1.

(i) **Fig. 6.1** shows the hands of a fetus at two different stages in development.

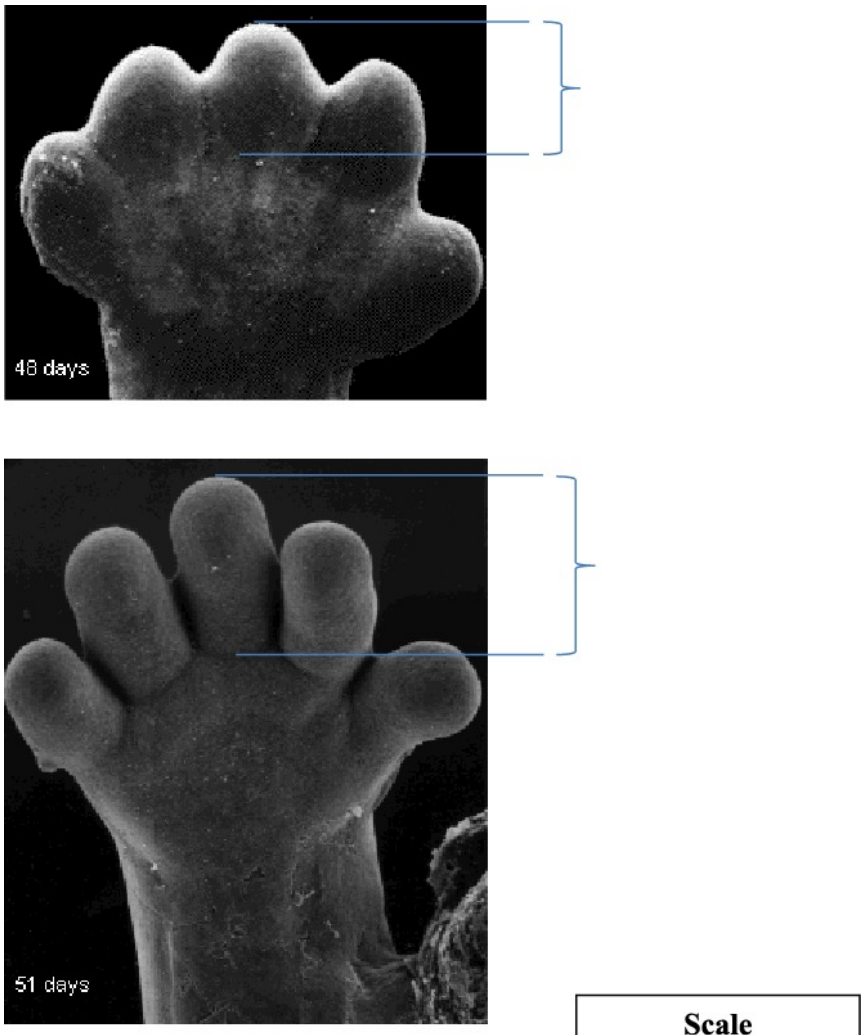


Fig. 6.1

Using **Fig. 6.1**, calculate the growth **rate** of the middle digit between 48 and 51 days.

Show your working.

growth rate _____ mm day^{-1} **[2]**

(ii) Name **one** nutrient that is required to support the growth of tissues in the developing fetus and state its role.

_____

_____ **[1]**

2(a). This question is based on Case Study: **The Thrifty Phenotype**

The hypothesis

The thrifty phenotype hypothesis suggests that a fetus receiving poor nutrition and exhibiting a slow growth rate in the womb has a greater chance of developing diabetes, coronary heart disease (CHD) and other chronic conditions later in life. A fetus adapts to an environment with a poor supply of nutrients, and conditions in the womb appear to programme an individual for their adult life. A person who receives poor nutrition as a fetus is less able to deal with an increased supply of nutrients later in life.

The evidence

Both men and women with low birth weight show increased rates of diabetes and CHD. One particularly stark piece of epidemiological evidence comes from the Dutch Hunger Winter. In 1944, populations in west Holland, including pregnant mothers, experienced severe food shortages. These nutritional restrictions during pregnancy had long-lasting consequences for the offspring. In adulthood, the offspring experienced above-average rates of obesity, diabetes, CHD and high blood pressure.

Animal studies have shown that poor nutrition before birth results in persistent changes in metabolic and physiological factors in the offspring of the animals receiving a poor diet.

What can be done?

Fetal growth rates can be monitored to make sure that babies are developing at the expected rates. Mothers can be given advice about their diets during pregnancy. In some cases, nutritional interventions are used, which involve mothers being provided with nutrient supplements during pregnancy. This type of intervention can be especially beneficial in poorer areas of the world.

In the UK, fetal growth measurements are taken during pregnancy and nutritional advice is given to mothers by medical professionals.

(i) Outline the antenatal care offered to mothers **other than** nutritional advice and fetal growth measurements.

---

[5]

(ii) Suggest how the oxygen and nutrient supply to a fetus could be monitored during pregnancy.

[2]

(iii) A baby's development is also monitored after birth.

Describe how a newborn baby's head circumference is measured.

[1]

(iv) An infant's organ systems develop at different rates.

The letters **A** to **D** below correspond to different developmental periods during the human life cycle:

A 0–5 years
B 5–10 years
C 10–15 years
D 15–20 years

Select the letter that corresponds to the fastest period of development in males of:

the nervous system _____

the reproductive system _____

[2]

(b). An individual who experiences poor nutrition as a fetus has a higher probability of developing diabetes in **adulthood**.

Suggest the type of diabetes that is likely to develop in adults as a result of fetal under-nutrition.

Explain your choice.

---

[3]

3(a). Conditions such as Turner syndrome and Klinefelter syndrome can be detected by a laboratory technique called karyotyping.

Complete the following passage, which describes how a karyotype is produced.

A sample of fetal cells is taken from the placenta or amniotic fluid. These cells are then cultured in an incubator. Two chemicals are added to the culture. One chemical stimulates cell division by mitosis and the other chemical, called _____, prevents spindle formation. This halts mitosis at the start of _____. The fetal cells swell up when they are added to a salt solution. A third chemical, a _____, is added to make the _____ visible so that they can be photographed and analysed.

[4]

(b).

(i) A friend suggests to a woman who is 10 weeks pregnant that she could have her baby tested for conditions such as Turner syndrome using amniocentesis and karyotyping.

Evaluate the suitability of the procedure suggested by the friend.

---

[2]

(ii) Fetal DNA, originating from the placenta, is present in a mother's blood after 7 weeks of pregnancy.

This fetal DNA can be sampled from the mother's blood in a new procedure known as cell-free fetal DNA (cffDNA) sampling. This represents an alternative to the traditional methods of obtaining fetal DNA, such as amniocentesis.

Suggest **two** advantages of cffDNA sampling over traditional methods, such as amniocentesis.

---

[2]

(c).

(i) Table 4.1 below lists three conditions diagnosed by karyotyping.

Complete Table 4.1 by indicating the sex chromosomes present in each of the three conditions and the total number of chromosomes in each body cell.

Condition diagnosed	Sex chromosomes present	Total number of chromosomes in each body cell
Turner syndrome		
Klinefelter syndrome		
Normal male		

Table 4.1

[3]

(ii) Individuals identified as having Turner or Klinefelter syndrome develop physical characteristics associated with their condition.

State **one** example of a typical characteristic found in people with Turner syndrome and **one** example of a typical characteristic found in people with Klinefelter syndrome.

Turner _____

Klinefelter _____

[1]

4. Meiosis is a type of nuclear division that produces haploid daughter cells (gametes). It also results in genetic variation in gametes.

Crossing-over introduces genetic variation during prophase I of meiosis. Further genetic variation is introduced during metaphase I and metaphase II of meiosis.

Explain why the genetic variation produced in **meiosis II** is dependent on crossing-over.

---

[2]

5(a). A scientist wanted to observe the different stages of nuclear division.

Table 6 describes some events that occur during mitosis and meiosis in **plant cell** samples.

Complete Table 6 by placing a tick (✓) if the event described does occur in the type of nuclear division or a cross (✗) if the event does not occur.

The first row has been completed for you.

Event	Mitosis	Meiosis I	Meiosis II
Chromosomes condense in prophase	✓	✓	✗
Nuclear envelope breaks down in prophase			
Bivalent pairs line up in metaphase			
Centromere splits during anaphase			
Centrioles move to opposite poles of the cell during prophase			

Table 6

[4]

(b). Explain how meiosis is significant in the life cycle of a plant.

---

[2]

6. Women are advised not to smoke during pregnancy.

Explain how smoking cigarettes during pregnancy can have a negative effect on the baby.

---

[5]

7(a). Cell division by meiosis is essential for sexual reproduction in eukaryotes.

Explain the importance of meiosis in sexual reproduction.

---

[3]

(b). Turner's syndrome is a genetic disorder that may be detected during fetal development.

Turner's syndrome is caused by a chromosomal mutation that results from the non-disjunction of chromosomes during meiosis.

State a stage in meiosis when non-disjunction can occur.

---

[1]

(c). Ultrasound, amniocentesis and karyotyping are all techniques used in the diagnosis of fetal disorders such as Turner's syndrome.

Outline how each of the following techniques is used in the diagnosis of Turner's syndrome during pregnancy.

ultrasound

---

amniocentesis

---

karyotyping

---

[3]

8. Once DNA has been replicated, cell division can occur.

Fig. 3.2 shows the stages of meiosis, a type of cell division. Two stages are missing.

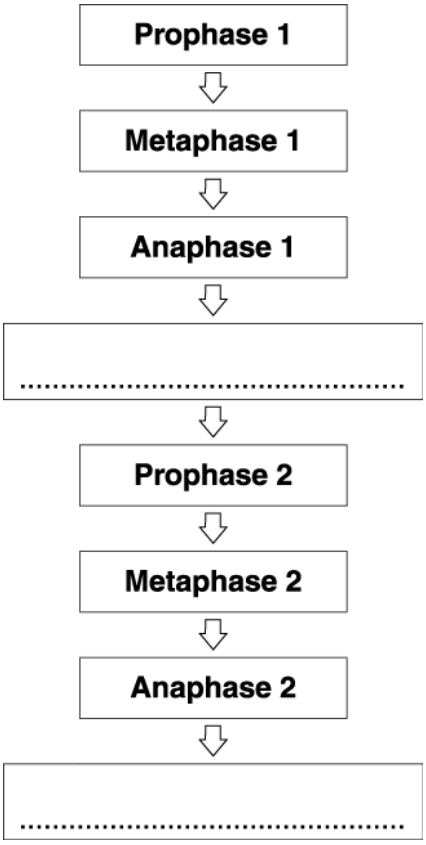


Fig. 3.2

(i) **Write the names** of the two missing stages in the empty boxes in Fig. 3.2.

[1]

(ii) Processes during metaphase 1 and metaphase 2 contribute to genetic variation of the gametes formed in meiosis.

Name the processes that contribute to genetic variation in metaphase 1 and metaphase 2.

---

[2]

(iii) Genetic variation is generated in metaphase 1, metaphase 2 and in one other stage of meiosis.

Name this stage and explain how it contributes to genetic variation.

stage

---

explanation

---

[4]

9. Fetal growth is measured during pregnancy to check that the baby is developing as expected.

Fig. 4.1 shows one of the measurements that can be made. This measurement is labelled **A**.

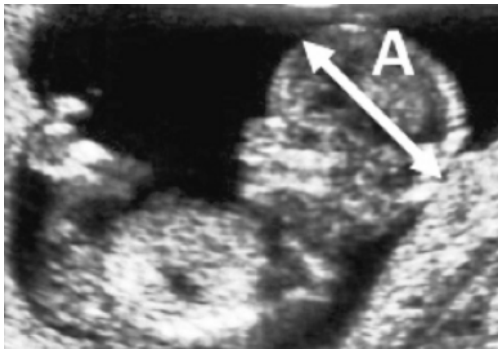


Fig. 4.1

(i) Name the measurement shown at **A** in Fig. 4.1.

---------- [1]

(ii) State the method used to obtain this image from which the measurement can be made.

---------- [1]

10(a) State the correct term for each of the following definitions.

.

A pair of chromosomes that contain genes for the same characteristics.

---------- [1]

(b). A type of cell division that produces genetic variation.

---------- [1]

11.

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]

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

.

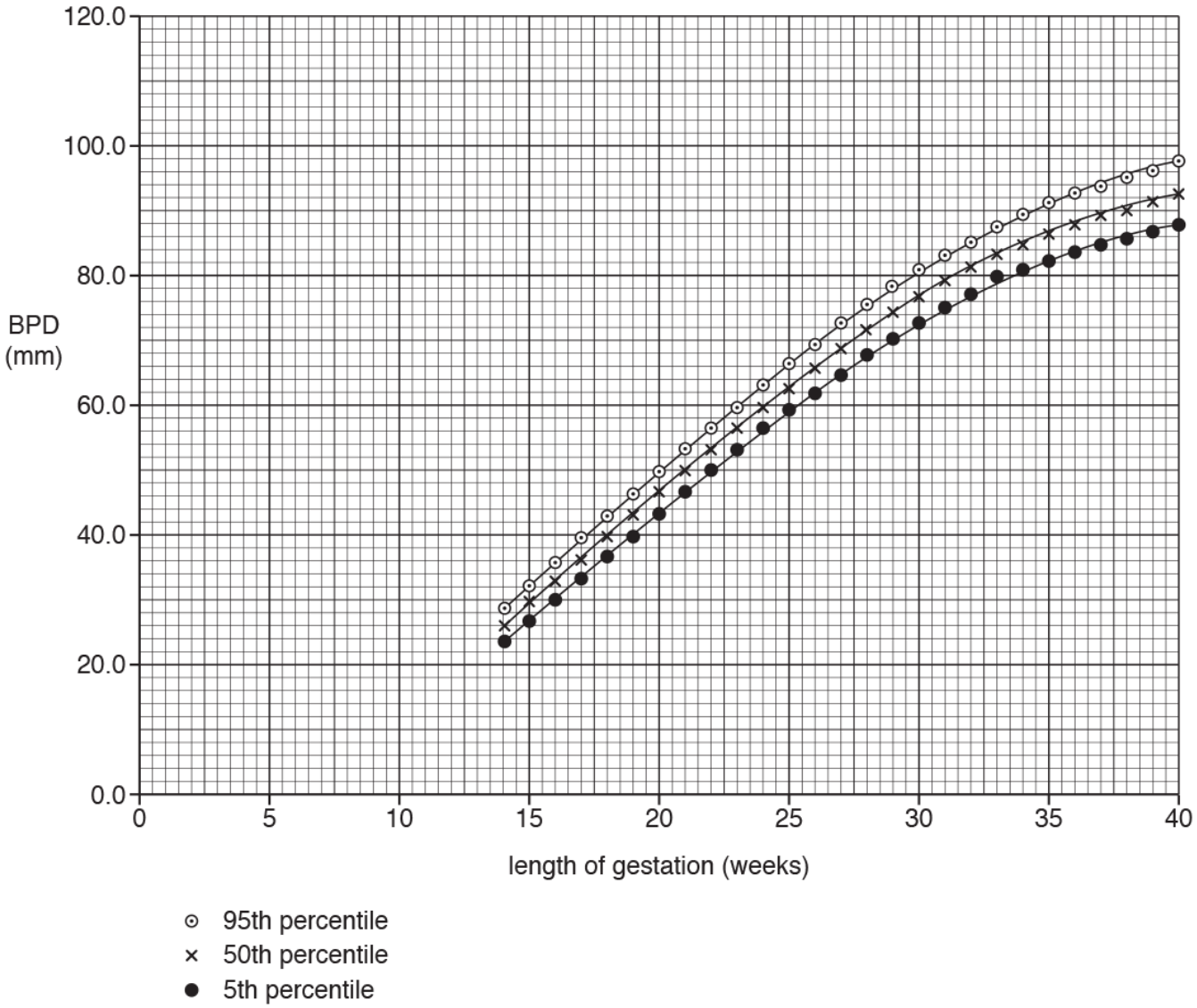


Fig. 1

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]

13(a) Fig. 23.1 is a photograph of non-identical twin fetuses, **A** and **B**, in the uterus.

.

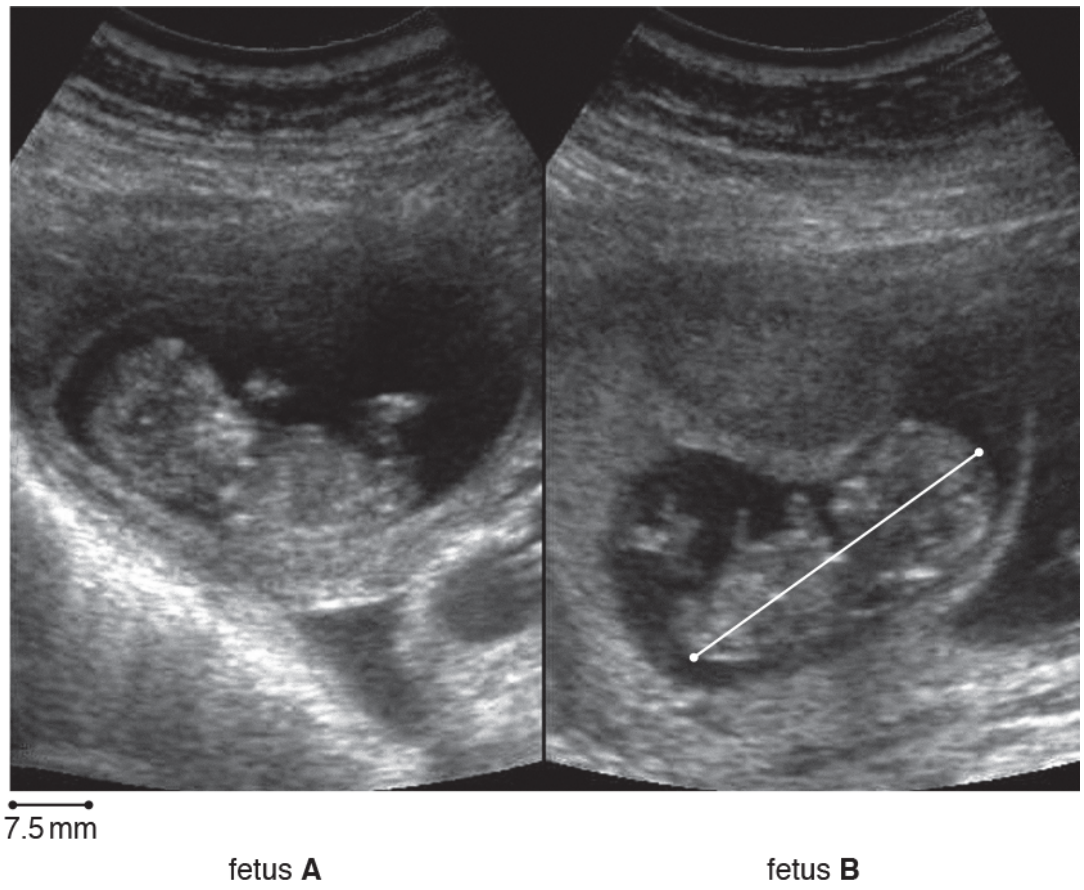


Fig. 23.1

(i) Describe how the diagnostic technique, used to produce the photograph in Fig. 23.1, is used to measure the biparietal diameter of a fetus.

---

[3]

(ii) Calculate the crown-rump length (CRL) of fetus **B** in Fig. 23.1.

Use the white line as an indicator for the positions of the crown and rump of the fetus.

Show your working and give your answer to **two** significant figures.

=_____ mm **[2]**

(iii) Fig. 23.2 shows a fetal growth chart.

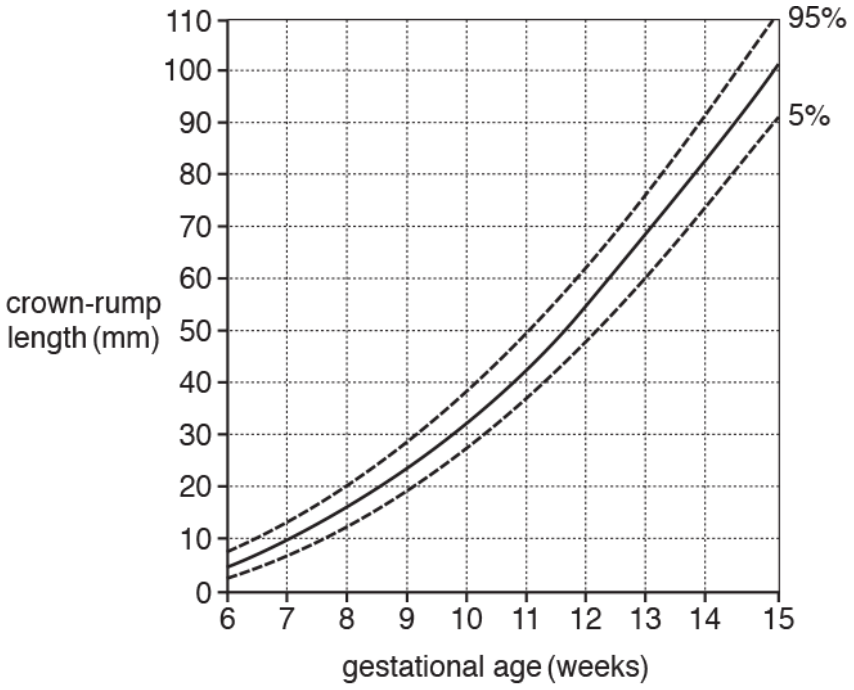


Fig. 23.2

Using Fig. 23.2 and your calculation in **(a)(ii)**, estimate the gestational age of fetus **B**.

_____ **[1]**

(iv) Suggest **two** factors that must be taken into account when using the growth chart in Fig. 23.2 to estimate the gestational age of fetus B.

---

[2]

(b). Non-identical twins show as much genetic variation as other offspring.

Using the most appropriate word(s), complete the sentences below about the processes that contribute to genetic variation.

Two processes occur during meiosis that contribute to genetic variation. During _____ of meiosis 1, _____ chromosomes begin to pair up to form a bivalent. Crossing over occurs in which sister _____ exchange genetic information at points of cross over called _____.

As meiosis 1 continues, alignment on the equator of the spindle and separation of the chromosomes in each pair to opposite poles of the cell is random. This process is called _____.

[5]

14. 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]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1		i	0.58 (1) (1)	2	ALLOW 2 marks for the correct answer with no working ALLOW 1 mark for calculation without final step 24 – 17 = 7 / 3 = 2.3
		ii	Any 1 from: protein for production of new cells / enzymes / skin / bone (1) vitamin D for production of, bones / teeth (1) phosphorus / calcium, for production of, bones / teeth (1)	1	
			Total	3	
2	a	i	*mothers advised :* not to smoke; not to, drink (too much) alcohol / take recreational drugs; about, exercise / physical activity; to avoid contact with cat, litter / faeces; to have test for, kidney health / blood pressure / gestational diabetes; to have (antibody) tests for, hepatitis / HIV / syphilis / rubella; to have a test for, blood group / Rhesus factor / blood disorder;	5 max	IGNORE reference to gene screening as not regular antenatal advice. ACCEPT German Measles for rubella Examiner's Comments This question related to Case Study: The Thrifty Phenotype. This question was well answered in part although candidates did not appear to link the pre-release material with the relevant part questions. The majority of candidates scored at least three marks with the idea of testing for gestational diabetes or immunity to Rubella the most common correct response. Unfortunately, some candidates described these two in detail without outlining other ante-natal advice which restricted their marks. A few candidates did not understand the term ante-natal and referred to care offered to a new born baby and mother.

Question			Answer/Indicative content	Marks	Guidance
		ii	ultrasound; checking the development of, umbilical cord / placenta; measure maternal , haemoglobin / red blood cell count / blood glucose;	2 max	Examiner's Comments The majority of candidates offered ultrasound as a way of monitoring nutrient supply with stronger candidates developing this answer into explaining that this would allow for checking blood flow through the placenta or umbilical cord.
		iii	tape measure around widest part (of head);	1	Examiner's Comments This was accessible to candidates of all abilities but omission of the use of a tape measure or the fact that it needed placing around the widest part of the head were commonly seen examples where candidates could not be credited. Candidates did not appreciate that placing tape around the head could refer to any type of tape and not just the measuring kind. Reading answers through before the end of the examination should be encouraged to help spot and resolve this type of simple omission. Some candidates discussed various scanning techniques used for foetal measurements and so had not paid attention to the reference to a new born baby in the question.
		iv	*nervous system* **A /** 0-5 (years); *reproductive system* **D** / 15-20 (years);	2	Examiner's Comments The majority of candidates correctly stated A for the nervous system but incorrectly responded with C for the reproductive system.

Question			Answer/Indicative content	Marks	Guidance
	b		type 2 / late onset (diabetes); *idea that* type 2 diabetes results from, changes in metabolism / obesity; *idea of* genetic influence; (type 2) is not an autoimmune condition;	3 max	*2 max* for explanation Examiner's Comments Very few candidates understood that poor foetal nutrition would causes changes to metabolism, which is stated in the pre-release material. This question proved challenging and whilst the majority correctly suggested Type 2 diabetes, few went on to explain their choice correctly. Candidates described the reasons for Type 2 diabetes and their explanation referred to the fact that it was late onset. Candidates did not appear to relate this question to any information provided in the pre-release material. A few candidates described Type 2 diabetes as a lack of insulin production.
			Total	13	

Question			Answer/Indicative content	Marks	Guidance
3	a		colchicine; metaphase; stain / dye; chromosomes / chromatids;	4	Examiner's Comments This question shifted to genetic disorders and required knowledge of particular chromosomal disorders and foetal diagnostic testing. Most mark points were A01 but both AO2 and AO3 were tested. This was well answered by most candidates with some candidates even stating a specific type of stain. The spelling of 'colchicine' proved difficult for some.
	b	i	*idea that* 10 weeks is too early for amniocentesis; risk of miscarriage; *idea that* Turner syndrome not life-threatening (no need for amniocentesis); *idea of* low incidence in population (no need for amniocentesis);	2 max	ACCEPT idea that at this early stage CVS is normally used instead Examiner's Comments Most candidates achieved at least one mark. Mark points 3 and 4 were rarely seen by Examiners but many candidates gained both marks with the first two points. Many answers included the abortion time limit as an evaluation of suitability. Some candidates discussed the methodology behind amniocentesis and karyotyping which deviated from the question.
		ii	non-invasive; no risk of miscarriage / damage to fetus; sampling can be performed earlier (than amniocentesis);	2 max	IGNORE reference to cost Examiner's Comments Candidates clearly read the information provided for this question part and answered it well.

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>c</td><td>i</td><td>
<table>
<tr><th>Condition diagnosed</th><th>Sex chromosomes present</th><th>Total number of chromosomes in each body cell</th></tr>
<tr><td>Turner syndrome</td><td>X / X0</td><td>45</td></tr>
<tr><td>Klinefelter syndrome</td><td>XXY</td><td>47</td></tr>
<tr><td>Normal male</td><td>XY</td><td>46</td></tr>
</table>
</td><td>3</td><td>One mark for each correct row

ACCEPT ‘45 and 46’ (mosaic form)

ACCEPT ‘46 and 47’ (mosaic form)

<u>Examiner's Comments</u>

This was a straightforward recall for the majority of candidates who were able to complete the rows correctly, although some candidates mixed up Turner's and Kleinfelter's and some were unsure of the number of chromosomes in body cells. A few candidates wrote the number of chromosome pairs instead of total number.</td></tr>
<tr><td></td><td></td><td>ii</td><td>one typical characteristic for Turner syndrome

AND

one typical characteristic for Klinefelter syndrome;</td><td>1</td><td>e.g. small fingernails, skin folds, lack of menstruation, short stature, nevi (brown spots)

e.g. small testes, reduced facial hair

<u>Examiner's Comments</u>

Most candidates were able to state a typical characteristic for each and a wide variety of correct responses were seen. A few answers were too vague e.g. short AND tall but the majority stressed the ‘abnormal’ nature of the difference.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>12</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td></td><td></td><td>(crossing over) enables exchange of genetic information between non sister chromatids;

(sister) chromatids, assort / segregate, randomly / independently;</td><td>2</td><td>ACCEPT crossing over results in non-identical sister chromatids

<u>Examiner's Comments</u>

Candidates struggled with this question and made general statements, not referring to chromatids in their responses.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
<tr><td>5</td><td>a</td><td></td><td>
<table>
<tr><th>Event</th><th>Mitosis</th><th>Meiosis I</th><th>Meiosis II</th></tr>
<tr><td>Chromosomes condense in prophase</td><td>✓</td><td>✓</td><td>✗</td></tr>
<tr><td>Nuclear envelope breaks down in prophase</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Bivalent pairs line up in Metaphase</td><td>✗</td><td>✓</td><td>✗</td></tr>
<tr><td>Centromere splits during Anaphase</td><td>✓</td><td>✗</td><td>✓</td></tr>
<tr><td>Centrioles move to opposite poles of the cell during prophase</td><td>✗</td><td>✗</td><td>✗</td></tr>
</table>
✓
✓
✓
✓
</td><td>4</td><td><u>Examiner's Comments</u>

Few candidates scored four marks, it was probably most common to see one or two correct rows in the table. This suggests that candidates are generally not very confident with what happens during the different stages of the types of cell division. The first row was most often correct and the last row the most often incorrect. Candidates often mixed up meiosis and mitosis and answered the question with statements referring to asexual reproduction and the production of genetically identical cells for growth or repair.</td></tr>
<tr><td></td><td>b</td><td></td><td>forms, haploid cells / gametes ✓
gametes that are genetically different / allows variation ✓
prevents doubling of the chromosome number ✓</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6</td><td></td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
6			carbon monoxide combines with haemoglobin; nicotine reduces diameter of blood vessels (in placenta and fetus); reduces oxygen supply to, fetus / baby; fetus's heart beats faster; (increased chance of) premature birth; (increased chance of) low birth weight; baby's lungs less well developed; higher risk of, still birth / death in early infancy;	5	ACCEPT forms carboxyhaemoglobin ACCEPT vasoconstriction Examiner's Comments This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed AO1, AO2 and AO3 skills. Candidates often scored well on this question, and knew about the effect of carbon monoxide on haemoglobin and its subsequent effects. Some candidates quoted the effects of alcohol abuse rather than smoking, or quoted the general effects of smoking (on adult lungs) and assumed this would apply to the fetus also.
			Total	5	

Question			Answer/Indicative content	Marks	Guidance
7	a		to produce gametes; ref haploid (chromosome number); maintain / restore, correct number of chromosomes; *Idea of* source of (genetic) variation;	3	ACCEPT sex cells / eggs and sperm 'to produce haploid gametes' = **2 marks** ACCEPT 'one copy of each chromosome' ACCEPT restore diploid number / 46 / 23 pairs (at fertilisation) ACCEPT genetically different gametes **Examiner's Comments** This question had elements of **AO2** and **AO3**, but mainly addressed **AO1**. Most candidates knew that meiosis resulted in genetic variation, and many knew it formed haploid cells, and gametes. Some realised that this was important in maintaining the diploid chromosome number at fertilisation.
	b		anaphase;	1	IGNORE ref to Anaphase 1 or 2 **Examiner's Comments** This question had elements of **AO2** and **AO3**, but mainly addressed **AO1**. Most candidates gave the correct answer (anaphase), with metaphase being the most frequent incorrect response.

Question			Answer/Indicative content	Marks	Guidance
	c		*Ultrasound* *Idea of* to find / see the position of, fetus / placenta (during amniocentesis); OR to guide needle into amniotic sac / chorionic villus / placenta / AW; *amniocentesis* to obtain (fetal) cells (from amniotic fluid); *karyotyping* to identify that there is, only one X / sex, chromosome / AW;	3	ACCEPT to see where the baby or fetus or placenta is ACCEPT to know where to insert the needle ACCEPT to identify that X / Y / one sex, chromosome is missing ACCEPT to see the genotype is XO REJECT chromatid Examiner's Comments This question had elements of AO2 and AO3, but mainly addressed AO1. Some candidates believed that ultrasound could be used to diagnose Turner's syndrome either by measurement or features, rather than it being used to identify the position of the foetus and placenta to correctly guide the amniocentesis needle. Most candidates failed to identify that foetal cells are extracted with the fluid. Most candidates offered a description of the preparation of chromosomes for analysis, rather than stating how the karyotype was used for diagnosis.
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
8		i	telophase 1 **and** telophase 2;	1	Examiner's Comments An accessible mark for nearly all candidates.
		ii	Independent / random, assortment; (independent assortment of) <u>chromosomes</u> **AND** <u>chromatids</u>;	2	**ACCEPT** random distribution, random alignment **Max1** if part of a list with crossing over or random / independent segregation Examiner's Comments Many candidates were confused about exactly when in meiosis each process happens. Most candidates stated that crossing over occurred in metaphase rather than prophase 1. Candidates mostly gained the independent assortment mark but often failed to make the distinction between chromosomes and chromatids.
		iii	1 prophase 1; 2 crossing over; 3 genetic material / DNA / genes / alleles, exchanged; 1 (exchange between) homologous chromosomes / non-sister chromatids;	4	**ACCEPT** chiasma(ta) formation **CREDIT** 'new combinations of alleles' **CREDIT** in the context of mark point 2 or 3 Examiner's Comments As in question **(ii),** candidates demonstrated their lack of knowledge regarding when in meiosis particular events occur. Whilst many candidates could correctly identify the process of crossing over and what it involves, many of them gave the incorrect stage.
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
9		i	biparietal diameter;	1	ACCEPT biparietal width ACCEPT phonetic spelling Examiner's Comments This question had elements of AO3, but mainly addressed AO1 and AO2. The correct name of this measurement is biparietal diameter, although some candidates incorrectly wrote biparietal measurement or length. There was great variation in the spelling of 'biparietal'. Candidates should learn to accurately spell key terms. Some candidates identified the measurement as crown-rump.
		ii	ultrasound (scan);	1	CREDIT ultrasonograph(y) / ultrasonogram Examiner's Comments This question had elements of AO3, but mainly addressed AO1 and AO2. An accessible mark for most candidates.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
10	a		homologous (chromosomes) **OR** homologue(s) ;	1	**Mark the first answer for each question part.** If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** This was a straightforward question testing candidates' knowledge of terms. Most candidates knew many of the terms but a couple were less well known. **IGNORE** bivalent **Examiner's Comments** This term was well known to the majority of candidates.
	b		meiosis ;	1	**CREDIT** correct spelling only **Mark the first answer for each question part.** If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** This term was well known to the majority of candidates. However, fewer candidates were able to spell meiosis correctly.
			Total	2	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>11</td><td></td><td>i</td><td><u>Meiosis</u> ✓</td><td>1</td><td>IGNORE ref to I or II.

Examiner's Comments
The vast majority of candidates achieved the mark for (a)(i).</td></tr>
<tr><td></td><td></td><td>ii</td><td>
<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>
</td><td>4</td><td>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.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>5</td><td></td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
12	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.

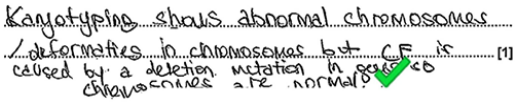
Question			Answer/Indicative content	Marks	Guidance
	b		growth of the fetus is unexpected if the value is outside the, band / range OR growth of the fetus is expected if the value is inside the, band / range ✓	1	ALLOW ‘abnormal growth’ for unexpected ALLOW ‘normal growth’ for expected DO NOT ALLOW answers 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.

Question			Answer/Indicative content	Marks	Guidance
	c			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
			One mark for useful statement ✓		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
			One mark for idea of limitation ✓		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	

Question			Answer/Indicative content	Marks	Guidance
13	a	i	ultrasound (scan)✓ *idea that* image of fetus is produced on , monitor / screen ✓ description of how image is produced ✓ *max 2* head of fetus is measured at widest point (for BPD) ✓	3 max	Max 2 for description of technique e.g. sound waves emitted into mother's body are reflected back by fetus e.g. transducer can be used to provide different angles (to view BPD) Examiner's Comments This question also addressed aspects across the assessment objectives AO1, AO2 and AO3. The candidates' knowledge of the concepts surrounding fetal growth and meiosis were examined in the context of twin fetuses. Q23(a)(i) The majority of candidates correctly identified and described ultrasound as the technique used but few went on to describe how it could be used to measure BPD for the final mark point. Some candidates mistakenly described how it could be used to measure crown-rump length which was not credited.

Question			Answer/Indicative content	Marks	Guidance
		ii	34 ± 1 ✓✓	2	ALLOW white line measurements of 44 – 46mm If answer not given to two significant figures allow 1 mark for: *44mm* 33.1 / 33.08 *45mm* 33.8 / 33.83 *46mm* 34.6 / 34.59 OR Correct working e.g. 45 divided by magnification of 1.33 Examiner's Comments In Q23(a)(ii), whilst the majority of candidates were able to perform the calculation, some did not then give their response to 2 significant figures as requested thereby only gaining one mark. This was followed by a straight-forward reading from the growth chart for Q23(a)(iii) and as ECF was applied from the previous question, it was pleasing for examiners to see that most candidates were credited.
		iii	9.5 –11 weeks ✓	1	ALLOW ECF from Q23aii ALLOW any estimate within this range e.g. 10.2 weeks Examiner's Comments In Q23(a)(ii), whilst the majority of candidates were able to perform the calculation, some did not then give their response to 2 significant figures as requested thereby only gaining one mark. This was followed by a straight-forward reading from the growth chart for Q23(a)(iii) and as ECF was applied from the previous question, it was pleasing for examiners to see that most candidates were credited.

Question			Answer/Indicative content	Marks	Guidance
		iv	*idea that* (fetus **B**) is a twin so could be smaller ✓ gender ✓ maternal lifestyle ✓ genetics ✓	2	e.g. smoking / nutrition / caffeine / drug use **Examiner's Comments** **Q23(a)(iv)** proved more challenging than expected and there were many responses referring to the lack of accuracy of the ultrasound or equipment problems which were not credited. Responses regarding maternal lifestyle were the most commonly seen correct answers.
	b		23 (b) prophase ✓ homologous ✓ chromatids ✓ chiasma / chiasmata ✓ independent / random , assortment / segregation ✓	5	**Examiner's Comments** The gap fill in **Q23(b)** enabled the majority of candidates to show their knowledge about meiosis and many gained at least three out of the five marks available. *'Chiasma / chiasmata'* provided the main challenge here.
			Total	13	

Question			Answer/Indicative content	Marks	Guidance
14		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 Examiner's Comments 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  Karyotyping shows abnormal chromosomes / deformaties in chromosomes but CF is caused by a deletion mutation in gene so chromosomes are normal? [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	