Name ……………………………………….…. Group ………………………….

**WHAT YOU NEED TO KNOW**

**AQA GCSE BIOLOGY. UNIT 5 – HOMEOSTASIS AND RESPONSE**

Cells in the body can only survive within narrow physical and chemical limits. They require a constant temperature and pH as well as a constant supply of dissolved food and water. In order to do this the body requires control systems that constantly monitor and adjust the composition of the blood and tissues. These control systems include receptors which sense changes and effectors that bring about changes. In this section we will explore the structure and function of the nervous system and how it can bring about fast responses. We will also explore the hormonal system which usually brings about much slower changes. Hormonal coordination is particularly important in reproduction since it controls the menstrual cycle. An understanding of the role of hormones in reproduction has allowed scientists to develop not only contraceptive drugs but also drugs which can increase fertility.

**4.5.1 Homeostasis**

| **Specification code** | **Expected knowledge and understanding** | **** |
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| 4.5.1 Homeostasis | 1. Students should be able to explain that homeostasis is the regulation of the internal conditions of a cell or organism to maintain optimum conditions for function in response to internal and external changes.
2. Homeostasis maintains optimal conditions for enzyme action and all cell functions.
3. In the human body, these include control of:
* blood glucose concentration
* body temperature
* water levels.
1. These automatic control systems may involve nervous responses or chemical responses.
2. All control systems include:
* cells called receptors, which detect stimuli (changes in the environment)
* coordination centres (such as the brain, spinal cord and pancreas) that receive and process information from receptors.
* effectors, muscles or glands, which bring about responses which restore optimum levels.
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**4.5.2 The human nervous system**

| **Specification code** | **Expected knowledge and understanding** | **** |
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| 4.5.2.1 Structure and function | 1. Students should be able to explain how the structure of the nervous system is adapted to its functions.
2. The nervous system enables humans to react to their surroundings and to coordinate their behaviour.
3. Information from receptors passes along cells (neurones) as electrical impulses to the central nervous system (CNS). The CNS is the brain and spinal cord. The CNS coordinates the response of effectors which may be muscles contracting or glands secreting hormones.

Stimulus 🡪 receptor 🡪 coordinator 🡪 effector 🡪 response1. Students should be able to explain how the various structures in a reflex arc – including the sensory neurone, synapse, relay neurone and motor neurone – relate to their function. Students should understand why reflex actions are important.
2. Reflex actions are automatic and rapid; they do not involve the conscious part of the brain.
3. Students should be able to extract and interpret data from graphs, charts and tables, about the functioning of the nervous system.
4. Students should be able to translate information about reaction times between numerical and graphical forms.
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**Required practical activity 7:** plan and carry out an investigation into the effect of a factor on human reaction time.

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| **Specification code** | **Expected knowledge and understanding** | **** |
| 4.5.2.2The brain (biology only) | 1. The brain controls complex behaviour. It is made of billions of interconnected neurones and has different regions that carry out different functions.
2. Students should be able to identify the cerebral cortex, cerebellum and medulla on a diagram of the brain, and describe their functions.
3. (HT only) Students should be able to explain some of the difficulties of investigating brain function and treating brain damage and disease.
4. (HT only) Neuroscientists have been able to map the regions of the brain to particular functions by studying patients with brain damage, electrically stimulating different parts of the brain and using MRI scanning techniques. The complexity and delicacy of the brain makes investigating and treating brain disorders very difficult.
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| 4.5.2.3The eye (biology only) | 1. Students should be able to relate the structures of the eye to their functions. This includes:

• accommodation to focus on near or distant objects• adaptation to dim light.1. The eye is a sense organ containing receptors sensitive to light intensity and colour.
2. Students should be able to identify the following structures on a diagram of the eye and explain how their structure is related to their function:
* retina
* optic nerve
* sclera
* cornea
* iris
* ciliary muscles
* suspensory ligaments.
1. Accommodation is the process of changing the shape of the lens to focus on near or distant objects.
2. To focus on a near object:
* the ciliary muscles contract
* the suspensory ligaments loosen
* the lens is then thicker and refracts light rays strongly. To focus on a distant object:
* the ciliary muscles relax
* the suspensory ligaments are pulled tight
* the lens is then pulled thin and only slightly refracts light rays.
1. Two common defects of the eyes are myopia (short sightedness) and hyperopia (long sightedness) in which rays of light do not focus on the retina.
* Generally these defects are treated with spectacle lenses which refract the light rays so that they do focus on the retina.
* New technologies now include hard and soft contact lenses, laser surgery to change the shape of the cornea and a replacement lens in the eye.
1. Students should be able to interpret ray diagrams, showing these two common defects of the eye and demonstrate how spectacle lenses correct them.
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| **Specification code** | **Expected knowledge and understanding** | **** |
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| 4.5.2.4 Control of body temperature (biology only) | 1. Body temperature is monitored and controlled by the thermoregulatory centre in the brain. The thermoregulatory centre contains receptors sensitive to the temperature of the blood. The skin contains temperature receptors and sends nervous impulses to the thermoregulatory centre.
2. If the body temperature is too high, blood vessels dilate (vasodilation) and sweat is produced from the sweat glands. Both these mechanisms cause a transfer of energy from the skin to the environment.
3. If the body temperature is too low, blood vessels constrict (vasoconstriction), sweating stops and skeletal muscles contract (shiver).
4. (HT only) Students should be able to explain how these mechanisms lower or raise body temperature in a given context.
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**4.5.3 Hormonal coordination in humans**

| **Specification code** | **Expected knowledge and understanding** | **** |
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| 4.5.3.1 Human endocrine system | 1. Students should be able to describe the principles of hormonal coordination and control by the human endocrine system.
2. The endocrine system is composed of glands which secrete chemicals called hormones directly into the bloodstream. The blood carries the hormone to a target organ where it produces an effect. Compared to the nervous system the effects are slower but act for longer.
3. The pituitary gland in the brain is a ‘master gland’ which secretes several hormones into the blood in response to body conditions. These hormones in turn act on other glands to stimulate other hormones to be released to bring about effects.
4. Students should be able to identify the position of the following on a diagram of the human body:
* pituitary gland
* pancreas
* thyroid
* adrenal gland
* ovary
* testes.
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| 4.5.3.2 Control of blood glucose concentration | 1. Blood glucose concentration is monitored and controlled by the pancreas.
2. If the blood glucose concentration is too high, the pancreas produces the hormone insulin that causes glucose to move from the blood into the cells. In liver and muscle cells excess glucose is converted to glycogen for storage.
3. Students should be able to explain how insulin controls blood glucose (sugar) levels in the body.
4. Type 1 diabetes is a disorder in which the pancreas fails to produce sufficient insulin. It is characterised by uncontrolled high blood glucose levels and is normally treated with insulin injections.
5. In Type 2 diabetes the body cells no longer respond to insulin produced by the pancreas. A carbohydrate controlled diet and an exercise regime are common treatments. Obesity is a risk factor for Type 2 diabetes.
6. Students should be able to compare Type 1 and Type 2 diabetes and explain how they can be treated.
7. Students should be able to extract information and interpret data from graphs that show the effect of insulin in blood glucose levels in both people with diabetes and people without diabetes.
8. (HT only) If the blood glucose concentration is too low, the pancreas produces the hormone glucagon that causes glycogen to be converted into glucose and released into the blood.
9. (HT only) Students should be able to explain how glucagon interacts with insulin in a negative feedback cycle to control blood glucose (sugar) levels in the body.
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| **Specification code** | **Expected knowledge and understanding** | **** |
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| 4.5.3.3 Maintaining water and nitrogen balance in the body (biology only) | 1. Students should be able to explain the effect on cells of osmotic changes in body fluids.
2. Water leaves the body via the lungs during exhalation. Water, ions and urea are lost from the skin in sweat.
3. There is no control over water, ion or urea loss by the lungs or skin.
4. Excess water, ions and urea are removed via the kidneys in the urine.
5. If body cells lose or gain too much water by osmosis they do not function efficiently.
6. (HT only) The digestion of proteins from the diet results in excess amino acids which need to be excreted safely. In the liver these amino acids are deaminated to form ammonia. Ammonia is toxic and so it is immediately converted to urea for safe excretion.
7. Students should be able to describe the function of kidneys in maintaining the water balance of the body.
8. The kidneys produce urine by filtration of the blood and selective reabsorption of useful substances such as glucose, some ions and water.
9. Knowledge of other parts of the urinary system, the structure of the kidney and the structure of a nephron is not required.
10. Students should be able to translate tables and bar charts of glucose, ions and urea before and after filtration.
11. (HT only) Students should be able to describe the effect of ADH on the permeability of the kidney tubules.
12. (HT only) The water level in the body is controlled by the hormone ADH which acts on the kidney tubules. ADH is released by the pituitary gland when the blood is too concentrated and it causes more water to be reabsorbed back into the blood from the kidney tubules. This is controlled by negative feedback.
13. People who suffer from kidney failure may be treated by organ transplant or by using kidney dialysis. Students should know the basic principles of dialysis.
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| **Specification code** | **Expected knowledge and understanding** | **** |
| 4.5.3.4 Hormones in human reproduction | 1. Students should be able to describe the roles of hormones in human reproduction, including the menstrual cycle.
2. During puberty reproductive hormones cause secondary sex characteristics to develop.
3. Oestrogen is the main female reproductive hormone produced in the ovary. At puberty eggs begin to mature and one is released approximately every 28 days. This is called ovulation.
4. Testosterone is the main male reproductive hormone produced by the testes and it stimulates sperm production.
5. Several hormones are involved in the menstrual cycle of a woman.
* Follicle stimulating hormone (FSH) causes maturation of an egg in the ovary.
* Luteinising hormone (LH) stimulates the release of the egg.
* Oestrogen and progesterone are involved in maintaining the uterus lining.
1. (HT only) Students should be able to explain the interactions of FSH, oestrogen, LH and progesterone, in the control of the menstrual cycle.
2. (HT only) Students should be able to extract and interpret data from graphs showing hormone levels during the menstrual cycle.
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| 4.5.3.5 Contraception | 1. Students should be able to evaluate the different hormonal and non-hormonal methods of contraception.
2. Fertility can be controlled by a variety of hormonal and non- hormonal methods of contraception.
3. These include:
* oral contraceptives that contain hormones to inhibit FSH
* production so that no eggs mature
* injection, implant or skin patch of slow release progesterone to inhibit the maturation and release of eggs for a number of months or years
* barrier methods such as condoms and diaphragms which prevent the sperm reaching an egg
* intrauterine devices which prevent the implantation of an embryo or release a hormone
* spermicidal agents which kill or disable sperm
* abstaining from intercourse when an egg may be in the oviduct
* surgical methods of male and female sterilisation.
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| **Specification code** | **Expected knowledge and understanding** | **** |
| 4.5.3.6The use of hormones to treat infertility (HT only) | 1. Students should be able to explain the use of hormones in modern reproductive technologies to treat infertility.
2. This includes giving FSH and LH in a 'fertility drug' to a woman. She may then become pregnant in the normal way.
3. In Vitro Fertilisation (IVF) treatment.
* IVF involves giving a mother FSH and LH to stimulate the maturation of several eggs.
* The eggs are collected from the mother and fertilised by sperm from the father in the laboratory.
* The fertilised eggs develop into embryos.
* At the stage when they are tiny balls of cells, one or two embryos are inserted into the mother's uterus (womb).
1. Although fertility treatment gives a woman the chance to have a baby of her own:
* it is very emotionally and physically stressful
* the success rates are not high
* it can lead to multiple births which are a risk to both the babies and the mother.
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| 4.5.3.7 Negative feedback (HT only) | 1. Students should be able to explain the roles of thyroxine and adrenaline in the body.
2. Adrenaline is produced by the adrenal glands in times of fear or stress. It increases the heart rate and boosts the delivery of oxygen and glucose to the brain and muscles, preparing the body for ‘flight or fight’.
3. Thyroxine from the thyroid gland stimulates the basal metabolic rate. It plays an important role in growth and development.
4. Thyroxine levels are controlled by negative feedback.
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**4.5.4 Plant hormones (biology only)**

| **Specification code** | **Expected knowledge and understanding** | **** |
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| 4.5.4.1 Control and coordination | 1. Plants produce hormones to coordinate and control growth and responses to light (phototropism) and gravity (gravitropism or geotropism). Unequal distributions of auxin cause unequal growth rates in plant roots and shoots.
2. HT only) Gibberellins are important in initiating seed germination.
3. (HT only) Ethene controls cell division and ripening of fruits.
4. (HT only) The mechanisms of how gibberellins and ethene work are not required.
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**Required practical activity 8:** investigate the effect of light or gravity on the growth of newly germinated seedlings.

Record results as both length measurements and as careful, labelled biological drawings to show the effects.

| **Specification code** | **Expected knowledge and understanding** | **** |
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| 4.5.4.2Use of plant hormones (HT only) | 1. Students should be able to describe the effects of some plant hormones and the different ways people use them to control plant growth.
2. Plant growth hormones are used in agriculture and horticulture. Auxins are used:
* as weed killers
* as rooting powders
* for promoting growth in tissue culture.
1. Ethene is used in the food industry to control ripening of fruit during storage and transport.
2. Gibberellins can be used to:
* end seed dormancy
* promote flowering
* increase fruit size.
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