

BioMedical Admissions Test (BMAT)

Section 2: Biology

Topic B9 (part 2) - Hormones, Homeostasis and Diseases

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Topic B9 (part 2) - Hormones, Homeostasis and Diseases

Hormones

Hormones are **chemical messengers** released from specific endocrine glands that travel in the blood plasma. However, hormones will only have an effect on specific cells, which we call **'target cells'**.

Nerves and hormones exhibit differences in their actions; hormones are **slower**, act for a **longer period of time** and have more **general effects**. These are important things to remember and they occur because hormones are limited by the speed of blood passing around the body.

Thyroxine:

- Thyroxine is important for **regulating basal metabolic rate** (the rate at which chemical reactions within the body take place when at rest)
- **Thyroid stimulating hormone (TSH)** controls the release of thyroxine through **negative feedback**
- Levels in blood is monitored by the **hypothalamus**
- When thyroxine is too high
 - The TSH released by the pituitary gland is **inhibited**
 - Less thyroxine is released from thyroid gland
 - Level falls back to normal
- The opposite occurs when levels in the blood are too low

Adrenaline:

- Released by the **adrenal glands**
- Responsible for **'fight or flight'** response
- Actions:
 - Increases heart rate
 - Stimulate liver to break down glycogen to glucose for energy
 - Increases breathing rate
 - Causes dilation of vessels to direct blood to muscles
 - Causes the pupils to dilate

Hormones in human reproduction

- **Oestrogen** is the main female reproductive hormones and is produced in the ovaries
- **Testosterone** is the main male reproductive hormones and is produced in the testes



Menstrual cycle:

- **Follicle stimulating hormone (FSH)**
 - Produced by the **pituitary gland**
 - Acts in the ovary
 - Stimulates ovaries to develop follicle containing an egg and to produce oestrogen
- **Oestrogen**
 - Produced by the **ovaries**
 - Stimulates the uterus lining to thicken
 - Inhibits FSH and LH
- **Luteinising hormone (LH)**
 - Produced by the **pituitary gland**
 - Acts on ovaries
 - Stimulates the mature follicle to release the egg around day 14 - ovulation
- **Progesterone**
 - Secreted by empty follicle in ovary (**corpus luteum**)
 - Maintains the lining of the uterus so that the fertilised egg can implant
 - Inhibits LH
 - Decrease levels cause the lining to break down - menstruation

Contraceptives:

- Hormonal contraceptive
 - **Oral pill** - combined or progesterone only
 - Not 100% effective
 - Side effects, e.g. nausea, headaches
 - Does not protect against STDs
 - Need to take every day
 - **Skin patch**
 - Same hormones as combined pill
 - Patch changed every week
 - **Implant**
 - Lasts up to 3 years
 - Continuous amount of progesterone
 - **Injection**
 - Lasts up to 3 months
 - **Intrauterine devices**
 - T-shaped device inserted into the uterus
 - Stops implantation and plastic IUDs release progesterone
- Non-hormonal methods
 - **Barrier methods**
 - Condoms, diaphragm, spermicide
 - Condoms protect against STDs
 - **Natural methods**



- Abstinence - 100% effective
- Planning to avoid sex during most fertile time of ovulation
- Not very effective
- **Intrauterine devices**
 - As mentioned before
 - Copper IUDs instead of plastic - can stop sperm surviving
- **Surgical methods**
 - Cutting/tying structures, e.g. oviducts or sperm ducts

Exam Tip - If a response is rapid, it is likely caused by nerves; if a response is longer lasting, it is likely caused by a hormone.

Homeostasis

Homeostasis is the process of **maintaining a constant internal environment** in the body - this means balancing what goes into the body, with what comes out.

Homeostasis is maintained using **negative feedback** - this is a process where a condition's level becomes too high or too low, and this is fed back to the brain. The brain then alters the level of this condition to bring it back to the **normal value**.

Body temperature:

- The thermoregulatory centre in the **hypothalamus** detects **changes in temperature** and sends signals to effectors that can alter these changes
- When body temperature is too high
 - More **sweating** occurs to maintain body temperature
 - Kidneys respond to more water being lost in sweat by producing **smaller volume of more concentrated urine** to avoid dehydration
 - **Vasodilation** occurs to remove more heat from the blood
- When body temperature is low
 - Less sweating occurs
 - Kidneys respond by producing a **higher volume of less concentrated urine**
 - This avoids excess water being taken in by osmosis, causing the cells to burst
 - **Hairs** stand up on end to create an insulation layer
 - **Vasoconstriction** occurs to reduce heat lost from blood
 - Involuntary muscle contraction (**shivering**) occurs to raise body temperature



Blood glucose:

- When blood glucose is **too high**, a hormone called **insulin** is released from the **pancreas** into the blood. This acts to decrease glucose levels in the blood
- When glucose is **too low**, a hormone called **glucagon** is released to increase glucose levels

Water content:

- The water content of the blood is controlled by a hormone called **ADH**
- This is released into the blood by the **pituitary gland**
- If water content is too high, less ADH is released so the kidneys reabsorb less water and more urine is produced.
- Alcohol causes a suppression of ADH production, so that higher volumes of dilute urine are produced.
- Ecstasy causes an increase of ADH production, so that smaller volumes of very concentrated urine are produced.

Exam Tip - To remember the function of ADH, you can just remember that it causes less urine to be produced, which increases water levels in the blood. Therefore, it is released when water content of the blood is too low.

ADH stands for **Antidiuretic Hormone**, and diuresis is the process of making urine - knowing this makes solving questions a lot easier!

Communicable Diseases

Communicable diseases are **infectious** diseases that are caused by **pathogens**. These include viruses, bacteria, protists and fungi.

Viral diseases:

- **HIV/AIDS**
 - Retrovirus - RNA and contains **reverse transcriptase**
 - HIV passes through **infected body fluids**, e.g. sexually, blood through infected needles or transfusions, breast milk
 - Reduces white blood cell count, meaning a weakened immune system which leads to AIDS (acquired immune deficiency syndrome)
 - No cure but anti-retroviral drugs can control infection
- **Influenza**

Spread in **airborne droplets**, e.g. sneezing

 - Vaccines containing inactive or weakened virus are available
 - This forms an immune response where antibodies to the pathogen's antigens are created and retained in memory cells.



- When the person comes into contact with the real virus, the memory cells can produce that antibody faster and in larger amounts so that the person does not have any symptoms (secondary immune response)
- **Measles**
 - Spread by **direct contact**, e.g. touching infected person, and by airborne mucus droplets, e.g. sneezing
 - Red blotchy rash that spreads across skin
 - mmR vaccine contain live attenuated version of virus
- **Tobacco mosaic disease**
 - Tobacco mosaic virus attacks tobacco plants

Bacterial diseases:

- **Salmonella food poisoning**
 - Occurs when someone eats **food contaminated with bacteria**
 - Oral rehydration supplements can be given to replace lost electrolytes from diarrhoea and vomiting caused by the bacterium
- **Antibiotics** can be used against bacteria, although recently **antibiotic resistance** is increasing amongst bacteria populations

Non-Communicable Diseases

These types of diseases are **not infectious** and are caused by the **interaction of many different factors** in a person's life. Some of the main non-communicable diseases that you should be aware of are: cardiovascular disease (CVD), many forms of cancer, some lung diseases, some liver diseases and nutrition-influenced diseases (e.g. type 2 diabetes).

Cardiovascular disease (CVD)

- **Coronary heart disease** - an atheroma or blood clot blocking the coronary arteries, stopping oxygen and glucose reaching the heart and causing anaerobic respiration to occur, which can cause the cells to die
- **Hypertension** - consistently raised blood pressure (over 140/90mmHg), due to the narrowing of an artery lumen
- **Stroke** - narrowing or hardening of arteries supplying the brain tissue, which leads to part of the brain becoming deprived of oxygen and glucose and dying.

Risk factors:

- Diet high in fat and cholesterol or salt
- Too little exercise
- Smoking
- Obesity
- Non-modifiable risk factors, such as genetics, age and gender



Treatments:

- Life-long treatment
 - **Statins** - reduce cholesterol production to avoid an atheroma blocking arteries
 - **Anticoagulants** - reduce likelihood of blood clots
 - **Anti-hypertensive** drugs - relax blood vessels to reduce blood pressure
- Surgical procedures
 - **Stent** - a mesh tube is placed into the coronary arteries to increase the lumen diameter so that blood can flow freely
 - **Bypass** - a small part of a blood vessel is removed from elsewhere in the body, e.g. the leg, and used to reroute blood around a blockage
- **Lifestyle** changes
 - Reducing smoking
 - More exercise
 - Balanced diet

