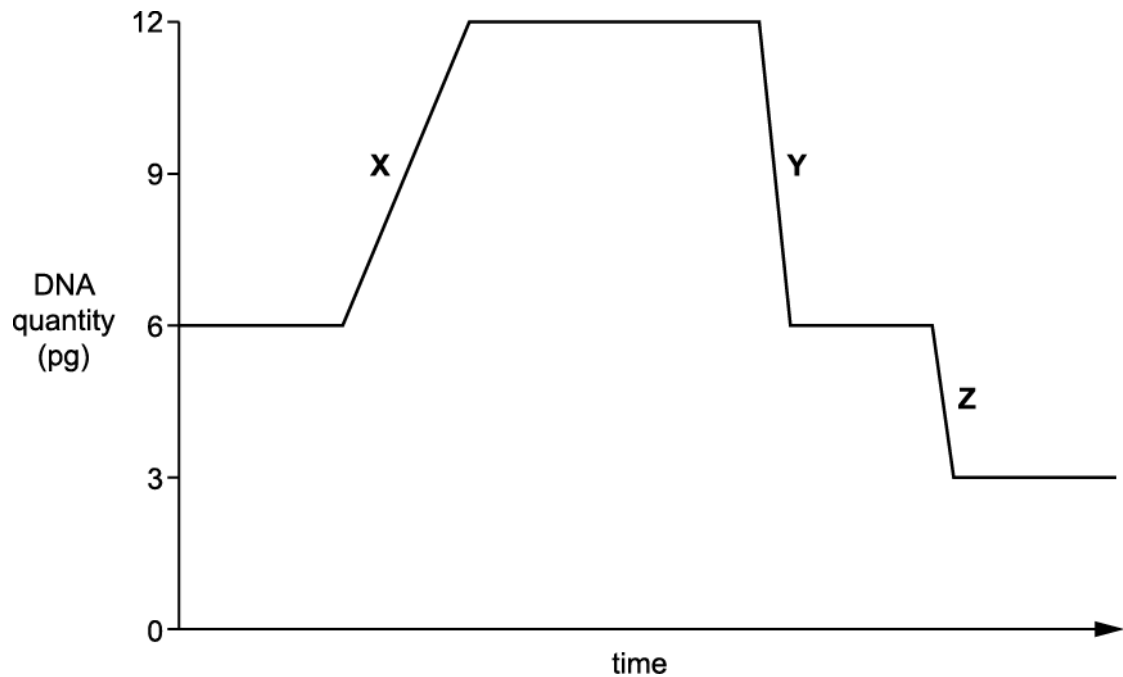
.....
..... [1]

- (iv) State **one** way in which the design of the study could be modified to improve the **validity** of the conclusion drawn in (iii).

.....
..... [1]

- 17 The quantity of DNA in a cell changes throughout the cell cycle. The graph below shows these changes in a primary spermatocyte.

Three points on the graph are labelled X, Y and Z.



Which of the following statements is/are correct?

- 1 X represents the semi-conservative replication of DNA.
- 2 Z would result in the formation of a spermatid.
- 3 Y and Z represent telophase.

- A 1, 2 and 3 are correct
B Only 1 and 2 are correct
C Only 2 and 3 are correct
D Only 1 is correct

Your answer

[1]

- 18 The growth of a human being from a zygote into a sexually mature adult involves many cycles of cell division by both mitosis and meiosis.

Once formed, cells may differentiate. Some cells will group and become part of a tissue or an organ. Other cells, such as gametes, remain as individual single cells.

The following cells, J, K, L and M, are found in either the human male or human female:

J	oogonium
K	primary spermatocyte
L	secondary oocyte
M	Sertoli cell.

State the cell or cells from the list above that fit the following descriptions:

- (i) diploid cells

-----[1]

- (ii) an embryonic diploid cell

-----[1]

- (iii) a cell formed by meiosis I.

-----[1]

- 19 *Spirulina* are photosynthetic bacteria belonging to a group known as the Cyanobacteria. Unlike other Cyanobacteria, *Spirulina* do not fix nitrogen.

Spirulina are widely grown in some parts of the world for use as food for humans and animals.

Fig. 3.1, shows the green bacterial 'mats' being harvested. Once harvested these are dried and processed.



Fig. 3.1

Spirulina is also sold in the United Kingdom as a dietary supplement in the form of capsules, tablets or powder.

Fig. 3.2 below is an extract from a leaflet promoting the benefits of *Spirulina* as a dietary supplement.

- *Spirulina* is one of the most concentrated and nutritious food sources in nature.
- *Spirulina* contains all the amino acids.
- *Spirulina* is a rich source of many vitamins such as B3 (nicotinamide), B9 (folate), C and D.
- *Spirulina* is rich in all essential minerals.
- *Spirulina* is rich in essential fatty acids.
- *Spirulina* is a good source of antioxidants.

Fig. 3.2

Using the information given in Fig. 3.2 about the substances found in *Spirulina*:

- (i) identify **one** substance which is necessary for the synthesis of haemoglobin;

-----[1]

- (ii) identify **one** substance which forms part of a respiratory co-enzyme;

-----[1]

- (iii) identify **one** substance which may prevent DNA damage;

-----[1]

- (iv) identify **one** substance which is recommended in routine pre-conceptual care.

-----[1]

20(a) Dietary reference values (DRVs) are estimated requirements for groups of people. They are based on the normal distribution of the daily requirement for a nutrient within a population.

For energy, the DRV used is the Estimated Average Requirement (EAR).

DRV values for energy and calcium for both pregnant and non-pregnant adult females are given in Table 7.1.

	Energy (kJ)	Calcium (mg)
Adult females	8100	700
Pregnant females	8900	700

Table 7.1

Fig. 7.1 shows the normal distribution curve for energy requirement within a population.

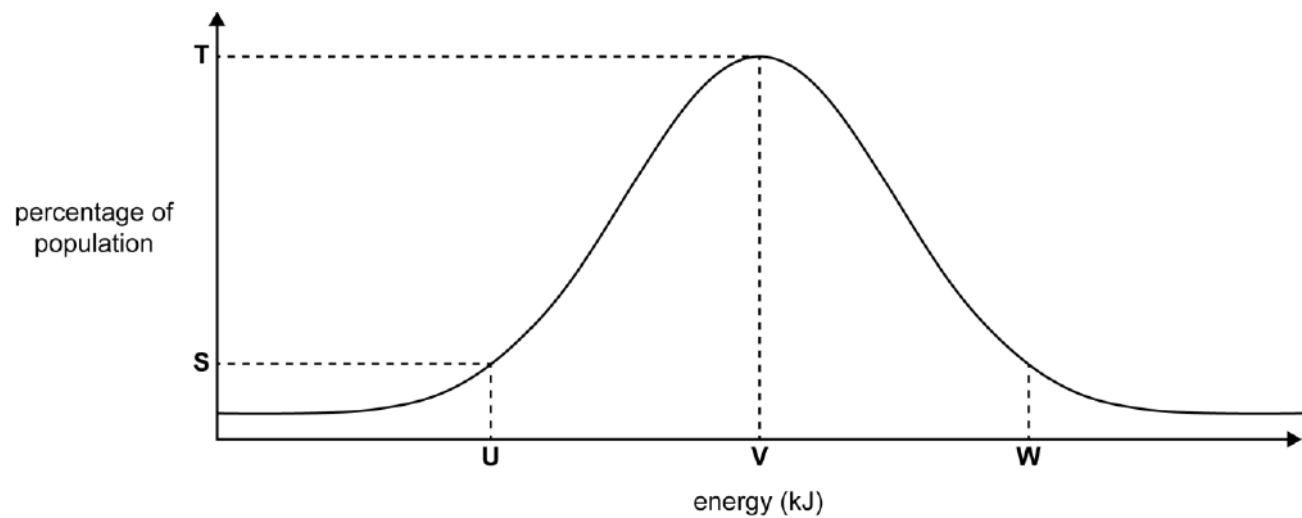


Fig. 7.1

Using the information in Table 7.1 and Fig. 7.1, identify the **value(s)** or **letter(s)** that corresponds to the following:

- (i) A percentage of the population with an energy requirement below average.

-----[1]
- (ii) The modal value for energy requirement for a population of pregnant women.

-----[1]

- (b) The same dietary intake of calcium in pregnant and non-pregnant women results in different concentrations of calcium ions in their blood plasma.

A student wrote the following statement:

I think plasma calcium ion concentration will be higher in pregnant women because there is no change in the DRV value in Table 7.1.

- (i) Explain why the student's statement is correct.

----- [2]

- (ii) Suggest how changes in the proximal convoluted tubule in the kidney might result in an increase in the concentration of calcium ions in blood plasma.

----- [2]

- (c) An energy intake during pregnancy that is in excess of the energy requirement can increase the risk of conditions such as gestational diabetes.

- (i) Suggest how excess energy intake can be monitored in a pregnant woman during routine antenatal visits.

----- [1]

- (ii) How is gestational diabetes monitored during pregnancy in routine antenatal visits?

----- [1]

(d) As part of antenatal care, a pregnant woman will be tested for the presence of **atypical** red blood cell antibodies such as antibodies to the Rhesus antigen.

(i) If a pregnant woman is blood group O, which blood group antibodies would be **expected** in her blood plasma?

-----[1]

(ii) Rhesus antibodies in maternal blood plasma can cross the placenta and enter the fetal circulation. The antibodies can cause fetal red blood cells to agglutinate.

How do antibody molecules cause agglutination of red blood cells with the Rhesus antigen on their cell surface membrane?

-----[2]

21 In human fertilisation, a spermatozoon penetrates an ovum and forms a diploid cell known as a zygote.

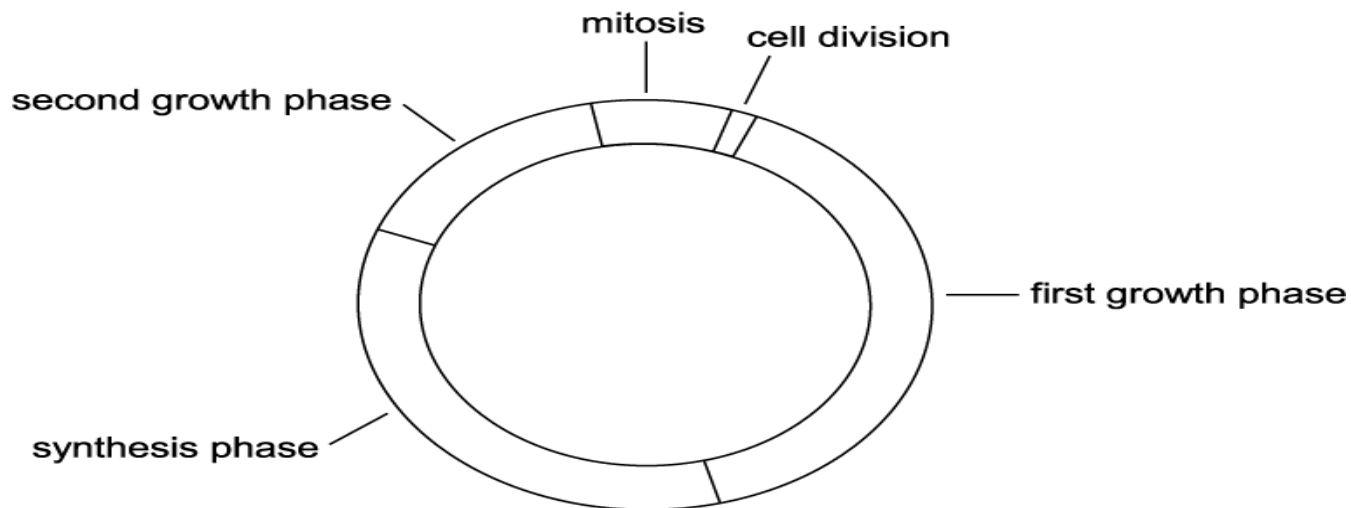
Which of the options, **A** to **D**, correctly describes the zygote?

- A multipotent
- B pluripotent
- C totipotent
- D unipotent

Your answer

[1]

22 The diagram below represents the cell cycle in eukaryotes.



Which of the options, A to D, is the phase in which spontaneous mutations are most likely to arise?

- A mitosis
- B first growth phase
- C synthesis phase
- D second growth phase

Your answer

[1]

23 Which of the options, A to D, is a meiotic process that does **not** give rise to genetic variation?

- A crossing over of non-sister chromatids
- B crossing over of sister chromatids
- C independent assortment of chromatids
- D independent assortment of chromosomes

Your answer

[1]

24 Fig. 29.1 is a diagram of a section through the flower of the bean plant, *Vicia fabia*.

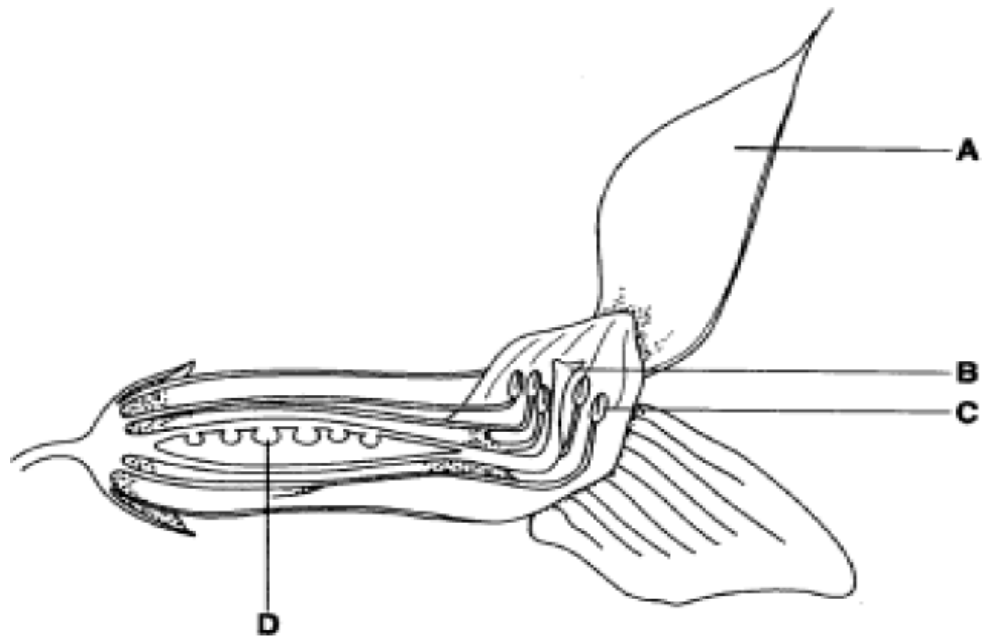


Fig. 29.1

Which of the letters on the diagram indicate sites where meiosis occurs?

- A A and B
- B B and C
- C B and D
- D C and D

Your answer

[1]

25 Karyotypes, as shown below in Fig. 8.1, can be used to diagnose chromosome abnormalities.

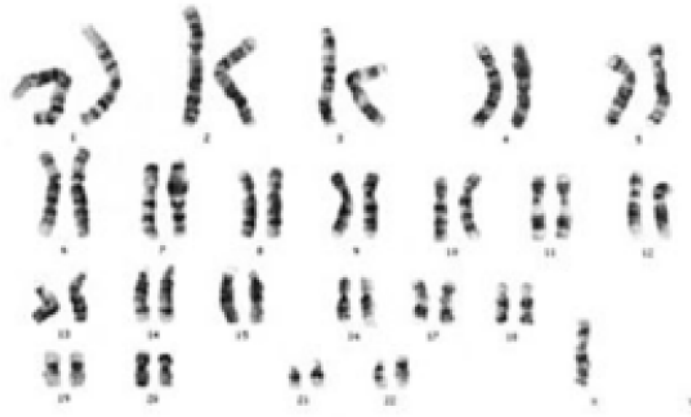


Fig. 8.1

The karyotype above shows someone diagnosed with which genetic condition?

- A male with Down's syndrome
- B female with Down's syndrome
- C Turner's syndrome
- D Klinefelter's syndrome

Your answer

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance												
1		i	cilia connect inner and outer segments of (cone) cell ✓ (mutated BBS genes cause) production of non-functional proteins in , cilia / microtubules ✓ less / no , transport of proteins between segments ✓	2 max(AO2.1)													
		ii	different (cone) cells have different type of iodopsin ✓ (so iodopsin) absorbs either red or green or blue light ✓ (so) cone cells differ in sensitivity to different wavelengths of light ✓ trichromatic vision ✓	3 max(AO1.1)	ALLOW description												
		iii	widespread effects in the body ✓ affects , several organs / systems, in the body ✓	1 max(AO2.5)													
		iv	apoptosis ✓	1(AO1.1)	ALLOW description												
			Total	7													
2			C	1(AO2.2)													
			Total	1													
3	a		<table><tr><th>Stage</th><th>Reason</th><th></th></tr><tr><td>ultrasound scan</td><td>locates position of , fetus / placenta</td><td>✓</td></tr><tr><td>addition of colchicine</td><td>stops mitosis</td><td>✓</td></tr><tr><td>addition of a fluorescent stain</td><td>allows chromosomes to be seen</td><td>✓</td></tr></table>	Stage	Reason		ultrasound scan	locates position of , fetus / placenta	✓	addition of colchicine	stops mitosis	✓	addition of a fluorescent stain	allows chromosomes to be seen	✓	3 AO1.2	One mark per row ALLOW AW e.g.so fetus does not get damaged when needle inserted
Stage	Reason																
ultrasound scan	locates position of , fetus / placenta	✓															
addition of colchicine	stops mitosis	✓															
addition of a fluorescent stain	allows chromosomes to be seen	✓															
	b		photograph is taken and cut ✓ chromosomes are put in pairs ✓ chromosomes put in order (of size) ✓	2 max AO2.1	ALLOW e.g. produce computerised image ALLOW e.g. chromosomes in image are rearranged into pairs using computer for two marks												

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c	i	abnormality seen on ultrasound scan ✓ family history of (named) syndrome caused by chromosomal mutation ✓ first baby has (named) syndrome ✓ reason for needing to know sex of baby ✓	2 max AO2.1	ALLOW e.g. ultrasound scan shows need for further investigation ALLOW (named) e.g. Down's syndrome ALLOW (named) e.g. Down's syndrome e.g. family history of genetic disorder affecting males
		ii	amniocentesis can be done at 15 weeks ✓ less chance of miscarriage than CVS ✓ less chance of causing fetal deformities than CVS ✓	2 max AO2.1	CVS or chorionic villus sampling only needs to be mentioned once for MP2 and 3
			Total	9	
4		i	$(72/254) \times 100$ ✓ 28.3% ✓	2 AO2.4	28.35% or 28% = 1 mark
		ii	any 2 from: crossing over (of homologous chromosomes / chromatids) in <u>prophase 1</u> ✓ independent / random, assortment/segregation of chromosomes in <u>metaphase I/anaphase I</u> ✓ independent / random, assortment/segregation of chromatids in <u>metaphase II/anaphase II</u> ✓	max 2 AO1.2	DO NOT ALLOW sister chromatids
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5	a	i	oviduct / fallopian tube / uterine tube ✓	1 AO1.1	
		ii	C F A E D B ✓✓	2 AO1.2	all correct = 2 marks any 2 correct = 1 mark
	b	i	any 2 from: complementary to antigen ✓ light and heavy chains ✓ variable region ✓	max 2 AO1.1	
		ii	<i>region A:</i> bind, hCG / human chorionic gonadotropin ✓ <i>region B:</i> bind / capture, (hCG)-bound antibodies ✓ <i>region C:</i> bind / capture, unbound / excess antibodies ✓	3 AO2.7 1.2	
			Total	8	
6			C	1 AO2.2	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a	i	chromosome number is halved / <u>haploid</u> cells are produced from <u>diploid</u> cells ✓	1 AO1.1	DO NOT ALLOW diploid cell changes to haploid cell <u>Examiner's Comments</u> Most candidates achieved this mark. A few candidates referred to a reduced number of chromosomes without referring to the idea of half and they didn't score any marks.
		ii	translocation / non-disjunction ✓	1 AO1.1	ALLOW description <u>Examiner's Comments</u> A lot of candidates referred to a stage of meiosis without referring to or describing the event that leads to chromosome mutations.
		iii	Down's / Turner's / Klinefelter's ✓	1 AO1.1	<u>Examiner's Comments</u> The majority of candidates answered this question correctly with the most common syndrome being Downs Syndrome.
		iv	somatic / body, cells divide by mitosis OR meiosis produces gametes ✓	1 AO2.1	DO NOT ALLOW meiosis occurs in gametes <u>Examiner's Comments</u> Only a few candidates were able to score this mark. Most candidates referred to the idea of it occurring earlier in life if due to meiosis but not stating why.

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	Summary of instructions to markers: <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> ◦ <i>award the higher mark where the Communication Statement has been met.</i> ◦ <i>award the lower mark where aspects of the Communication Statement have been missed.</i> • The science content determines the level. • The Communication Statement determines the mark within a level. Level 3 (5–6 marks) A comprehensive response that covers the effects of alcohol AND evaluation of the evidence <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated</i> Level 2 (3–4 marks) A description of the effects of alcohol with an evaluation of the evidence. OR A detailed description of the effects of alcohol or comprehensive evaluation of the evidence <i>There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence</i>	6 AO3.1	Indicative scientific points may include Effects of alcohol Ethanol crosses placenta Moderate drinking can cause language and speech problems (<i>Fetal Alcohol Syndrome / FAS</i>): damage to the CNS psychological or behavioural problems after birth learning difficulties other signs include facial features (small eye openings, thick upper lip) and growth deficiency Fetal liver is less able to detoxify ethanol Evaluation of evidence Advice is based on excessive drinking May not be valid to extrapolate to moderate drinking Individual women may respond differently Limited sample number Study may be biased Evidence, not long term / only recent No (conclusive) evidence between, light alcohol consumption and birth weight / light to moderate consumption and fetal alcohol syndrome. Examiner's Comments Most candidates were able to state effects of fetal alcohol syndrome and recognise the relevance of light/moderate and heavy drinking in relation to this. Thus, many candidates achieved at least a Level 1 answer. Few candidates were able to recognise clues in the information to assist with both sides of the evaluation, e.g. 'Recently, scientists found...' and lack of information given e.g. how many scientists/ where are these scientists? All aspects of information given for an evaluate level of response should be checked for these areas otherwise evaluate questions will focus on only one side of the discussion.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Level 1 (1–2 marks) A description of the effects of alcohol or evaluation of the evidence. <i>There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>		
			Total	0	
8		i	CVS: placenta amniocentesis: amniotic fluid ✓	1	IGNORE chorionic villus Both required for 1 mark
		ii	1 from: (karyotype) cannot detect gene/allele (mutations) ✓ (karyotype) can only detect changes in chromosome size/shape ✓	1	AW e.g. abnormal base sequence <u>Examiner's Comments</u> Most candidates were able to identify the source of fetal cells. In order to explain why karyotyping cannot be used to test for CF, candidates had to have some knowledge of the cause of CF. Exemplar 3 <i>Karyotyping shows abnormal chromosomes / abnormalities in chromosomes but CF is caused by a deletion mutation in gene so chromosomes are normal</i> ✓ (1) This response describes the cause of CF. Any idea of CF being a gene mutation would be sufficient. The response also explains why it would not be picked up on a karyotype.
			Total	2	
9			A	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10			C	1	<u>Examiner's Comments</u> The level of recall demanded by this question proved problematic for many candidates. Despite the question asking about the completion of meiosis II, many candidates selected option A or B which referred to homologous chromosomes. The question was testing the knowledge that meiosis II is halted at metaphase II prior to fertilisation.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11	a		2.7 ✓ mm week⁻¹ ✓	2	IGNORE working determined from reading a single value at 30 weeks i.e. 81/30. Candidates should use the slope of a tangent to a curve as a measure of a rate of change. ALLOW marks within range of 2.35-2.85 when calculated from a tangent ALLOW 'mm per week' or 'mm / week' Examiner's Comments In (a) many candidates calculated the growth rate by taking the single value at 31 weeks and dividing by the period of time. In accordance with the Maths Skills handbook, a tangent should be drawn by hand and eye to approximate the instantaneous rate of change at a particular point. While aligning the ruler, make sure that in the vicinity of the point none of the line of the curve is covered by the ruler. The aim is to have the entire curve visible as the line is drawn, otherwise the tangent will not be accurate. Some candidates found the formatting of the units difficult with answers such as 'mm per week⁻¹' and 'mm/weeks' not gaining credit.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		growth of the fetus is unexpected if the value is outside the, band / range OR growth of the fetus is expected if the value is inside the, band / range ✓	1	ALLOW 'abnormal growth' for unexpected ALLOW 'normal growth' for expected DO NOT ALLOW answers using just one set of data, e.g. if the growth rate is in the 5th percentile the fetus is growing (too) slowly ALLOW idea that 'BPD values which vary between the three sets of data indicates unexpected growth' DO NOT ALLOW references to unhealthy growth Examiner's Comments The majority of candidates found (b) difficult and few achieved the mark. Candidates either related their answers to the 'health' of the fetus or made no reference to the 'three sets of data'. Whilst the question emboldened 'three sets of data' some candidates misinterpreted this and provided answers referring to calculating a mean. Responses should refer to the range of growths that fell between the values and how that could indicate abnormal growth.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c		<i>One mark for useful statement ✓</i> <i>One mark for idea of limitation ✓</i>	2	DO NOT ALLOW descriptions of methodology as these are not evaluative comments DO NOT ALLOW incorrect reference to inaccurate IGNORE references to black and white / 2D image IGNORE references to clear image / clarity of image Examples include - non-invasive - low risk to / safe for, fetus / mother - low cost - more <u>precise</u> than external measurements e.g. fundal height - can monitor growth of different part of fetus' body - idea of mobile equipment Examples include - idea that produces image which can lack detail - depends on correct position of fetus - requires interpretation by trained medical staff - resolution is low(er) (compared to other scans e.g. MRI, CT) - level of detail is low(er) (compared to other scans e.g. MRI, CT) - image can be blurred due to baby movement (hence the value is <u>imprecise</u>) Examiner's Comments In Q1(c), as referred to above, many candidates provided two useful statements about USSs and as such did not interpret the command word appropriately. Descriptions of the actual methodology itself were not credited as this is not evaluative.
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																				
12		i	<u>Meiosis</u> ✓	1	IGNORE ref to I or II. Examiner's Comments The vast majority of candidates achieved the mark for (a)(i).																				
		ii	<table><tr><th>Event</th><th>Type of nuclear division</th><th>Stage in nuclear division</th><th></th></tr><tr><td>Chromosomes line up on the equator; there is no association between homologous chromosomes.</td><td>mitosis</td><td>(early / late) metaphase</td><td>✓</td></tr><tr><td>Homologous chromosomes form bivalents.</td><td>meiosis</td><td>prophase I</td><td>✓</td></tr><tr><td>Homologous chromosomes separate and are pulled to opposite poles.</td><td>meiosis</td><td>anaphase I</td><td>✓</td></tr><tr><td>Crossing over occurs.</td><td>meiosis</td><td>prophase I</td><td>✓</td></tr></table>	Event	Type of nuclear division	Stage in nuclear division		Chromosomes line up on the equator; there is no association between homologous chromosomes.	mitosis	(early / late) metaphase	✓	Homologous chromosomes form bivalents.	meiosis	prophase I	✓	Homologous chromosomes separate and are pulled to opposite poles.	meiosis	anaphase I	✓	Crossing over occurs.	meiosis	prophase I	✓	4	1 mark per row – needs correct type and stage Examiner's Comments In (a)(ii) although most candidates scored, many failed to state the correct stage of nuclear division for meiosis by omitting I or II.
Event	Type of nuclear division	Stage in nuclear division																							
Chromosomes line up on the equator; there is no association between homologous chromosomes.	mitosis	(early / late) metaphase	✓																						
Homologous chromosomes form bivalents.	meiosis	prophase I	✓																						
Homologous chromosomes separate and are pulled to opposite poles.	meiosis	anaphase I	✓																						
Crossing over occurs.	meiosis	prophase I	✓																						
			Total	5																					
13			A ✓	1	Examiner's Comments Another straightforward question but a disappointing number of candidates answered correctly.																				
			Total	1																					
14			A ✓	1	Examiner's Comments This question was straightforward recall and the majority of candidates chose the correct response.																				
			Total	1																					
15		i	<u>meiosis</u> ✓	1	DO NOT ALLOW mitosis ALLOW meiosis 1																				
		ii	anaphase 1 ✓	1	ALLOW telophase 1 ALLOW anaphase OR telophase if (i) states meiosis 1																				
			Total	2																					

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16	a		narrows blood vessels / induces vasoconstriction ✓ reduced supply of oxygen to fetus ✓ stimulates release of adrenaline ✓ raises heart rate ✓	max 3	
	b	i	28.7 ✓	1	DO NOW ALLOW 28.73
		ii	$t = 2.14$ ✓ ✓ ✓	2	ALLOW 2.13 $(28.1 - 28.7) / \sqrt{((0.38^2/6) + (0.58^2/6))} = 1$ mark
		iii	cigarette smoke marginally reduced CRL in mice / no significant difference ✓ OR t is close to the 95% confidence level / data do not allow a clear conclusion ✓	1	
		iv	use mice with same litter sizes ✓ use female mice at same age ✓ repeat CRL measurements ✓	max 1	
			Total	8	
17			B ✓	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
18		i	J / oogonium AND K / primary spermatocyte AND M / sertoli cell;	1	All three required for one mark Examiner's Comments This required a precise knowledge of the stages involved in the development of the reproductive cells and their genetic components, followed by a comparison of the mechanisms of action of oestrogen, FSH and LH. It initially required detail regarding the entry / or not of these hormones into target cells, followed by identifying the source of FSH and LH. Candidates were then asked to identify molecules or organelles involved in the action of the hormone oestrogen on a target cell as shown in a simplified diagram, followed by the location and role of the target cell. Finally candidates were asked to suggest the effect of FSH in the nuclei of endometrial cells. The question tested both AO1 and AO2. In parts (i) - (iii) most candidates correctly obtained one or two of the correct answers, those obtaining all three were in the minority. Oogonium was correctly answered by most candidates and secondary oocyte the least. Often the two were given the wrong way round and if oogonium was given correctly, it didn't follow that secondary spermatocyte would be given correctly as well.
		ii	J / oogonium;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks
		iii	L / secondary oocyte;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19		i	amino acid(s);	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks ALLOW iron IGNORE mineral unqualified (as given in question)
		ii	(Vitamin) B3 / nicotinamide;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks
		iii	antioxidant(s) / vitamin C;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks
		iv	(Vitamin) B9 / folate / folic acid;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
20	a	i	S	1	Any additional letter = no mark
		ii	8900 (kJ)	1	
	b	i	<i>Statement correct because;</i> <i>idea that extra calcium needed but no increase in DRV (1)</i> <i>idea that calcium needed for fetal bone formation (1)</i>	2	
		ii	<i>idea of increased reabsorption (of calcium ions) (1)</i> <i>idea of more (calcium ion) transport proteins / more active transport / more facilitated diffusion (1)</i>	2	DO NOT ALLOW reference to ultrafiltration
	c	i	<i>idea of weighing OR BMI calculated (1)</i>	1	
		ii	<i>idea of testing a urine sample for glucose</i>	1	
	d	i	(anti) A AND (anti) B antibodies	1	
		ii	(antibody has) two, binding sites / variable regions (1) <i>idea that sites bind to antigens on different blood cells (1)</i>	2	ALLOW an explanation from a diagram
			Total	11	
21			C	1	
			Total	1	
22			C	1	
			Total	1	
23			B	1	
			Total	1	
24			D	1	
			Total	1	
25			C	1	
			Total	1	