

ESAT

Biology

Homeostasis, hormones and disease

Free lesson notes

Covers	B9.3 to B9.5
Format	Lesson, worked examples, self-check
Price	Free

About this lesson

Cells work properly only within narrow limits: the wrong temperature, too much or too little glucose, or too much water can stop the chemistry of life. Yet your surroundings change all the time. **Homeostasis** is how the body keeps its internal conditions steady, using nervous and hormonal control. This lesson explains the general principle (negative feedback) and applies it to blood glucose, water balance and body temperature, then to the hormones that control the menstrual cycle and how contraception works.

The second half is about what happens when things go wrong. We look at communicable diseases (caused by pathogens that spread from person to person), how the body defends itself, how vaccines and antibiotics work, how new drugs are tested, and at non-communicable diseases such as cardiovascular disease and cancer, including how to interpret data on risk. Calculations that appear in this topic (percentages, rates, exponential growth of bacteria, comparing risks) are practised throughout.

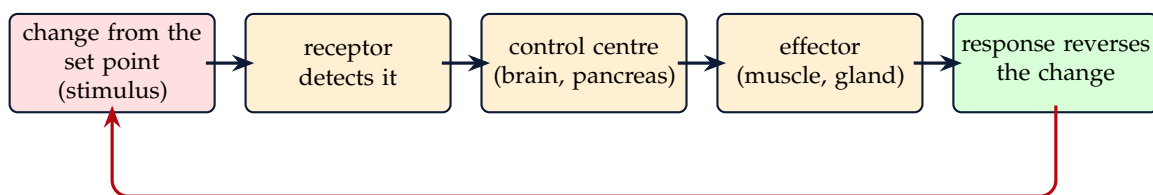
How to use it. Cover each worked example and try it yourself. In the real ESAT there is no calculator, so the numbers are friendly. Finish with the self-check and the practice set. Specification covered: B9.3 (homeostasis: negative feedback, glucose, insulin and glucagon, diabetes, ADH, temperature), B9.4 (hormones: adrenaline, the menstrual cycle, contraception) and B9.5 (communicable and non-communicable disease, defence, antibiotics, vaccines, drug development).

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1 Homeostasis and negative feedback (B9.3)

Homeostasis is the maintenance of a relatively constant internal environment, in spite of changes outside and inside the body. Things the body keeps steady include body temperature (about 37°C), blood glucose concentration, water content and blood pH. Constant conditions matter because enzymes work best at particular temperatures and pH (see the Enzymes lesson) and because cells exchange water and dissolved substances with the blood.

All control systems have three parts. A **receptor** detects a change from the ideal value (the *set point*). A **control centre** (the brain, or a gland such as the pancreas) receives the information and decides what to do. An **effector** (a muscle or a gland) carries out the response. Control is usually by **negative feedback**: a change in one direction triggers a response that pushes the level back in the opposite direction.



negative feedback: the response cancels the original change, so the level returns to normal

The word “negative” means that the response *cancels* the change; it does not mean something bad. A thermostat is the model: if the room becomes too warm, the heating switches off; too cold, and it switches on. The level therefore oscillates around the set point rather than going off in one direction.

Two control systems. The body has two communication systems. The **nervous system** sends fast electrical impulses along neurones, with short-lived and precise effects (a reflex, a muscle contraction). The **endocrine system** releases chemical messengers called **hormones** into the blood; they are carried everywhere but affect only certain *target organs*. Hormone effects are slower, longer lasting and usually more widespread. Homeostasis uses both.

Key ideas

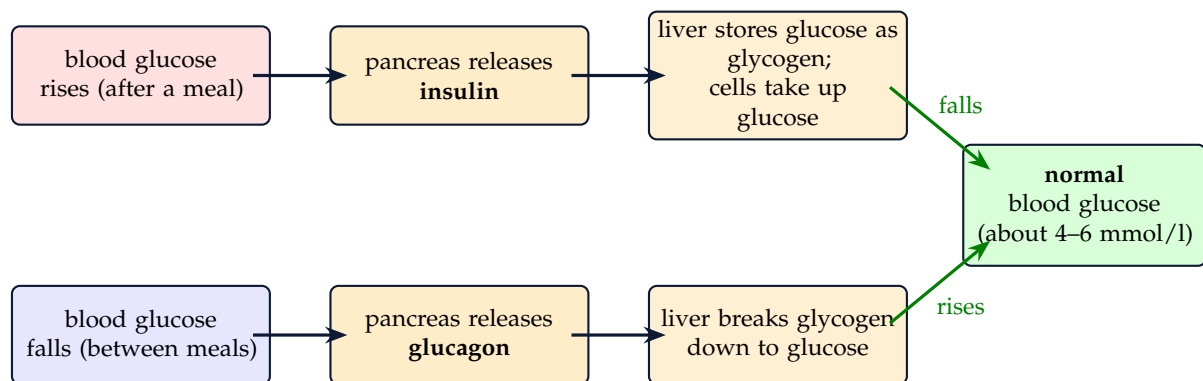
- Homeostasis keeps the internal environment (temperature, glucose, water, pH) within narrow limits.
- Negative feedback: receptor → control centre → effector → response that reverses the change.
- Nerves: fast, short-lived, precise. Hormones: slower, longer-lasting, carried in the blood to target organs.

Common mistakes

- Treating negative feedback as “a bad outcome”. It is the response that opposes and corrects the change.
- Saying homeostasis keeps conditions exactly constant. They fluctuate slightly around the set point.
- Saying hormones travel along nerves. They travel in the blood plasma.
- Saying a receptor and an effector are the same thing: the receptor detects, the effector responds.

2 Blood glucose and diabetes (B9.3)

Cells need glucose for respiration, so the concentration of glucose in the blood must not fall too low; but too much glucose upsets the water balance of cells and damages blood vessels. The normal concentration is about 4 to 6 mmol/l. It is controlled by the **pancreas**, which monitors the blood glucose and releases two hormones with opposite effects, and by the **liver**, which stores and releases glucose.

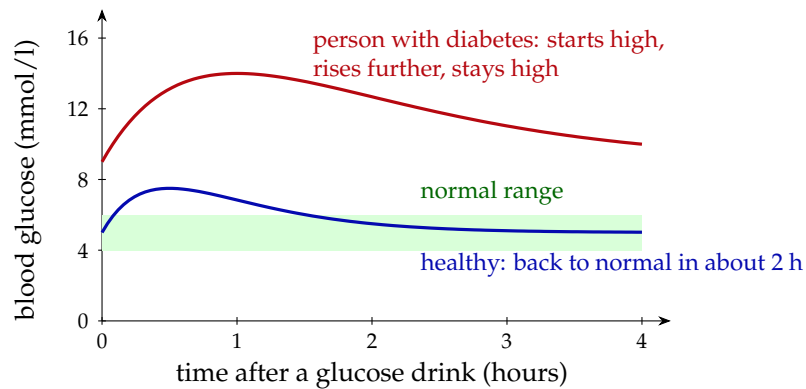


- After a meal, glucose from digestion enters the blood and its concentration rises. The pancreas releases **insulin**. Insulin makes liver and muscle cells take up glucose from the blood, and the liver converts the glucose to the storage carbohydrate **glycogen**. Blood glucose falls.
- Between meals or during exercise, glucose levels fall. The pancreas releases **glucagon**, which makes the liver convert glycogen back into glucose and release it. Blood glucose rises.
- Insulin and glucagon are *antagonistic* (opposite in effect), which allows tight control in both directions. Adrenaline also makes the liver release glucose (section 4).

Diabetes. In diabetes, blood glucose is not properly controlled and can become too high.

- **Type 1 diabetes:** the pancreas does not make enough (or any) insulin, because the body’s own immune system destroys the insulin-producing cells. It usually starts in childhood or youth. It is treated with **insulin injections** (or a pump), matched to meals, with monitoring of blood glucose and diet. It is not caused by lifestyle.
- **Type 2 diabetes:** the body’s cells stop responding properly to insulin (insulin resistance), and eventually the pancreas may not make enough. It is strongly linked to obesity, poor diet and inactivity. It is managed by a healthy diet, regular exercise and weight loss, and by drugs; some patients later need insulin.

Glucose tolerance test. A fasting patient drinks a glucose solution and blood glucose is measured over several hours. In a healthy person it rises modestly and returns to the normal range within about two hours. In a person with diabetes it starts higher, rises much more and stays high, because insulin is missing or ineffective.



Worked example: reading a glucose tolerance curve

In the graph above, compare the healthy person and the person with diabetes. What is the *rise* in glucose in each case, and how much higher is the diabetic's value after 3 hours? (Read: healthy starts at 5, peaks at about 7.5, and is 5 at 3 h; diabetic starts at 9, peaks at about 14, and is 11 at 3 h.)

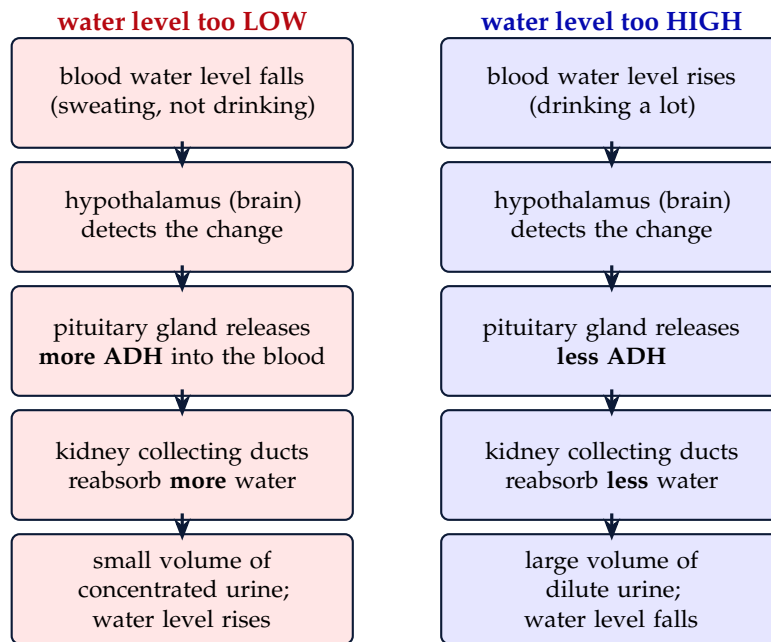
Healthy rise: $7.5 - 5 = 2.5$ mmol/l. Diabetic rise: $14 - 9 = 5$ mmol/l, twice as large. After 3 h the healthy person is in the normal range (5), while the diabetic person is at 11, which is $11 - 5 = 6$ mmol/l higher and well above the normal range. The diabetic's blood glucose started above normal and did not return to it in the time shown.

Common mistakes

- Mixing up the hormones: insulin *lowers* blood glucose; glucagon *raises* it.
- Saying insulin changes glucose into glycogen in the pancreas. The pancreas releases it; the *liver* (and muscles) store the glucose.
- Saying type 2 diabetes is cured by insulin injections in the same way as type 1. In type 2 the problem is mainly that cells do not respond.
- Saying that sugar in the diet *directly* causes type 1 diabetes.

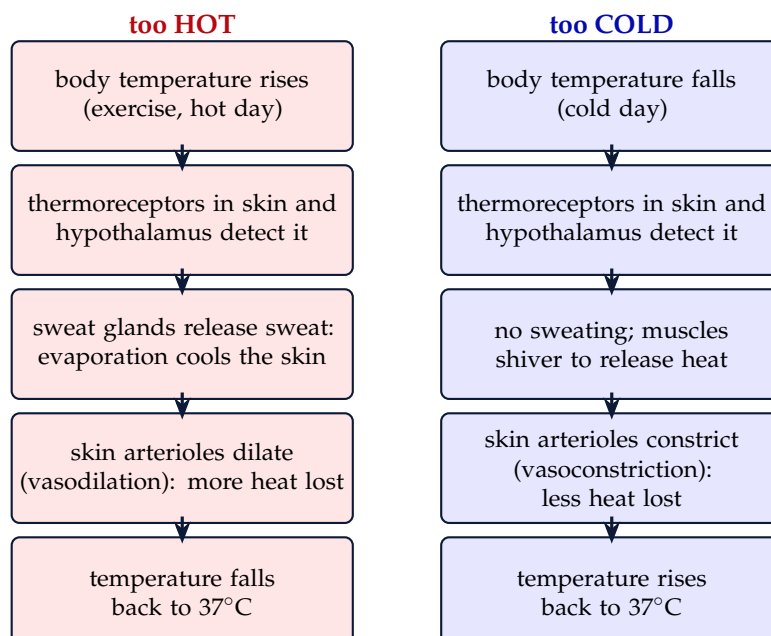
3 Water balance and temperature control (B9.3)

Water balance. We lose water in sweat, breath and urine and gain it by drinking and eating. If the blood is too dilute, cells swell; too concentrated, they shrink. The water content of the blood is monitored by the **hypothalamus** in the brain. When the blood is too concentrated (low water content), the hypothalamus makes the **pituitary gland** release more **antidiuretic hormone (ADH)** into the blood. ADH acts on the kidney tubules and collecting ducts, making them *more permeable to water*, so more water is reabsorbed into the blood. The urine becomes smaller in volume and more concentrated. If the blood is too dilute, less ADH is released, less water is reabsorbed, and a large volume of dilute urine is made.



Notice again the pattern of negative feedback: the change (low water) causes a response (more ADH, more reabsorption) that reverses it. Alcohol reduces ADH release, which is why it makes you pass a lot of dilute urine and leads to dehydration.

Temperature control. Body temperature must stay near 37°C , the optimum for most of our enzymes. The **thermoregulatory centre** in the hypothalamus receives information from thermoreceptors in the brain (which monitor the blood temperature) and in the skin. If we are too hot, the skin arterioles **dilate** (vasodilation), so more blood flows near the surface and more heat is lost to the surroundings; the sweat glands release **sweat**, and as it evaporates it takes energy from the skin and cools the body. If we are too cold, the arterioles **constrict** (vasoconstriction) so less heat is lost; sweating stops; and the muscles **shiver**, contracting rapidly, because the respiration needed to power them releases heat.



(Capillaries themselves do not move: it is the small *arterioles* leading to them whose muscle walls relax or contract. Also, hair erection and “goosebumps” do very little in humans, whose body hair is sparse, though they trap warm air in furry mammals.)

Worked example: how much water does ADH save?

A person produces 1.5 L of urine per day when well hydrated. In a dehydrated state, the same amount of urea (30 g) is excreted in 0.5 L. Compare the urea concentration in the two cases.

Hydrated: $30 \div 1.5 = 20 \text{ g/L}$. Dehydrated: $30 \div 0.5 = 60 \text{ g/L}$. The urine is 3 times as concentrated, because ADH increased the reabsorption of water while the urea remained in the tubule.

Common mistakes

- Saying ADH is made in the kidney or released by the hypothalamus. It is released by the pituitary gland (under the control of the hypothalamus).
- Saying capillaries dilate or move closer to the skin. It is the arterioles that dilate (vasodilation) or constrict.
- Saying shivering “generates heat by friction”. It generates heat because muscle respiration releases energy.
- Mixing up the direction: more ADH means *more* water reabsorbed and *less* urine.

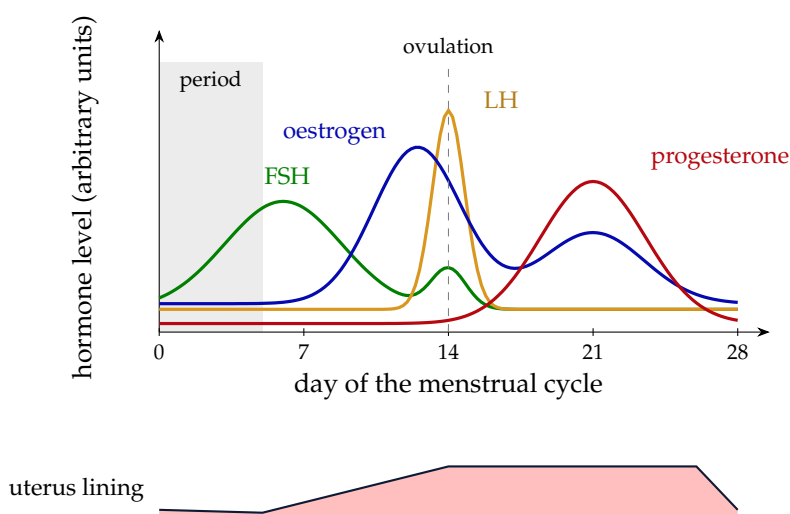
4 Hormones, the menstrual cycle and contraception (B9.4)

Hormones are made in **endocrine glands**, which release them directly into the blood. The **pituitary gland**, at the base of the brain, makes many hormones and controls other glands (it is called the “master gland”). Other glands include the pancreas (insulin, glucagon), the adrenal glands, the ovaries (oestrogen, progesterone) and the testes (testosterone).

Adrenaline is released by the adrenal glands (above the kidneys) in times of fear, excitement or stress. It prepares the body for “fight or flight”: the heart beats faster and harder (more blood, oxygen and glucose reach the muscles), the breathing rate rises, the liver releases glucose, and blood is diverted from the gut to the muscles; the pupils widen. Its effects appear within seconds and last a few minutes.

The menstrual cycle. In the female reproductive system the ovaries release an egg about once every 28 days, and the uterus lining is prepared to receive an embryo. Four hormones coordinate this:

- **FSH** (follicle stimulating hormone, from the pituitary) makes an egg mature in a follicle in the ovary, and stimulates the ovary to make oestrogen.
- **Oestrogen** (from the ovary) repairs and thickens the uterus lining, and its rising level triggers the pituitary to release a surge of LH. It also inhibits FSH.
- **LH** (luteinising hormone, from the pituitary): the surge at about day 14 triggers **ovulation**, the release of the egg.
- **Progesterone** (from the empty follicle, which forms the corpus luteum) maintains the thick uterus lining, and also inhibits FSH and LH. If no pregnancy occurs, progesterone falls, and the lining breaks down in the period (menstruation, days 1–5).



Contraception is the prevention of pregnancy. Methods work in different ways:

- **Hormonal methods** (the oral contraceptive pill, implants, patches, injections) contain oestrogen and/or progesterone. They *inhibit* FSH release, so that eggs do not mature (and so no ovulation); progesterone also thickens the mucus at

the cervix so that sperm cannot get through. They are very effective but give no protection against infection, and can have side effects.

- **Barrier methods:** condoms (male or female) and diaphragms stop sperm reaching the egg. Condoms are the only method that also protect against sexually transmitted infections.
- **Intrauterine devices (IUD)** (a small device in the uterus) prevent fertilisation or implantation; **spermicides** kill sperm.
- **Surgical methods:** sterilisation (cutting or sealing the sperm duct in men, or the oviducts in women), a permanent method.
- **Natural methods:** abstaining at the fertile time, which is much less reliable.

Worked example: reading the menstrual cycle graph

In the graph, on which day does ovulation occur, and which hormone peaks just before it? Which hormone is at its highest on day 21, and why is that important?

Ovulation is at about day 14, immediately after the surge of LH, the hormone that triggers it. The hormone that is highest on day 21 is progesterone, and it keeps the thick lining of the uterus in place, ready for an embryo. If pregnancy does not occur, progesterone falls and the lining is lost on about day 28 (the next period).

Common mistakes

- Saying FSH causes ovulation. FSH matures the egg; the LH surge triggers ovulation.
- Saying the pill works by *stimulating* FSH. It inhibits it.
- Believing the pill protects against STIs. Only condoms (barrier methods) do so.
- Thinking adrenaline is a nerve impulse. It is a hormone, released into the blood by the adrenal glands.

5 Communicable disease (B9.5)

A **communicable disease** is one that can be passed from one organism to another, because it is caused by a **pathogen**, a microorganism that causes disease. There are four main types.

type	what it is	examples
bacteria	single-celled, no nucleus; can multiply quickly; some release toxins	Salmonella (food poisoning), gonorrhoea, chlamydia, tuberculosis
viruses	tiny, not cells; reproduce only inside host cells, damaging them	measles, influenza, HIV, the common cold
fungi	some are single-celled, some multicellular	athlete's foot, thrush
protists	single-celled organisms with a nucleus; often spread by a vector	malaria (spread by mosquitoes)

How diseases spread. By *direct contact* (skin, body fluids, sex), by *water* or *food* that is contaminated, through the *air* (droplets from coughs and sneezes), and by **vectors**, organisms that carry a pathogen from one host to another without being ill themselves (a mosquito carries the malaria protist). Spread can be reduced by hygiene (hand washing), clean water and food preparation, isolating infected people, destroying vectors, and vaccination.

Sexually transmitted infections (STIs) spread by sexual contact (and, for some, blood). Chlamydia and gonorrhoea are bacterial and curable with antibiotics, though some strains of gonorrhoea have become resistant. Using a condom reduces the risk.

HIV (human immunodeficiency virus) is a virus that spreads by sexual contact, by blood (shared needles) and from mother to baby. It infects and destroys certain *white blood cells* (lymphocytes) that coordinate the immune system. Over years, the immune system weakens, and the person develops **AIDS**: they can no longer fight off infections and some cancers that a healthy person would resist. HIV cannot be cured, but **antiretroviral drugs** slow the multiplication of the virus, so that most patients stay healthy for decades. Antibiotics do not work against viruses.

Worked example: how fast does a disease spread?

In an outbreak, one infected person infects 3 others after one week, and each newly infected person does the same each following week. How many *new* infections occur in week 4, if no one is protected or isolated?

Week 1: 3 new; week 2: $3 \times 3 = 9$; week 3: 27; week 4: 81. The number multiplies by 3 each week, which is why

isolating infected people early is so important: it reduces the factor.

Common mistakes

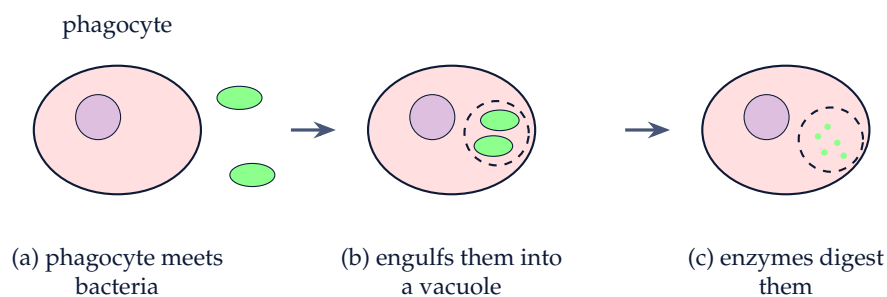
- Saying viruses are living cells or that antibiotics kill viruses.
- Saying "HIV is AIDS". HIV is the virus; AIDS is the condition that develops late in the infection.
- Saying a vector is ill with the disease. It carries the pathogen without being affected.
- Thinking all microbes cause disease. Most are harmless or useful (such as gut bacteria).

6 Defence, vaccines, antibiotics and drug testing (B9.5)

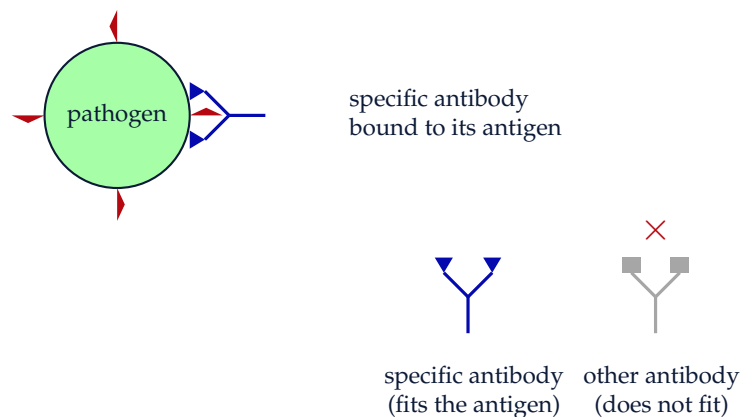
Defences. The body has barriers that keep most pathogens out: the *skin* (a tough barrier that is sealed by clotting at a wound, where platelets form a scab), *mucus and cilia* in the airways that trap and sweep out microbes, *stomach acid* (which kills most microbes swallowed with food), and tears and saliva that contain enzymes that digest bacteria.

If a pathogen gets in, the **immune system** attacks it using white blood cells in three ways.

- **Phagocytosis:** *phagocytes* engulf pathogens and digest them with enzymes.



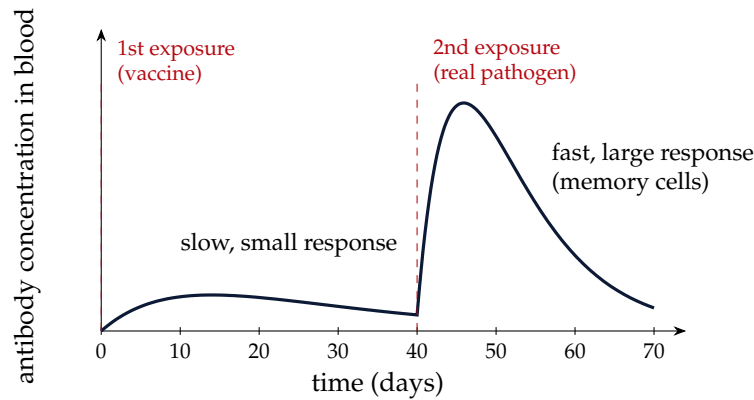
- **Antibodies:** each pathogen carries markers called **antigens**. A *lymphocyte* whose antibody fits the antigen multiplies and releases large numbers of that *specific* antibody. The antibodies bind to the pathogens, making them clump together and marking them for destruction by phagocytes.



- **Antitoxins:** lymphocytes also release antitoxins that neutralise toxins made by bacteria.

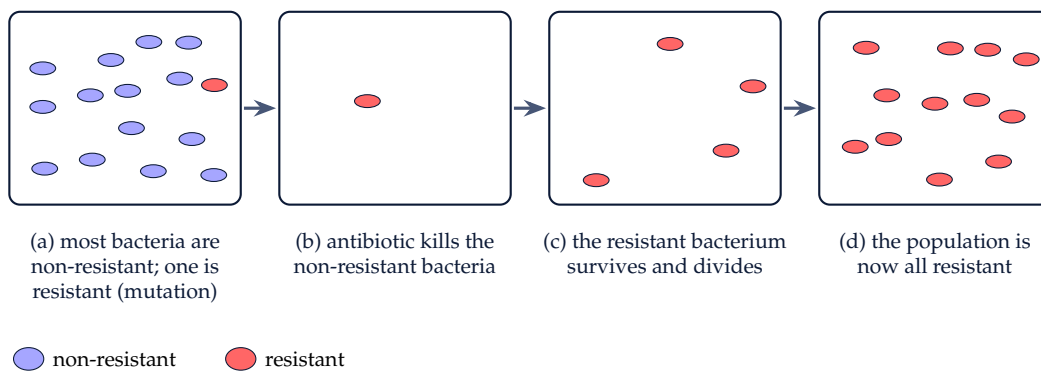
After an infection some lymphocytes remain as **memory cells**. If the same pathogen enters again, memory cells make the right antibody much faster and in greater quantity, and the pathogen is destroyed before it can make you ill. You are then *immune*.

Vaccination. A vaccine contains a harmless form of the pathogen (dead, inactivated or weakened, or just its antigens). It stimulates lymphocytes to make antibodies and memory cells without causing the disease. If the real pathogen later arrives, the response is fast and large (see the graph), so the person does not become ill. If enough of a population is vaccinated, the pathogen cannot easily spread, which protects even the unvaccinated: this is **herd immunity**.

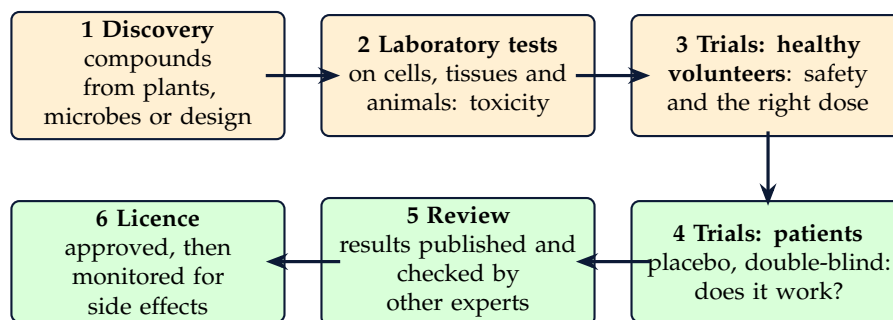


Antibiotics (such as penicillin) kill bacteria, or stop them multiplying, without harming human cells. They do *not* work on viruses, because viruses live inside our cells, and they are not effective for colds or influenza. Painkillers relieve symptoms but do not kill pathogens.

Antibiotic resistance. Bacteria reproduce rapidly, and occasionally one mutates so that it is resistant to an antibiotic. When the antibiotic is used, the non-resistant bacteria die, and the resistant one survives and reproduces, so the population becomes resistant. This is natural selection, and it creates “superbugs” such as MRSA. It is made worse by overuse of antibiotics, by not finishing courses, and by using them for viral infections. Doctors therefore prescribe antibiotics only when needed.



How a new drug is developed. Drugs come from plants (aspirin from willow bark), from microbes (penicillin from *Penicillium* mould) or are designed in the laboratory. A new drug must pass several stages before it can be used: tests on *cells and animals* for toxicity and effect; *clinical trials* on healthy volunteers to find out about safety and the right dose; then trials on patients to see if it works. Good trials use a large sample, *randomly* divided into a group that gets the drug and a group that gets a **placebo** (a dummy treatment), and they are **double-blind**: neither patients nor doctors know who gets which, so that expectation cannot affect the result. The results are checked by other scientists (peer review) before the drug is licensed.



Worked example: how many bacteria?

One resistant bacterium divides every 20 minutes. How many resistant bacteria are there after 2 hours, if none die?
 2 hours = 120 minutes = 6 divisions of 20 minutes. Each division doubles the number: $2^6 = 64$. A single resistant

bacterium can become 64 in two hours, and after 3 hours $2^9 = 512$, which is why resistance spreads so fast.

Worked example: vaccination coverage

A town has 10 000 people. 80% are vaccinated and the vaccine is 90% effective in those who receive it. How many people are protected by the vaccine?

Vaccinated: $0.80 \times 10000 = 8000$. Protected: $0.90 \times 8000 = 7200$, i.e. 72% of the town. (The other 2800 are not protected, though fewer people carry the pathogen, which helps them too.)

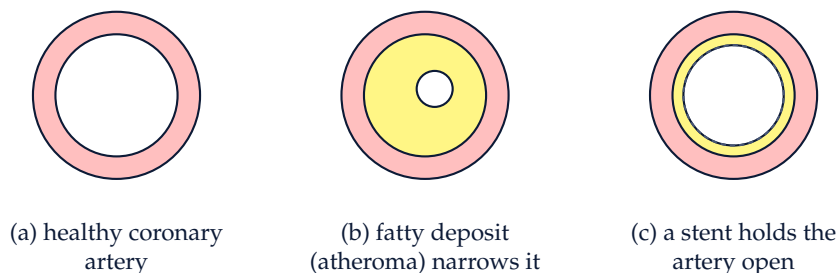
Common mistakes

- Saying a vaccine contains antibodies. It contains antigens (or a harmless form of the pathogen); the body makes the antibodies.
- Saying antibiotics make you resistant. The *bacteria* become resistant by mutation and natural selection.
- Saying a placebo is a cheaper drug. It contains no active drug.
- Saying vaccines cure the disease. They prevent it.

7 Non-communicable disease (B9.5)

A **non-communicable disease** is not caused by a pathogen and cannot be passed from person to person. Examples include cardiovascular disease, cancer, type 2 diabetes and lung diseases. They are usually caused by a mixture of factors: lifestyle, genes, age and the environment. A **risk factor** is something that increases the chance of getting a disease, but does not make it certain.

Cardiovascular disease (CVD) is disease of the heart and blood vessels. In **coronary heart disease**, fatty deposits (including cholesterol) build up inside the coronary arteries and narrow them (atheroma). Less blood reaches the heart muscle, causing chest pain; if a blood clot forms on the deposit and blocks the artery, part of the heart muscle is starved of oxygen and a **heart attack** occurs.



Risk factors include smoking, a diet high in saturated fat and salt, obesity, lack of exercise, high blood pressure, excessive alcohol, age and family history. Treatments include **statins** (drugs that lower blood cholesterol), **stents** (a small mesh tube that holds a narrowed artery open), **bypass surgery**, drugs that lower blood pressure or prevent clots, and, for a failing heart, a *heart transplant*. Prevention (a healthy diet, exercise, not smoking) is cheaper and safer than treatment.

Cancer is caused by uncontrolled cell division. Normal cells divide in a regulated way; if a mutation damages the genes that control division, the cells divide without stopping and form a lump called a **tumour**. A *benign* tumour grows but stays in one place, enclosed; a *malignant* tumour invades neighbouring tissue and can break off and spread through the blood to form secondary tumours elsewhere (this is called metastasis). Risk factors include smoking (lung cancer), ultraviolet radiation from the Sun (skin cancer), ionising radiation, some viruses and chemicals, obesity and inherited genes. Treatment includes surgery, radiotherapy, chemotherapy (drugs), and screening aims to find cancers early, when treatment is most effective.

Interpreting data on disease. Studies often compare *rates*, not raw numbers, because groups differ in size. A **correlation** (the two things occur together) does not by itself prove a **causal** link. We become confident that smoking *causes* lung cancer when (a) the correlation is found in many large studies, (b) there is a plausible mechanism (chemicals in smoke cause mutations), and (c) other factors have been ruled out.

Worked example: comparing risks

In a study, 20 000 smokers had 240 deaths from heart disease and 40 000 non-smokers had 160. Compare the death rates.

Smokers: $240 \div 20000 = 0.012 = 12$ per 1000. Non-smokers: $160 \div 40000 = 0.004 = 4$ per 1000. The smokers' rate is $12 \div 4 = 3$ times higher. Comparing the raw numbers (240 and 160, a ratio of 1.5) would be misleading because the groups are of different sizes. The data show a strong correlation, and together with other evidence it supports a causal link.

Common mistakes

- Comparing raw numbers of cases for groups of different size. Compare the rates (per 1000, for example).
- Claiming a correlation proves a cause ("ice cream sales and drownings both rise in summer").
- Saying all tumours are cancers. Benign tumours are not cancerous because they do not spread.
- Saying a risk factor guarantees the disease, or that its absence guarantees health.

8 Putting it together

A routine for homeostasis questions. (1) Name the variable and the change. (2) Name the receptor and control centre. (3) Name the effector and say what it does. (4) State that the response reverses the change (negative feedback), and say which way the level moves. For hormone questions, add: where the hormone is made, what it targets, and what the effect is.

A routine for disease questions. (1) Is it communicable (caused by a pathogen) or not? (2) If a pathogen, which type, and how does it spread? That tells you the control measure (antibiotics for bacteria only; vaccines for those with vaccines; hygiene and vectors control for others). (3) If non-communicable, list the risk factors and what the data can and cannot show.

Connections. Many diseases are connected to homeostasis. Diabetes is a failure of glucose control; the damage it does to blood vessels makes it a risk factor for CVD; obesity is a risk for CVD, type 2 diabetes and some cancers; and the immune system's attack on the body's own insulin-producing cells causes type 1 diabetes. A weakened immune system (HIV) leads to infections and some cancers.

Worked example: diagnosing a symptom pattern

A patient produces a very large volume of very dilute urine each day, with no glucose in it, and is always thirsty. Which hormone is probably affected, and why?

The urine is dilute, so the kidney is not reabsorbing enough water, and there is no glucose, so it is not diabetes mellitus. A lack of ADH (or failure of the kidney to respond to it) would cause this: the collecting ducts stay impermeable and the water is lost; the thirst is the brain's response to a high blood concentration.

Exam tip

In an "explain" question about control, always name *where* the hormone is made and *which organ* it acts on; and always state which way the controlled variable moves.

Common mistakes

- Giving the effect without the *target organ* (for example saying ADH "makes less urine" without the kidney).
- Confusing communicable and non-communicable diseases (type 2 diabetes and cancer are not infectious).
- Interpreting data without calculating a rate per group size.

Check yourself

Try these without looking back, then compare with the answers on the next page.

1. Describe how the body responds when blood glucose rises after a meal.
2. Distinguish between type 1 and type 2 diabetes.
3. A runner loses a lot of water by sweating. Explain how the kidneys respond.
4. Give two ways the body loses less heat when it is cold.
5. Name the hormone that triggers ovulation, and where it is made.
6. Why does the second exposure to a pathogen cause a faster and bigger antibody response?
7. Explain how antibiotic-resistant bacteria arise and spread.
8. Why is a double-blind, placebo-controlled trial better than giving a drug to all the patients?

Answers to the self-check

1. The pancreas detects the rise and releases insulin. Insulin makes the liver and muscle cells take up glucose, and the liver converts it to glycogen, so blood glucose falls.
2. In type 1 the pancreas makes little or no insulin (treated with insulin injections). In type 2 the cells stop responding to insulin, linked to obesity (managed with diet, exercise and drugs).
3. The hypothalamus detects the concentrated blood, and the pituitary releases more ADH. ADH makes the collecting ducts more permeable, more water is reabsorbed, and a small volume of concentrated urine is produced.
4. Vasoconstriction (skin arterioles narrow, less blood near the surface) and no sweating; also shivering generates heat.
5. Luteinising hormone (LH, the surge), made by the pituitary gland.
6. Memory cells remain after the first infection (or vaccination), so the right lymphocytes quickly multiply and release large numbers of antibodies.
7. A mutation makes a bacterium resistant. Antibiotics kill the non-resistant bacteria, so the resistant one survives and reproduces. The population becomes resistant (natural selection).
8. It removes bias and the placebo effect: neither patients nor doctors know who has the drug, and the placebo group is a control to compare with.

Next step

Heurisco's *ESAT Biology: Homeostasis, Hormones and Disease Practice Set* has twenty original exam-style questions on this lesson, with graphs and data tables, in order of difficulty, with a full worked solution, a common-trap note and the specification code for every question.