Exercise walk-through

16.4.1 The reproductive systems, the gametes and the placenta

IGCSE Biology

You must be able to

- identify, and state the functions of, the testes, **scrotum** 阴囊, **sperm ducts** 输精管, **prostate gland** 前列腺, **urethra** 尿道 and penis
- identify, and state the functions of, the ovaries, **oviducts** 输卵管, **uterus** 子宫, **cervix** 子宫颈 and vagina
- describe fertilisation as the fusion of the **nuclei** 细胞核 of a sperm and an egg cell
- explain the adaptive features of sperm: the **flagellum** 鞭毛, the **mitochondria** 线粒体 and the enzymes in the **acrosome** 顶体
- explain the adaptive features of egg cells: the energy stores and the **jelly coat** 卵膜 that changes at fertilisation
- compare male and female gametes by size, structure, **motility** 运动能力 and numbers

You must be able to

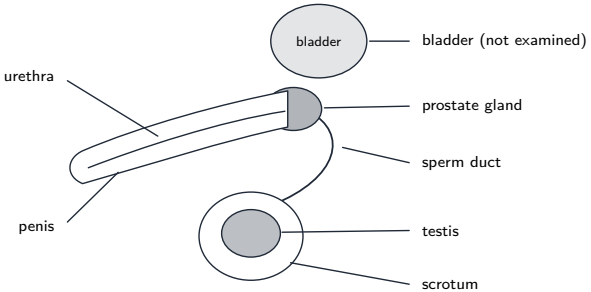
- state that the **zygote** 受精卵 forms an **embryo** 胚胎, a ball of cells that implants into the lining of the uterus
- identify, and state the functions of, the **umbilical cord** 脐带, placenta, **amniotic sac** 羊膜囊 and **amniotic fluid** 羊水
- describe how the placenta and umbilical cord exchange dissolved nutrients, gases and excretory products, and state that some **pathogens** 病原体 and **toxins** 毒素 can cross the placenta

1 The method

Method — The male system: six parts, six functions

part	function
testis	makes sperm, and the hormone **testosterone** 睾酮
scrotum	holds the testes outside the body, where it is slightly cooler than body temperature
sperm duct	carries sperm from the testis towards the urethra
prostate gland	adds fluid to the sperm, which the sperm swim in
urethra	carries sperm (and, at other times, urine) out of the body
penis	becomes firm and places the sperm inside the vagina

Method — The male system: six parts, six functions

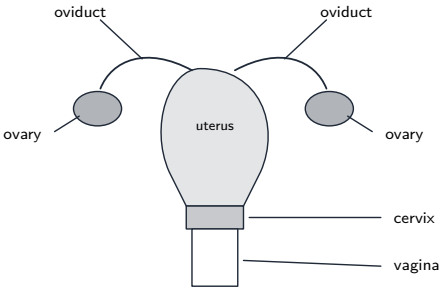


Each part has *one* function to learn: **testis** makes sperm and testosterone; **scrotum** holds the testes outside the body, slightly cooler; **sperm duct** carries sperm; **prostate gland** adds fluid; **urethra** carries sperm (and urine) out; **penis** places sperm inside the vagina.

Method — The female system: five parts, five functions

part	function
ovary	makes egg cells and releases one about once a month
oviduct	carries the egg cell towards the uterus; **fertilisation happens here**
uterus	where the embryo implants and the fetus develops; its muscular wall pushes the baby out at birth
cervix	a ring of muscle at the neck of the uterus, which holds the fetus in and widens at birth
vagina	receives the sperm, and is the birth canal

Method — The female system: five parts, five functions



Ovary releases an egg cell each month; **oviduct** carries it, and is where **fertilisation** happens; **uterus** is where the embryo implants and the fetus develops; **cervix** is the ring of muscle at its neck; **vagina** receives the sperm and is the birth canal.

Method — The gametes, and why each is shaped as it is

Fertilisation is the fusion of the nucleus of a sperm with the nucleus of an egg cell. Two haploid nuclei join, giving a diploid zygote. Say *nuclei*, not "the sperm joins the egg".

feature of a sperm	**what it does**
flagellum (tail)	beats so the sperm can **swim** to the egg cell
many **mitochondria** in the middle piece	release the **energy** for swimming, by respiration
enzymes in the **acrosome**	**digest** a way through the jelly coat so the nucleus can enter

Method — The gametes, and why each is shaped as it is

feature of an egg cell	**what it does**
energy stores in the cytoplasm	feed the embryo until it implants and the placenta takes over
the **jelly coat**	**changes** the instant one sperm enters, so no second sperm can get in

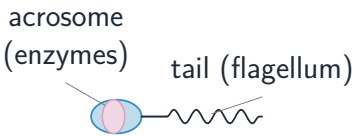
Method — The gametes, and why each is shaped as it is

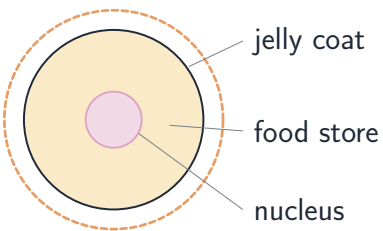
The comparison question asks for four things, so answer in four pairs:

	sperm	**egg cell**
size	much **smaller**	much **larger**
structure	a flagellum and many mitochondria	energy stores and a jelly coat, no flagellum
motility	**moves** itself	**cannot move** itself; it is carried along the oviduct
numbers	**millions** released at once	usually **one** a month

Method — The gametes, and why each is shaped as it is

Fertilisation is the fusion of the nucleus of a sperm with the nucleus of an egg cell.





sperm: small, millions, swims | egg: large, few, carried

Method — From zygote to implantation

1. The sperm nucleus fuses with the egg nucleus in the **oviduct**, giving a **zygote**.
2. The zygote divides by **mitosis 有丝分裂** into a **ball of cells**, the **embryo**, as it travels down the oviduct.
3. The embryo **implants** into the **lining of the uterus**, and the placenta begins to develop.

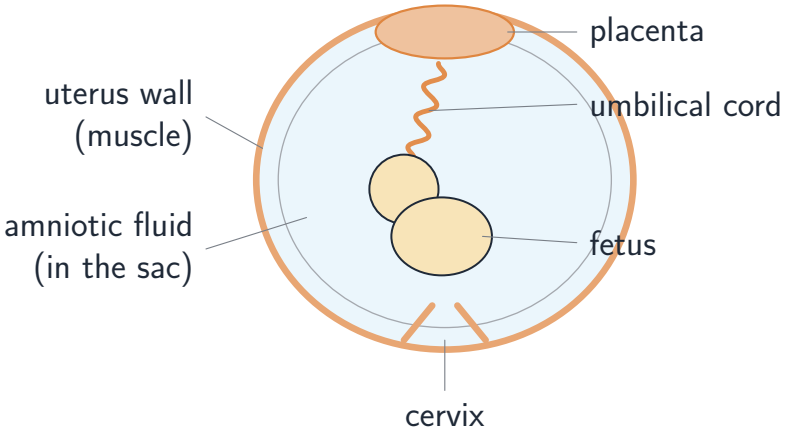
Method — The placenta: what crosses, and what does not

structure	function
placenta	the exchange surface between the mother's blood and the fetus's blood
umbilical cord	carries the fetus's blood to and from the placenta
amniotic sac	encloses the fetus and holds the amniotic fluid
amniotic fluid	**protects** the fetus from knocks and supports its weight

Method — The placenta: what crosses, and what does not

- **From mother to fetus:** dissolved **nutrients** (glucose, amino acids) and **oxygen**.
- **From fetus to mother: carbon dioxide** and **urea** 尿素 – the excretory products.
- Everything crosses by **diffusion** 扩散, so the placenta has a **large surface area** and a **thin barrier**, which gives a short diffusion distance.
- The two blood supplies stay **separate**. They come very close but never mix.
- △ Some **pathogens** and **toxins** can cross the placenta as well – for example nicotine and carbon monoxide from smoking, and alcohol.

Method — The placenta: what crosses, and what does not



2 Practice

Practice 2.1 ▪ 2 marks

Name the part of the male reproductive system that makes sperm, and the part that adds fluid to them.

Solution 2.1

Method: The male system: six parts, six functions — p.5

Worked steps

- the **testis** makes sperm B1
- the **prostate gland** adds fluid to them B1

Practice 2.2 ▪ 2 marks

Name the part of the female reproductive system where fertilisation happens, and the part where the embryo implants.

Solution 2.2

Method: The female system: five parts, five functions — p.7

Worked steps

- fertilisation happens in the **oviduct** B1
- the embryo implants in the **uterus**, in its lining B1

Practice 2.3 ▪ 2 marks

Describe what happens at fertilisation.

Solution 2.3

Method: The female system: five parts, five functions — p.7

Worked steps

- the **nucleus** of a sperm fuses with the **nucleus** of an egg cell B1
- the two haploid nuclei join, giving a **diploid zygote** B1

Practice 2.4 ▪ 3 marks

State the function of the jelly coat of an egg cell, and explain why it changes at fertilisation.

Solution 2.4

Method: The gametes, and why each is shaped as it is — p.9

Worked steps

- the jelly coat surrounds and **protects** the egg cell B1
- as soon as one sperm has entered, the coat **changes** B1
- so that **no other sperm can get in**, which keeps the zygote diploid B1

Practice 2.5 ▪ 2 marks

State **two** ways, other than size, in which an egg cell differs from a sperm cell.

Solution 2.5

Worked steps

- any **two** of: the sperm can **move itself** with its flagellum, while the egg cell cannot; **millions** of sperm are released at once, but usually only **one** egg a month; the egg cell has **energy stores** and a **jelly coat**, which the sperm does not B1 B1

Practice 2.6 ▪ 3 marks

Describe what happens to the zygote between fertilisation and implantation.

Solution 2.6

Worked steps

- the zygote divides by **mitosis** B1
- forming a **ball of cells**, the embryo, as it travels down the oviduct B1
- the embryo then **implants** into the lining of the uterus B1

3 Exam-style

Exam-style 3.1 ▪ 1 mark

Which row correctly compares a human egg cell with a human sperm cell?

	size of egg	which gamete moves itself	number released
A	larger	the egg	more eggs than sperm
B	larger	the sperm	fewer eggs than sperm
C	smaller	the sperm	more eggs than sperm
D	larger	the sperm	more eggs than sperm

Solution 3.1

Method: The gametes, and why each is shaped as it is — p.9

Worked steps

B

- the egg cell is much larger, the sperm is the gamete that swims, and far more sperm are released than eggs B1

Exam-style 3.2 ▪ 6 marks

A sperm cell and an egg cell are both adapted to their functions.

Exam-style 3.2 (a) ▪ 3 marks

Explain how the **acrosome**, the **mitochondria** and the **flagellum** each adapt a sperm cell to its function.

Solution 3.2 (a)

Method: The gametes, and why each is shaped as it is — p.9

Worked steps

- the **acrosome** contains enzymes that **digest** a way through the jelly coat, so the sperm nucleus can enter B1
- the **mitochondria** release **energy** by respiration, for swimming B1
- the **flagellum** beats, so the sperm can **swim** to the egg cell B1

Exam-style 3.2 (b) ▪ 3 marks

Explain how the **energy stores** and the **jelly coat** each adapt an egg cell to its function.

Solution 3.2 (b)

Worked steps

- the **energy stores** in the cytoplasm feed the embryo until it implants and the placenta can supply it B1
- the **jelly coat** protects the egg cell, and **changes** once a sperm has entered B1
- so that no second sperm can enter, which keeps the chromosome number correct B1

Exam-style 3.3 ▪ 10 marks

A fetus develops in its mother's uterus, joined to the placenta.

Exam-style 3.3 (a) ▪ 2 marks

Name the structure that joins the fetus to the placenta, and state the function of the amniotic fluid.

Solution 3.3 (a)

Method: The placenta: what crosses, and what does not — p.14

Worked steps

- the **umbilical cord** B1
- the amniotic fluid **protects the fetus from knocks** and supports its weight B1

Exam-style 3.3 (b) ▪ 3 marks

Name **two** substances that pass from the mother's blood to the fetus's blood, and **one** that passes from the fetus's blood to the mother's.

Solution 3.3 (b)

Worked steps

- from mother to fetus, any two of: **glucose**, **amino acids**, **oxygen** B1 B1
- from fetus to mother, either: **carbon dioxide** or **urea** B1

Exam-style 3.3 (c) ▪ 2 marks

The placenta has a large surface area and a very thin barrier between the two blood supplies. Explain why both of these features are needed.

Solution 3.3 (c)

Worked steps

- substances cross by **diffusion**, and a large surface area means **more can diffuse at once** B1
- a thin barrier gives a **short diffusion distance**, so diffusion is faster B1

Exam-style 3.3 (d) ▪ 3 marks

A pregnant woman smokes. Explain how this can affect her fetus.

Solution 3.3 (d)

Worked steps

- some **toxins** in tobacco smoke can **cross the placenta** into the fetus's blood B1
- **carbon monoxide** binds to the fetus's haemoglobin, so its blood carries **less oxygen** B1
- so the fetus receives less oxygen for respiration and grows more slowly, giving a low birth mass B1