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Endocrine System

At the end of this section you will understand and appreciate:

- Structure and function of the endocrine system
- Location of the endocrine organs
- Roles of the sex hormones
- The menstrual cycle
- Conditions affecting the endocrine system
- How massage affects the endocrine system

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The Endocrine System

The Endocrine **(ductless)** System is a very important part of the body, which is involved in co-ordinating physiological activities. It is involved in maintaining homeostasis (BALANCE) within the body.

The Endocrine System consists of a series of **glands** (see below) that secrete hormones directly in to the **blood**.

HORMONES

Hormones are **chemical messengers**, which are secreted into the blood and carried to a **target organ** where they produce their effect.

The action of the Endocrine System is similar to that of the Nervous System (**communication and maintenance of homeostasis – internal balance**), but it is much more **slower** acting and **longer** lasting.

Hormones are eventually inactivated in the **liver** and excreted by the **kidneys**.

The amount of hormone released by an endocrine gland is determined by the body's need for it. Secretion of a hormone is normally regulated so that there is no under or over-production of a particular hormone.

THE ENDOCRINE GLANDS

The Endocrine glands are found throughout the body. They are:

1. **Pineal gland** (part of the brain)
2. **Pituitary gland** (part of the brain)
3. **Thyroid gland** (at the front of the neck)
4. **Parathyroid gland** (at the front of the neck on the thyroid gland)
5. **Thymus gland** (behind sternum)
6. **Adrenal gland** (on the kidneys)
7. **Islets of Langerhan** (part of the Pancreas)
8. **Ovaries** (part of female reproductive system)
9. **Testes** (part of male reproductive system)

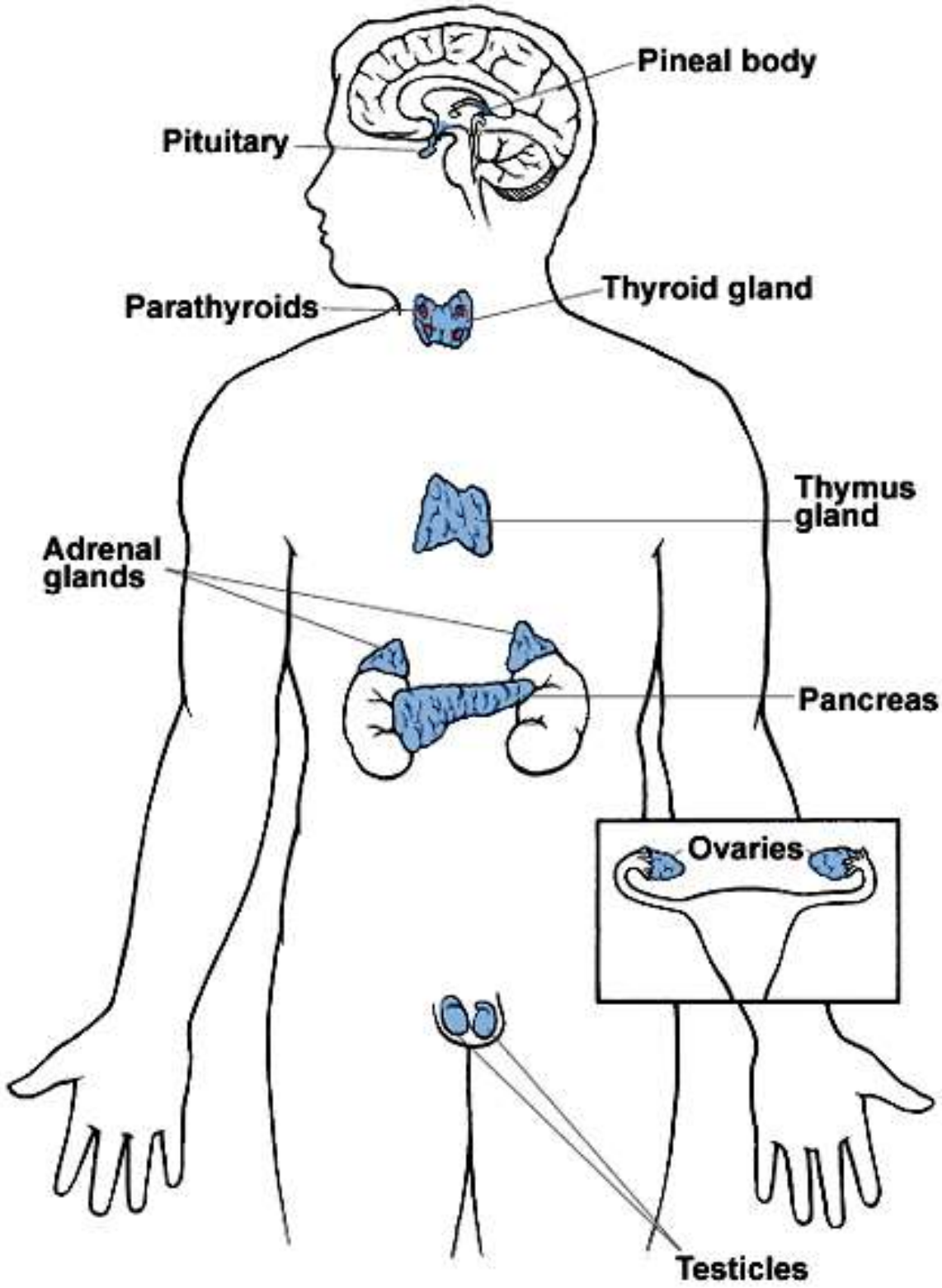


Diagram showing Endocrine glands of the body

When hormones secretion goes wrong (for whatever reason), two things can happen:

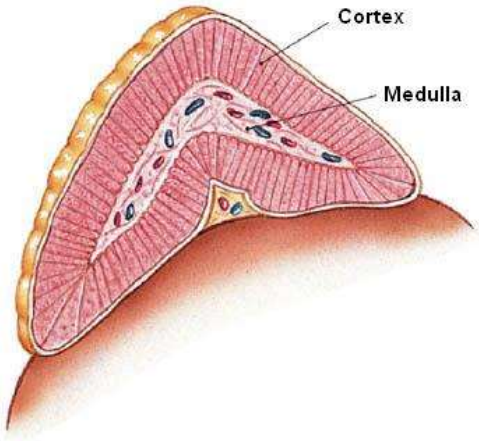
1. **Hypersecretion** – Over production of a hormone
2. **Hyposecretion** – Under production of a hormone

FUNCTIONS OF THE ENDOCRINE GLANDS

Name	Function	Malfunction
Pituitary Has 2 lobes	Is commonly called the ***"Master Gland"*** as it secretes hormones that control the other endocrine organs	
Anterior Pituitary		
Human Growth Hormone (HGH)	Regulates growth and height	*Hypersecretion* ⟶ gigantism (**acromegaly**)  *Hyposecretion* ⟶ **dwarfism**
Melanocyte Stimulating Hormone (MSH)	Stimulates production of melanin in basal layer of skin	
Thyrotrophin (Thyroid Stimulating Hormone TSH)	Controls thyroid gland	(see thyroid gland)
Adrenocorticotrophin (ACTH)	Controls adrenal cortex	(see adrenal gland)
Prolactin (Lactogenic Hormone)	Production of milk during lactation	
Gonadotropins	Controls sexual development and organs	Gonadotropins: Polycystic ovarian syndrome Endometriosis Fibroids
Luteinising Hormone	Stimulates the ovaries to produce the corpus luteum from ruptured follicle and produce progesterone	
Follicle Stimulating Hormone (FSH)	Stimulates the follicles of the ovary to produce oestrogen	
Interstitial cell-stimulating hormone (ICSH) (is equivalent to Luteinising hormone in females)	Stimulates sperm production and secretion of testosterone	

Posterior Pituitary		
Antidiuretic Hormone *ADH* (*Vasopressin)*	Regulation of water absorption in kidneys	Hyposecretion → **Diabetes Insipidus** Hypersecretion → **Oedema (swelling)**
Oxytocin	Contracts mammary glands when suckling begins to release milk secreted into ducts. Contraction of uterine muscle wall to begin childbirth	
Thyroid Gland		
	Secretes Thyroxin, Triiodothyronine and Calcitonin In response to TSH from anterior pituitary	
Thyroxin & *Triiodothyronine*	Stimulates tissue metabolism, and maintains basal rate metabolic rate (BMR)	Hypersecretion → **Graves' Disease** • *Bulging eyes* • *Weight loss* • *Hot* • *Sweaty* • *Restless*  Hyposecretion → ▪ At Birth - **Cretinism**  ▪ Adults - **Myxoedema** & **Goitre** (enlargement) • *Blank, puffy face* • *Increase in weight* • *Lethargic* • *Cold* 
Calcitonin	Maintains Calcium and Phosphorus balance	Hypersecretion → causes lowering of blood calcium level by inhibiting loss of calcium from bone

Parathyroid		
Parathormone	Maintains calcium level in plasma, stimulates calcium reabsorption in kidneys, and activates Vitamin D	Hyposecretion → Low blood calcium tetany (muscle spasm) Convulsions Hypersecretion → Softened bones Spontaneous fractures 
Pancreas		
Insulin by Islets of Langerhans	Helps blood sugar enter blood cell and converting it to glycogen (stored form of sugar) thus regulating blood sugar levels.	Hyposecretion → **Diabetes Mellitus** High blood sugar level High urine production Thirst Hypersecretion → Low blood sugar level Symptoms of hunger Coma in serious cases
Glucagon	Helps convert glycogen (stored in cell) into blood sugar	**Summary** Blood Sugar ⇄ (**Insulin** / **Glucagon**) Glycogen (cell)

Adrenal Gland		
Adrenal Gland has two parts Cortex – outer part Medulla – inner part		
Adrenal Cortex		
Mineralocorticoids – Aldosterone (Steroids)	Regulates salts in body especially sodium chloride and potassium	Hyposecretion → **Addison's Disease** Muscle wasting Weakness Body slows down Hypersecretion → Kidney failure High BP ↑ Blood potassium → abnormal heart rate
Glucocorticosteroids (Cortisol & cortisone) (Steroids)	Produced in response to ACTH from pituitary. Metabolises carbohydrates, fats and proteins	Hypersecretion → Cushings syndrome; • hypertension, • **moon shaped face** • muscular atrophy, • diabetes mellitus

		
Adrenal Medulla	**Supports the sympathetic nervous system**	
Adrenalin (Epinepherine) & Noradrenalin	Prepare body **for "fight or flight"** response by speeding up heart, slowing down digestion and urinary system Increases sugar levels Adrenalin is a powerful vasoconstrictor	 • **Increased Heart rate** • **Vasodilation to heart & muscles blood vessels** • **Increased BP** • **Vasoconstriction to skin and digestive system**
Ovaries		
Oestrogen *Progesterone*	Responsible for female sex characteristics e.g. breast growth, widening of hips etc.	Hypersecretion (in males) ⟶ muscle atrophy and breast growth
Testes		
Testosterone	Responsible for male sexual characteristics – deep voice, facial hair, muscle mass	Hypersecretion (in women) ⟶ virilism, **hirsutism ("hairiness")** and **amenorrhea ("no periods")**
Pineal Gland		
Melatonin	Controls body rhythms – responds to sunlight	Jet-lagged feeling,

(derived from serotonin)	(High light levels, less melatonin produced)	Depression, **SAD – Seasonal Affective Disorder**
Thymus		
Thymic Factor (TF) *Thymic Humeral Factor (THF)* *Thymosine* *Thymopoietin*	Promote development of T lymphocytes in the thymus gland, which are a part of the immune system.	Lowered immunity and /or stress

ROLES OF SEX HORMONES

Puberty

This is the age when internal **REPRODUCTIVE** organs of boys and girls reach **MATURITY** and become **FUNCTIONAL**.

Secondary sexual characteristics develop e.g. breaking of voice, hair growth etc.

The average age for girls to reach puberty is between **10 - 14** years

The average age for boys to reach puberty is between **13 - 16** years.

In females, the **ovaries** are stimulated by two hormones:

1. **Follicle Stimulating Hormone (FSH)**
2. **Luteinising Hormone (LH)**

These are known as **GONADOTROPHINS** and they are secreted by the anterior lobe of the Pituitary Gland. They have the following effects:

- uterus, fallopian tubes and ovaries reach maturity and become functional
- ovulation and the menstrual cycle begin
- growth of pubic and axillary hair
- breasts enlarge and develop
- increase in height and pelvic width
- increase in amount of subcutaneous fat.

In boys, the same gonadotropins are produced – Follicle Stimulating Hormone (FSH) and Luteinising Hormone (LH), though luteinising hormone is called **Interstitial Cell Stimulating Hormone** (ICSH) in men and it stimulates the testes to produce **Testosterone**. Most of the changes produced are caused by testosterone and the effects are:

- growth of muscle and bone
- noticeable height increase
- voice breaks and larynx enlarge
- growth of pubic, facial, axillary abdominal and chest hair
- sexual organs develop
- seminiferous tubules (in the testes; produce testosterone and sperm) become functional
- semen can be produced
- sperm production begins.

THE OVARY

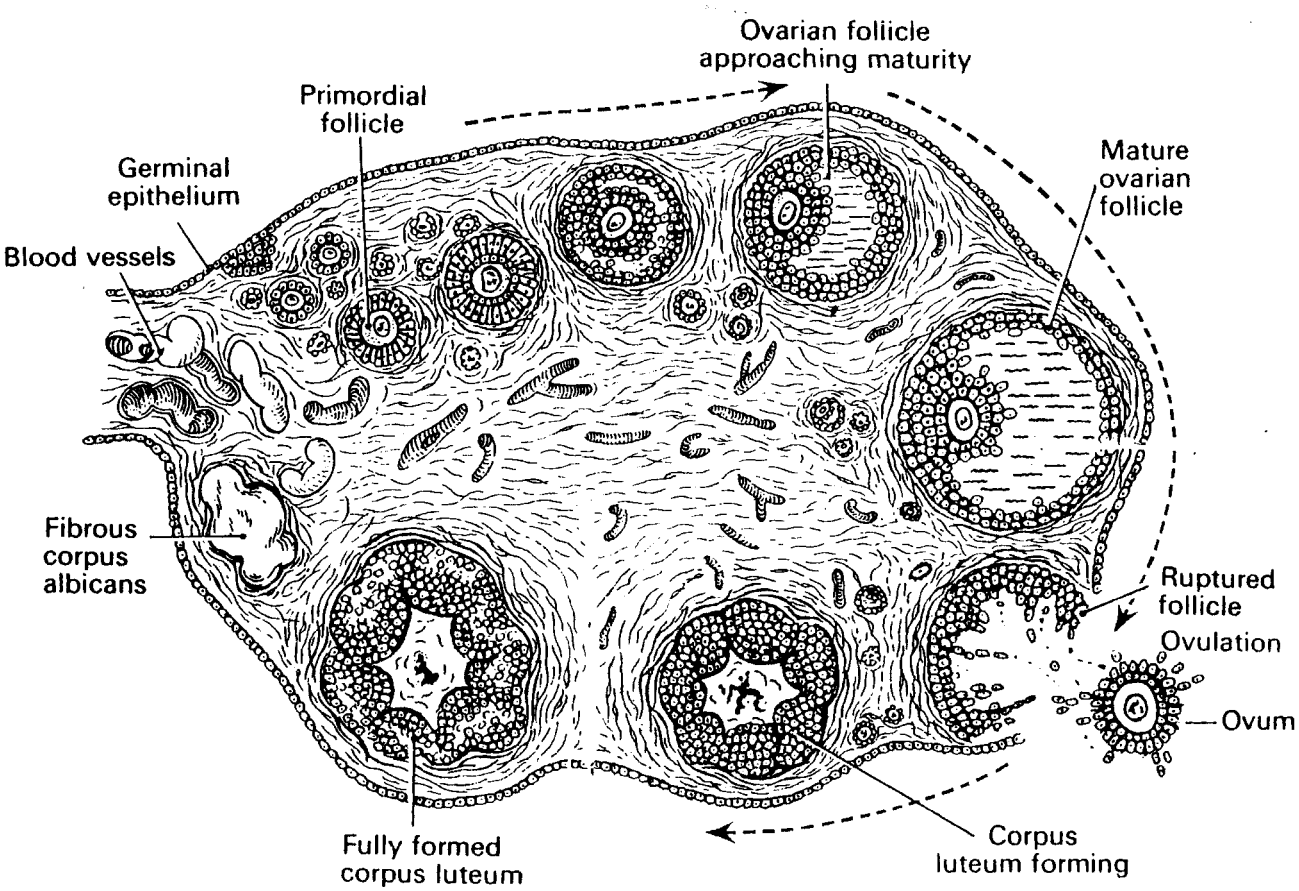


Diagram of a cross section of an ovary

DEFINITIONS

Term	Notes
Ovarian Follicle (Graafian Follicle)	Is stimulated by the FSH secreted by the anterior pituitary gland. The lining of the follicle produce Oestrogen
Ovum	This is the "egg" and contains only 23 chromosomes. If unfertilized it will die. If it is fertilized, the ovum produces the hormone ***Human Chorionic Gonadotropin***, which stimulates the Corpus Luteum to continue producing Progesterone.
Corpus Luteum	This is the cells, which formed the lining of the Ovarian follicle. It produces and secretes Progesterone.

THE MENSTRUAL CYCLE

The menstrual cycle is a hormonally controlled cycle, which occurs in women in order to prepare the womb for fertilization.

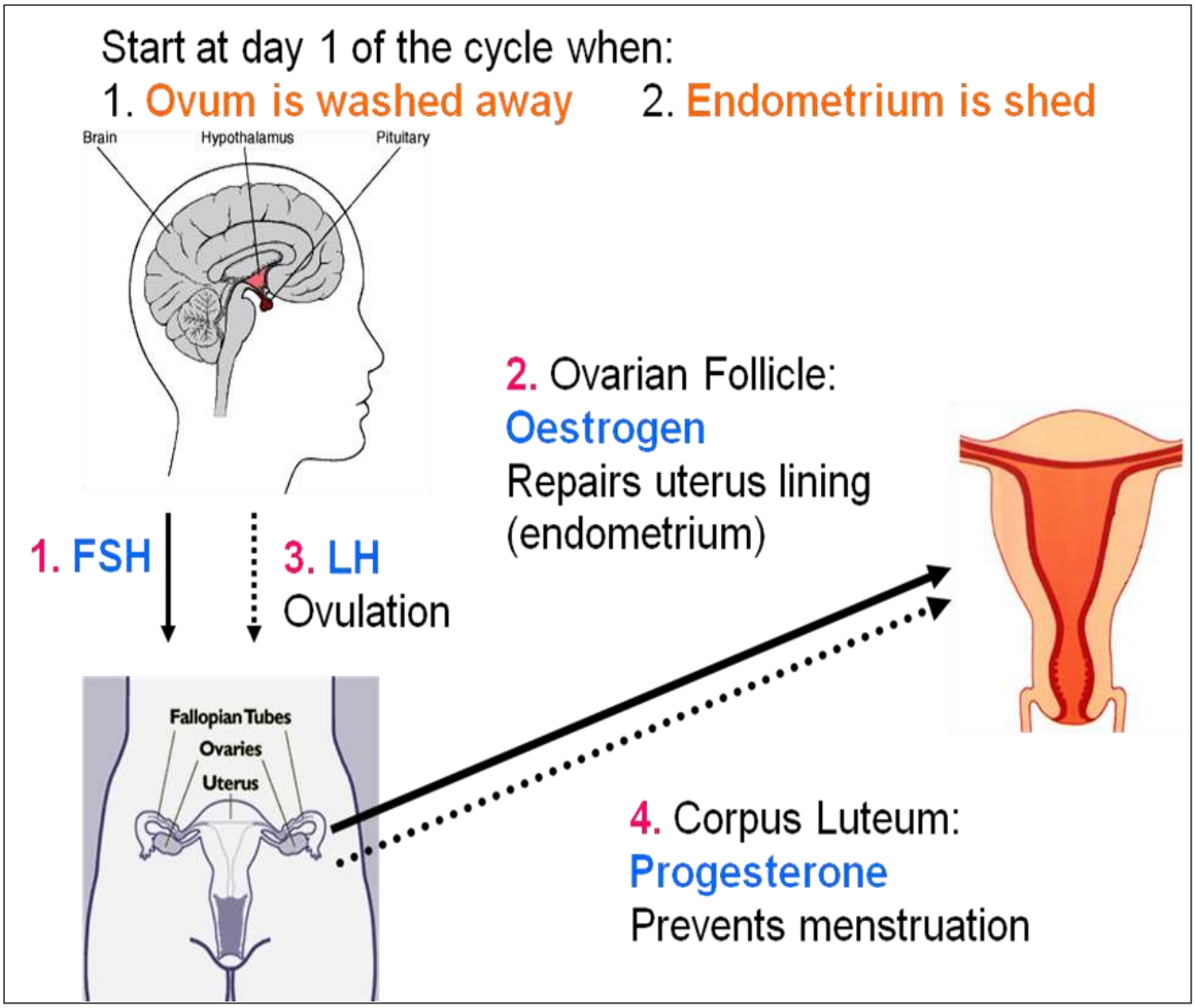
The cycle lasts for approximately 28 days and will continue on a monthly basis for about 35 years.

The onset (very first time) of the menstrual cycle is called the **MENARCHE**.

The **cycle** is broken down into 3 stages:

1. **First** (**menstrual**) **phase (↓ PROGESTERONE)**
2. **Second** (**proliferative**) **phase (↑ OESTROGEN)**
3. **Third** (**secretory**) **phase** (**↑LUTEINISING HORMONE)**

SIMPLIFIED VERSION OF THE MENSTRUAL CYCLE



The menstrual cycle stops on in 4 instances:

1. **PREGNACNY**
2. **DISEASE**
3. **MEDICATION**
4. **MENOPAUSE**

SUMMARY OF THE ACTIONS OF THE MENSTRUAL HORMONES

FSH	Oestrogen	Luteinising Hormone	Progesterone
Cause Graafian follicle to develop in ovary	Cause repair of uterus lining following menstruation	Causes Ovulation to take place	Causes the uterus lining to be maintained in readiness for young embryo

Stimulate ovary to produce Oestrogen	Stimulate pituitary to produce Luteinising Hormone	Stimulate the ovary to produce progesterone from the Corpus Luteum	Inhibits production of FSH by pituitary

MENOPAUSE (Climacteric)

A woman is born with a given number of eggs and with each menstrual cycle an egg is released. When these eggs run out the menopause begins – i.e. the menstrual cycle as a whole comes to an end.

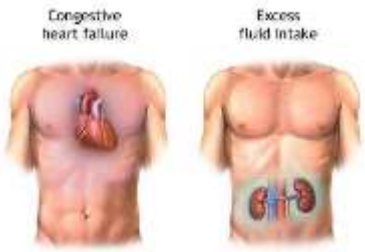
The average age for the menopause to begin is **45-55** years. At this stage the **ovaries** will gradually stop responding to Follicle Stimulating Hormone and Luteinising Hormone which in turn will produce less **oestrogen** and **progesterone**.

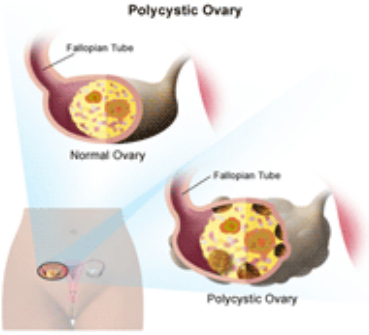
The reduction in these hormones causes:

- an irregular menstrual cycle
- Hot flushes
- Sweating
- Mood swings
- Palpitations
- Atrophied sex organs
- Predisposition to Osteoporosis (so give consideration to the type of massage)

To alleviate the above symptoms, some women are given HRT (Hormone Replacement Therapy)

DISEASES & DISORDERS OF THE ENDOCRINE SYSTEM

Condition	Description	Picture
Addison's disease	**Cause:** hyposecretion of adrenocortical hormones (sex, growth and salt regulation hormones). **Effects:** muscular atrophy and weakness; hypotension; gastric problems like vomiting, changes in skin pigmentation, irregular menstrual cycle and dehydration.	
Cushing's syndrome	**Cause:** hypersecretion of adrenocortical hormones (sex, growth and salt regulation hormones) i.e. the opposite of Addison's syndrome. **Effects**: muscular atrophy and weakness, hypertension, moon-shaped face, redistribution of body fat, sometimes mental illness, osteoporosis.	
Diabetes Insipidus	**Cause**: pituitary gland does not make enough of the hormone ADH. Antidiuretic Hormone is needed to control the amount of water in the body.	
Diabetes Mellitus	**<u>Type 1:</u>** **Cause:** Auto-immune disease results in pancreas being unable to produce insulin **Effects**: Symptoms include high blood glucose level, excessive thirst, high urine output, tiredness and weight loss. Cannot be cured but can be controlled by regular (2-4/day) insulin injections. **<u>Type 2:</u>** **Cause**: The body cells do not respond properly to insulin and the pancreas may not produce enough. Linked closely to obesity. **Effects**: Symptoms are as Type 1, but may not be as obvious and take longer to develop. Can be controlled by a healthy diet and physical activity. Tablets or insulin injections may also be required.	
Goitre	An abnormally enlarged thyroid gland; can result from underproduction or overproduction of hormone or from a deficiency of iodine in the diet.	

Condition	Description	Picture
Grave's disease	Is an autoimmune disease. It most commonly affects the thyroid gland, causing it to grow to twice its size or more, be overactive, with related hyperthyroid symptoms such as increased heartbeat, muscle weakness, disturbed sleep and irritability.	
Hyperthyroidism (Thyrotoxicosis)	An overactive thyroid gland; a glandular disorder resulting from an overproduction of thyroid hormones.	
Hypothyroidism	An underactive thyroid gland; a glandular disorder resulting from an underproduction of thyroid hormones.	
Hyperparathyroidism	Excessive secretion of parathyroid hormone resulting in abnormally high levels of calcium in the blood; can affect many systems of the body (especially causing bone reabsorption and osteoporosis)	
Hypoparathyroidism	Inadequate secretion of parathyroid hormone resulting in abnormally low levels of calcium in the blood.	
Polycystic Ovarian Syndrome *(also known as Stein-Leventhal syndrome)*	**Cause:** Unknown. **Effects**: irregular menstrual cycle, due to excessive stimulation of the ovaries by secretion of Luteinising hormone, multiple growth of follicular ovarian cysts and sometimes infertility, enlarged ovaries and often high levels of oestrogen; 50% of patients are obese and become hirsute; age range of sufferers is usually 16-30.	
Stress	Stress is a threat to the body and the body responds to it like any other danger - the adrenal medulla releases adrenaline and noradrenaline to help us with the fight or flight response. The physical manifestations of the arrival of adrenaline in the body are faster heart rate and breathing, sweating (hence sweaty palms when we are frightened or nervous), a glucose rush from the liver and heightened senses (like hearing and sight). Prolonged stress may cause amenorrhoea in women and low production of sperm in men.	
Myxoedema	Hypothyroidism marked by dry skin and swelling around lips and nose as well as mental deterioration and subnormal basal metabolic rate (BMR).	

INTERRELATIONSHIP OF ENDOCRINE SYSTEM WITH OTHER BODY SYSTEMS

Skeletal	Calcitonin & Parathormone – has control over level of bone calcium
CVS	Hormones are transported in the blood to their target organs
Nervous	Works closely with the nervous system to maintain homeostasis - balance in the body. The pituitary gland (endocrine) has an infinite link to the hypothalamus (nervous system/brain) both of which exert great control over the body.
GIT	Digestive is reliant upon hormones secreted in the stomach, small intestine and pancreas.
Reproductive	Governs the reproductive system particularly in females and controls the menstrual cycle and the release of hormones during pregnancy and childbirth.

EFFECTS OF MASSAGE ON THE ENDOCRINE SYSTEM

Assists in the circulation of blood thereby possibly helping hormonal feedback mechanisms.

SYMPTOMS OF THE ENDOCRINE SYSYEM

Symptoms are vast so relate to the hormone which has been disturbed.