

Oxford Cambridge and RSA Examinations
Advanced Subsidiary General Certificate of Education

HUMAN BIOLOGY
Energy, Control and Reproduction

2866

Specimen Paper 2003

Additional materials: Ruler (cm/mm)
Electronic calculator

TIME 1 hour 30 minutes

Candidate Name	Centre Number	Candidate Number												
	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%; height: 25px;"></td> </tr> </table>							<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%; height: 25px;"></td> </tr> </table>						

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and candidate number in the spaces above.
- Write your answers, in blue or black ink, in the spaces provided on the question paper.
- Answer **all** the questions.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is 90.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- *You will be awarded marks for the quality of written communication where an answer requires a piece of extended writing.*

FOR EXAMINER'S USE		
Question number	Max.	Mark
1	15	
2	17	
3	16	
4	15	
5	15	
6	12	
TOTAL	90	

1 Fig. 1.1 is a diagram showing the various stages of spermatogenesis in humans.

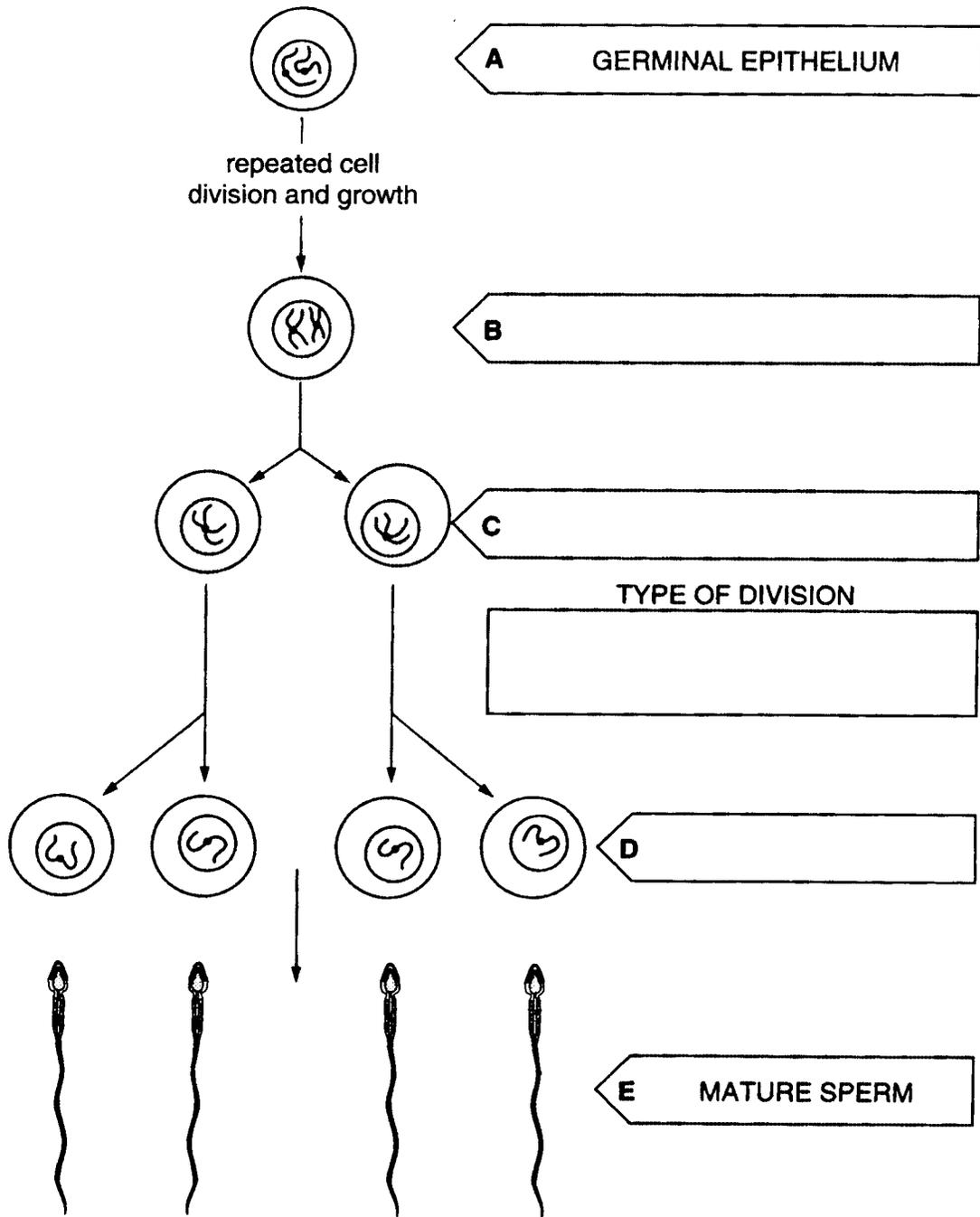


Fig. 1.1

(a) On Fig. 1.1,

- (i) name the cells shown at stages B, C and D; [3]
- (ii) state which type of division occurs between stages C and D. [1]

1 (b) Describe the importance of fertilisation in sexual reproduction.

[3]

(c) Complete the table below by stating **four** ways in which the process of **oogenesis** differs from the process of spermatogenesis as shown in **Fig. 1.1**.

	Spermatogenesis	Oogenesis
1		
2		
3		
4		

[4]

- 1 (d) **Table 1.1** shows the results of a study to measure the reduction in **primary** oocyte numbers from birth to age 45 years in females.

Table 1.1

Age/years	Number of females studied	Mean number of primary oocytes per female
birth	7	733 000
10	5	499 200
17	5	393 300
24	7	161 800
31	11	80 200
38	8	32 500
45	7	10 900

- (i) Use the data in **Table 1.1** to calculate the percentage decline in mean primary oocyte numbers from birth to 10 years. Show your working.

Answer _____% [2]

- (ii) With reference to **Table 1.1**, suggest **two** reasons for the decline in mean primary oocyte numbers from birth to age 45 years.

1 _____

2 _____
_____ [2]

- 2 The sketches **A** and **B** in **Fig. 2.1** represent the iris of a human eye in two different conditions.

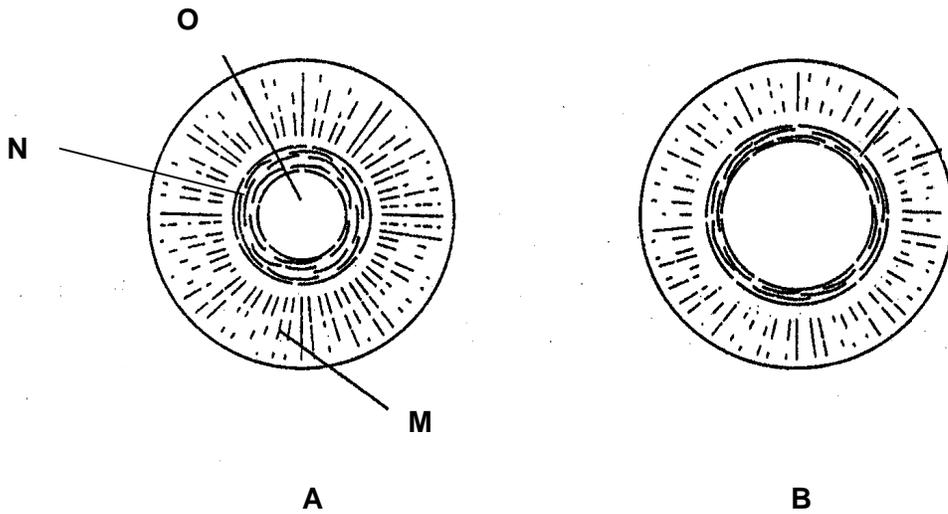


Fig. 2.1

- (a) Name **M** to **O**.

M _____

N _____

O _____

[3]

- (b) Explain briefly how the iris changes from the form shown in **A** to the form shown in **B**, during normal vision.

_____ [2]

- (c) State **three** ways in which the eyes of a patient can be used to help diagnose loss of consciousness or brain injury.

1 _____

2 _____

3 _____

_____ [3]

- 2 (d) **Fig. 2.2** represents a section through the back of the eye to show the neural connections in the retina.

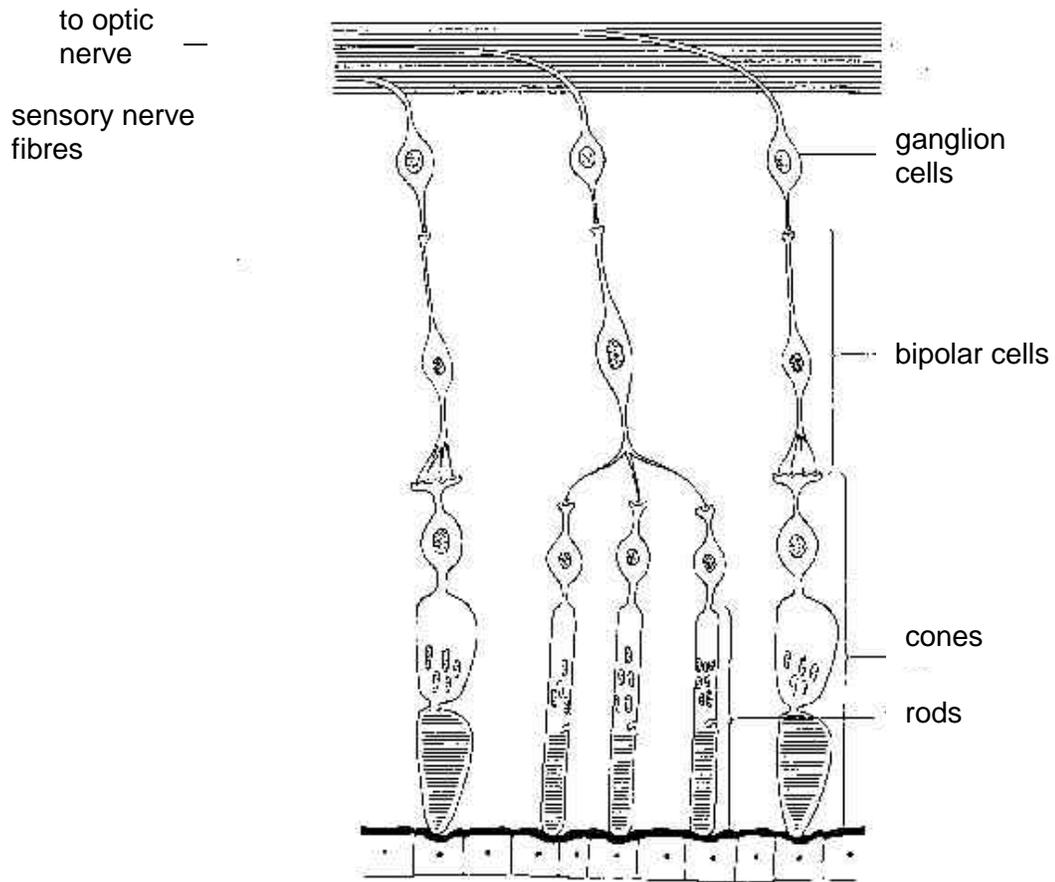


Fig 2.2

- (i) Draw an arrow on the left hand side of **Fig. 2.2** to show the direction that light takes through the retina. [1]
- (ii) Name the light sensitive pigment in the rod cells and describe how the pigment is affected by light.

[3]

2 (e) Cone cells enable the brain to produce more detailed images than rod cells.

(i) Describe **three other** ways in which cone cells differ from rod cells.

1 _____

2 _____

3 _____

[3]

(ii) Suggest why the neural connections of the rods shown in **Fig. 2.2** would prevent detailed images being produced by the brain.

[2]

3 (a) Suggest **two** different fertility problems for which IVF (*in-vitro fertilisation*) procedures might be a suitable part of the treatment.

1 _____

2 _____

[2]

3 (b) Fig. 3.1 shows the main stages in the procedure used for IVF and embryo transfer.

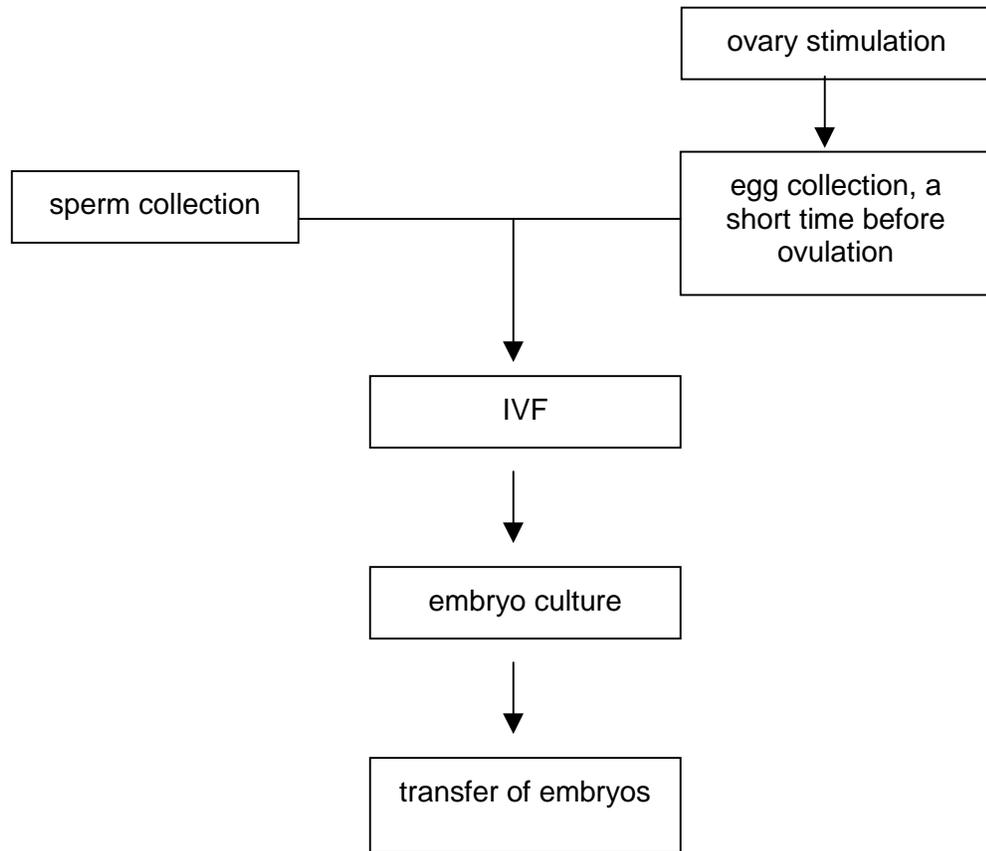


Fig. 3.1

Using the information shown on Fig. 3.1 and your own knowledge,

(i) suggest the techniques that may be used to stimulate egg production by the ovaries;

[2]

(ii) describe **one** way in which the appropriate time for egg collection may be determined;

[2]

- 4 Muscle attached to the skeleton is called skeletal muscle. Skeletal muscle fibres appear striped or striated when seen with an electron microscope.

Fig 4.1 is an electron micrograph of a longitudinal section of a striated muscle fibre.

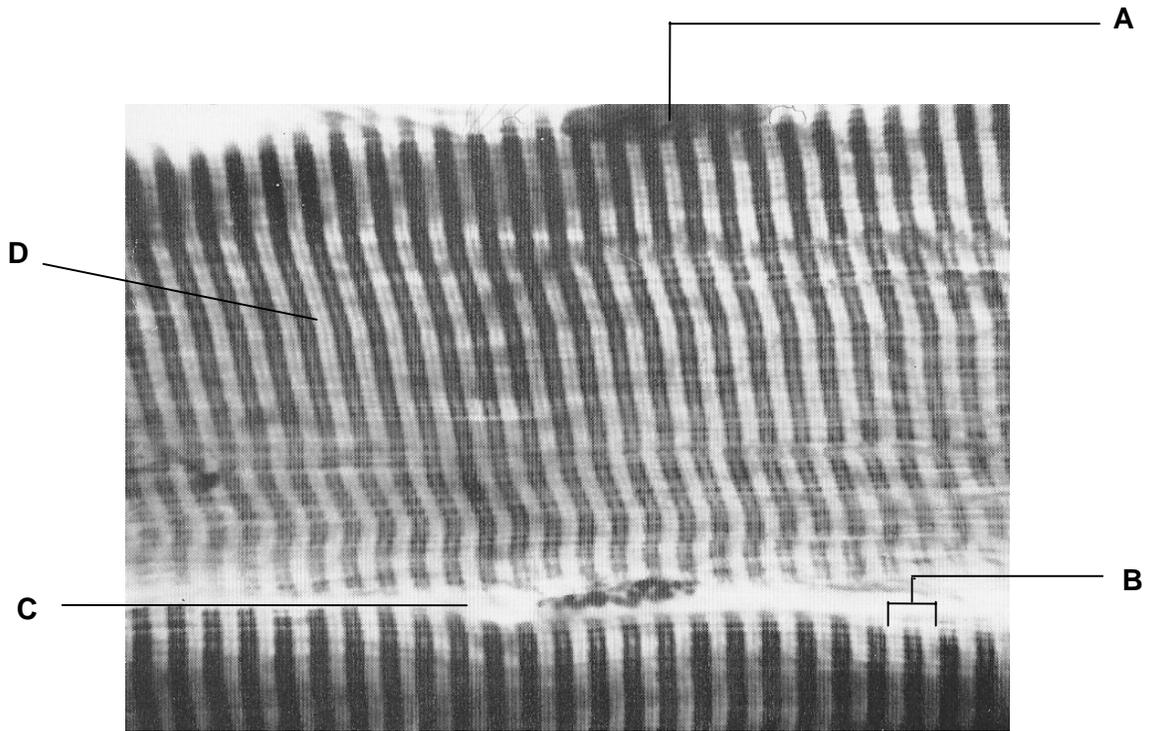


Fig. 4.1

- (a) Name the structures labelled **A** to **D**.

A _____

B _____

C _____

D _____

[4]

- 4 (b) After skeletal muscle has contracted for a period of time it reaches a point where it can no longer contract. This is called muscle fatigue. The muscles of people who show poor aerobic fitness reach this state relatively quickly.

Skeletal muscle is a mixture of two types of muscle fibre, fast twitch and slow twitch. The leg muscles of endurance athletes, such as marathon runners, comprise about 80% slow twitch fibres, whereas those of non-athletes may be around 50%.

Table 4.1 shows the features of these two types of muscle.

Features	Fast twitch muscle fibre	Slow twitch muscle fibre
number of mitochondria	very few	many
aerobic capacity	low	high
anaerobic capacity	high	low
blood supply	poor	good
time taken to reach maximum contraction	fast	slow
force of contraction	high	low

Explain why it is advantageous for endurance athletes to develop slow twitch fibres with,

- (i) many mitochondria;

[2]

- (ii) high aerobic capacity;

[2]

- (iii) good blood supply;

[1]

- (iv) slow time to maximum contraction and low force of contraction.

[1]

4 (c) Explain why glycogen stores are important in maintaining performance.

[3]

(d) State and explain why isotonic drinks are taken by athletes during a race or prior to competing.

[2]

5 The following passage is about substances that relieve severe pain.

Heroin is a drug produced from morphine. Both morphine and heroin have pain-killing effects because their molecular structure is similar to that of the body's natural pain-killers known as enkephalins.

Enkephalins are released by neurones in the brain and spinal cord and are believed to act as neurotransmitters. Our sensation or perception of pain is altered by the action of enkephalins. They suppress pain by reducing or preventing the transmission of information from peripheral pain receptors to the central nervous system.

Enkephalins are also produced in the part of the brain responsible for the emotions, the limbic system. It has been found that heroin also influences emotional state.

Enkephalin concentrations in heroin addicts are low and this may be one reason why addicts suffer withdrawal symptoms if their drug is not available.

(a) (i) State what is meant by the term *drug*.

[3]

- 5 (a) (ii) With reference to heroin, distinguish between tolerance and physical drug dependence.

[2]

- (iii) Morphine is lipid soluble. Explain how this makes it effective in treating severe pain.

[2]

- (b) A damaging stimulus, such as a severe burn, stimulates pain receptors in the skin. These receptors send nerve impulses to the brain and spinal cord. The brain projects the sensation of pain to the site of the burn.

Suggest how enkephalins may **reduce the sensation** of pain at the site of the burn. Your answer should include references to sensory neurones.

[3]

- (c) A neurotransmitter passes information across a synapse from a pre-synaptic neurone to a post-synaptic neurone.

Explain how the **continuous** production of action potentials is prevented when a post-synaptic neurone becomes depolarised.

[5]

- 6 (b) The blood transfusion service uses more than one system of blood grouping to prevent problems of incompatibility during and after transfusions. Blood can also be grouped by the ABO system.

Fig. 6.1 shows the agglutinogens (antigens) present on the red blood cells and the agglutinins (antibodies) present in the plasma of individuals with different ABO blood groups.

Blood group	Agglutinogens (antigens) on red blood cells	Agglutinins (antibodies) in plasma
A	A	b
B	A	a
AB	A and B	none
O	none	a and b

Fig. 6.1

Using the information on **Fig. 6.1** explain why,

- (i) individuals of blood group O are referred to as universal donors;

[2]

- (ii) individuals of blood group AB are referred to as universal recipients.

[2]

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MARK SCHEME

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

- 1 Please ensure that you use the **final** version of the Mark Scheme.
You are advised to destroy all draft versions.
- 2 Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If **two** (or more) responses are required for one mark, use only **one** tick. Half marks ($\frac{1}{2}$) should never be used.
- 3 The following annotations may be used when marking. **No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.**

X = incorrect response (errors may also be underlined)
^ = omission mark
bod = benefit of the doubt (where professional judgement has been used)
ecf = error carried forward (in consequential marking)
con = contradiction (in cases where candidates contradict themselves in the same response)
sf = error in the number of significant figures
- 4 The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.
- 5 In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), examiners should look at the responses given and make a judgement as to whether they are correct, incorrect or 'neutral'. They should then mark the first answer(s) given (unless they are judged to be 'neutral') up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.
- 6 Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)
- 7 Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.
- 8 An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct **and** answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

Abbreviations, annotations and conventions used in the Mark Scheme	/	=	alternative and acceptable answers for the same marking point
	;	=	separates marking points
	NOT	=	answers which are not worthy of credit
	()	=	words which are not essential to gain credit
	—	=	(underlining) key words which must be used to gain credit
	ecf	=	error carried forward
	AW	=	alternative wording
	ora	=	or reverse argument

Question	Answer	Mark																										
1(a)(i)	B = primary spermatocyte (s); C = secondary spermatocyte(s); D = spermatids;	3																										
1(a)(ii)	meiosis;	1																										
1(b)	DNA / nucleus to egg; ® genetic information creates <u>diploid / 2n nucleus</u> / 2n zygote; increases genetic variation; triggers fertilisation membrane / cortical reaction / prevents 2 nd sperm entering; activate development of egg / stimulate meiosis <u>II</u> to occur / AW;	3 max																										
1(c)	<i>accept first 4</i> <table style="width: 100%; border: none;"> <tr> <td style="text-align: center;"><i>spermatogenesis</i></td> <td style="text-align: center;"><i>oogenesis</i></td> </tr> <tr> <td>occurs in testis</td> <td>occurs in ovary;</td> </tr> <tr> <td>onset at puberty</td> <td>onset before birth;</td> </tr> <tr> <td>continuous</td> <td>monthly / cyclic;</td> </tr> <tr> <td>four gametes per germ cell</td> <td>one gamete / egg / ovum per germ cell;</td> </tr> <tr> <td>fully differentiated at end process</td> <td>not fully differentiated;</td> </tr> <tr> <td>mature sperm produced / division completed</td> <td>secondary oocyte produced / division completed at fertilisation;</td> </tr> <tr> <td>no polar bodies / equal division</td> <td>polar bodies / unequal division;</td> </tr> <tr> <td>millions / large numbers, produced</td> <td>usually only one at a time / per month;</td> </tr> <tr> <td>involves ICSH and testosterone</td> <td>involves FSH and oestrogen /and progesterone;</td> </tr> <tr> <td>accessory cells / Sertoli cells</td> <td>follicle cells;</td> </tr> <tr> <td>production ceases at 65+ / end of life</td> <td>production ceases at menopause / 45-60;</td> </tr> <tr> <td>smaller</td> <td>larger;</td> </tr> </table>	<i>spermatogenesis</i>	<i>oogenesis</i>	occurs in testis	occurs in ovary;	onset at puberty	onset before birth;	continuous	monthly / cyclic;	four gametes per germ cell	one gamete / egg / ovum per germ cell;	fully differentiated at end process	not fully differentiated;	mature sperm produced / division completed	secondary oocyte produced / division completed at fertilisation;	no polar bodies / equal division	polar bodies / unequal division;	millions / large numbers, produced	usually only one at a time / per month;	involves ICSH and testosterone	involves FSH and oestrogen /and progesterone;	accessory cells / Sertoli cells	follicle cells;	production ceases at 65+ / end of life	production ceases at menopause / 45-60;	smaller	larger;	4 max
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1(d)(i)	733,000-499,200 / 733,000 x 100; 31.89% / 31.9% / 32%;	2																										

Question	Answer	Mark
1(d)(ii)	no more produced after birth / A/W; breakdown / degeneration / atresia / many do not mature / die; monthly loss (unless pregnant) (from puberty to menopause) / AW; <i>Accept the first answer given on each answer line (unless the first is judged to be 'neutral'). If all the answer(s) given on one answer line are neutral, then look for a second correct answer on another line.</i>	2
Total mark:		15
2(a)	M = radial muscles; N = circular muscles; O = pupil;	3
2(b)	circular muscles relax; radial muscles contract;	2
2(c)	pupils fixed / unresponsive; pupillary light reflexes absent; pupils generally dilated; AVP;; e.g. eye-blink responses absent, eye movements uncoordinated / not synchronised <i>Accept the first answer given on each answer line (unless the first is judged to be 'neutral'). If all the answer(s) given on one answer line are neutral, then look for a second correct answer on another line.</i>	3 max
2(d)(i)	arrow from top of diagram pointing downwards;	1
2(d)(ii)	rhodopsin; (A) visual purple rhodopsin <u>absorbs</u> light energy / photons; light causes molecules to change shape; molecules broken down into opsin / protein and retinal; in bright light rate of breakdown faster than in dim light; ora	3 max
2(e)(i)	cones less sensitive than rods; cones need more/brighter/higher intensity, light than rods; cones are 3 types of cell, rods only 1 type of cell; cones absorb blue, green and red wavelengths, rods cannot; stimulation of different cones gives rise to colour vision, rods no colour / A/W;	3 max
2(e)(ii)	several rods synapse with one bipolar cell; information from several rods pooled / summated, by bipolar cell; summated signal transmitted to ganglion cell; cannot determine which rod(s) were originally activated by light; therefore cannot determine the 'boundaries' of the image; <i>Accept the first answer given on each answer line (unless the first is judged to be 'neutral'). If all the answer(s) given on one answer line are neutral, then look for a second correct answer on another line.</i>	2 max
Total mark:		17

Question	Answer	Mark
3(a)	<p>blocked fallopian tubes; low sperm count; sperm non-motile; woman past menopause; diseased ovaries; mucus hostile to sperm; hormone imbalance in woman; adhesions to ovaries; defective oocyte pickup; male / female immunity to sperm;</p> <p><i>Accept the first answer given on each answer line (unless the first is judged to be 'neutral'). If all the answer(s) given on one answer line are neutral, then look for a second correct answer on another line.</i></p>	2 max
3(b)(i)	<p>hormonal stimulation; FSH; HMG / clomiphene administration;</p>	2 max
3(b)(ii)	<p><i>accept method plus explanation</i> monitor LH levels; surge of LH indicates ovulation; ovulation 28-32 hours after surge; or inject HCG; collect eggs 36 hours later; or use ultrasound; monitor follicle (not eggs) size;</p>	2 max
3(b)(iii)	<p>some eggs damaged by procedure; some eggs fail to be fertilised / increase chances of fertilisation; some fertilized eggs fail to develop; some eggs fail to implant after return to mother/increase chances of implantation; some embryos abort after implantation; success rate is low;</p>	2 max
3(c)	<p>deviation from natural procreation; religious objections; superovulation / problem of spare embryos; costly procedure/money could be better spent; health risks to, mother/ baby, from multiple births; objection to parenthood in, post-menopausal women/lesbians; problem of surrogacy/refusal to give up child; introducing third party into relationship; treats baby as consumer product; elderly mothers/increased risk of mother dying when child is young; cost; better use of NHS facilities elsewhere; should identity of donor be known/declared; rights of child to know parent/donor; possible use of embryos in research; AVP;;</p>	7 max
	QWC: legible text, accurate spelling, punctuation and grammar;	1
	Total mark:	16

Question	Answer	Mark
4(a)	A = nucleus; B = sarcomere; C = sarcolemma; D = Z line / membrane;	4
4(b)(i)	more/higher rate of aerobic respiration more ATP/energy produced; by Krebs cycle and oxidative phosphorylation; therefore more sustained work/exercise can be done;	2 max
4(b)(ii)	reduces the amount of anaerobic respiration in fibres during exercise; reduces chances of building up oxygen deficit; therefore respiration produces carbon dioxide and water; less lactate built up;	2 max
4(b)(iii)	supplies more oxygen and glucose to exercising muscles/ or more efficiently; removes carbon dioxide from exercising muscles more efficiently;	1 max
4(b)(iv)	muscles can exercise for longer period; muscles take longer to reach point of fatigue;	1 max
4(c)	glycogen is carbohydrate store in muscles; it supports high rates of respiration during exercise; during exercise glycogen stores become depleted; becomes limiting factor/limits performance; store replenished by eating carbohydrate-rich foods (following exercise)	3 max
4(d)	water potential of solution is the same water potential as plasma; aid absorption; faster absorption; correct solute potential; AVP;	2 max
	Total mark:	15
5(a)(i)	chemical substance used to provide medical benefit; chemical which alters mood; perception; consciousness; modifies physical and / or mental functions; can be abused to cause physical and / or physiological harm;	3 max
5(a)(ii)	tolerance less effective/decrease in body's response; body needs more for same effect; increase in enzymes that destroy heroin; increase in receptors; physical dependence body can not function without heroin; body has adjusted to reduced experience of pain; pain is felt more keenly when heroin is not taken; more heroin needed to bind to all receptor sites;	2 max

Question	Answer	Mark
5(a)(iii)	diffuses across membranes; crosses blood-brain barrier; short diffusion distance;	2 max
5(b)	pain receptors transmit signals to CNS via sensory neurones / nerves; CNS (neurones) stimulated to release enkephalins; at synapses / synaptic clefts; lock onto receptors / AW; reduces incoming information from sensory neurones; this reduces sensation / perception of pain at site of burn; AVP; e.g. may reduce emotional anxiety / anxiolytic / distress	3 max
5(c)	enzyme(s) / named enzyme, in post-synaptic membrane / synaptic cleft; have active site(s) specific to neurotransmitter / shape of active site; complementary to neurotransmitter; splits/hydrolyses neurotransmitter; products reabsorbed by synaptic bulb / pre-synaptic membrane; re-combined in pre-synaptic vesicles; re-use / re-cycling avoids waste, more efficient; AVP; uses energy from mitochondria in synaptic knob	5 max
Total mark:		15
6(a)	If mother Rh ⁻ and foetus Rh ⁺ ; antibody / immune response in mother's blood / described; mother develops antibodies / agglutinins to Rh ⁺ blood; memory cells form; first child not affected; If second child also Rh ⁺ ; agglutinins in mother's plasma cross placenta; can bind to agglutinogens on baby's rbc; ref to complementary shape; haemolysis; ruptured cell membrane of rbc; agglutination of rbc; ® clotting when second child born mother forms more agglutinins to Rh ⁺ blood; reaction strong enough to threaten health of mother; more Rh agglutinins produced; remain in blood; second baby may be cyanosed / short of oxygen / may die; AVP;; QWC: clear well organised answer using specialist terms;	7 max 1
6(b)(i)	group O no A agglutinogens / antigens; no B agglutinogens / antigens; cannot therefore provoke immune response / antigen / antibody reaction / AW, in recipient; can donate blood to recipients of all four blood groups;	2 max

Question	Answer	Mark
6(b)(ii)	group AB has both A and B agglutinogens / antigens on rbc's; therefore have no A or B agglutinins / antibodies in plasma; therefore cannot attack donated red blood cells / AW; can receive blood of any group;	2 max
	Total mark:	12
	PAPER TOTAL:	90