Endocrine organs of the human body

- Pineal gland
- Hypothalamus
- Pituitary gland
- Thyroid gland
- Parathyroid glands (on dorsal aspect of thyroid gland)
- Thymus gland
- Adrenal glands
- Pancreas
- Ovary (female)
- Testis (male)
The hypothalamo-hypophyseal system

Hypothalamus

Pituitary

Paraventricular nucleus

Supraoptic nucleus

Hypothalamus

Neurosecretory neurons

Optic chiasm

Secretory cells

Capillary

Artery

Releasing hormones

Anterior lobe (adenohypophysis)

Posterior lobe (neurohypophysis)

Growth hormone

Prolactin

Thyrotropin

Follicle-stimulating hormone

Luteinizing hormone

Adrenocorticotropic hormone

Efferent vein

Para intermedia

Antidiuretic hormone

Oxytocin

Melanocyte-stimulating hormone
Schematics of the multi-level regulation of hormone release

Example for the regulation: Female hormones during ovulation
The female reproductive system

- Ampulla of uterine tube
- Infundibulum of uterine tube
- Isthmus of uterine tube
- Fundus of uterus
- Fimbriae of uterine tube
- Uterine cavity
- Endometrium
- Myometrium
- Perimetrium
- Internal os
- Cervix of uterus
- Cervical canal
- Lateral fornix
- Rugae
- View
- Posterior view of uterus and associated structures
The ovarian cycle
Development and fate of ovarian follicles
The ovarian cycle II.
Hormone levels and structural changes of the ovary and uterus

(a) Hormonal regulation of changes in the ovary and uterus
Hormonal regulation of the female reproductive system

GnRH stimulates release of FSH and LH

FSH stimulates

Growing follicles
Initial development of ovarian follicles

LH stimulates
Further development of ovarian follicles and their secretion of estrogens and inhibin

Corpus luteum
Secretion of progesterone, estrogens, relaxin, and inhibin by corpus luteum

Ovulation

Estrogens
- Promote development and maintenance of female reproductive structures, feminine secondary sex characteristics, and breasts
- Increase protein anabolism
- Lower blood cholesterol
- Moderate levels inhibit release of GnRH, FSH, and LH

Progesterone
- Works with estrogens to prepare endometrium for implantation
- Prepares mammary glands to secrete milk
- Inhibits release of GnRH and LH

Relaxin
- Inhibits contractions of uterine smooth muscle
- During labor, increases flexibility of pubic symphysis and dilates uterine cervix

Inhibin
- Inhibits release of FSH and, to a lesser extent, LH
Hormonal regulation of the female reproductive system II.

- High levels of estrogens (without progesterone) stimulate release of GnRH, LH, and FSH.
- Moderate levels of estrogens inhibit secretion of GnRH, FSH, and LH.
- Inhibin inhibits secretion of FSH and LH.
- Low levels of progesterone and estrogens promote secretion of GnRH, FSH, and LH.

- Anterior pituitary
  - Hypothalamus
  - GnRH
  - FSH
  - LH

- Ovary
  - Growth of primary and secondary follicles
  - Maturation of one dominant follicle
  - Ovulation
  - Formation of corpus luteum
  - Formation of corpus albicans
  - Ovarian hormones
    - Increasing secretion of estrogens and inhibin by granulosa cells
    - Increased secretion of progesterone and estrogens by cells of corpus luteum
    - Increased secretion of inhibin by cells of corpus luteum
    - No secretion of progesterone and estrogens by corpus albicans

- Uterus
  - Repair and proliferation of endometrium
  - Preparation of endometrium for arrival of fertilized ovum
  - Menstruation
Pregnancy

Possible locations of ectopic (extrauterine) pregnancy

Uterine levels during pregnancy
Hormonal induction of labor

- Estrogen from placenta
- Oxytocin from fetus and mother's posterior pituitary

Induces oxytocin receptors on uterus

- Stimulates uterus to contract
- Stimulates placenta to make Prostaglandins
- Stimulate more vigorous contractions of uterus

Positive feedback
Stages of labor

1. Early dilation stage
2. Late dilation stage
3. Expulsion stage
4. Placental stage
Pregnancy tests I. - Old type tests

Detecting the presence of the human chorionic gonadotrophin (hCG) hormone in the urine based on some physiological effects of the hormone.

**Galli-Mainini test**
- Injecting subcutaneously the woman's urine to the frog, and after few hours, checking the frog's own urine.
- If the frog's urine contain sperms, the woman is pregnant.

**Aschheim-Zondek test**
- Woman's urine is injected into an immature rat or mouse.
- If the subject is not pregnant, there would be no reaction.
- In the case of pregnancy, the rat would show an estrous reaction in the ovaries despite its immaturity.
Examination of vaginal smears

Sampling procedure using a female rat

Determination of the phase of the estrus cycle

**Estrus**: keratinocytes with no nuclear staining

**Metestrus**: keratinocytes, leukocytes, epithelial cells

**Diestrus**: epithelial cells with good nuclear staining, leukocytes, mucus

**Proestrus**: only epithelial cells with good nuclear staining
Pregnancy tests II. - Modern tests

Detecting the presence of the human chorionic gonadotrophin (hCG) hormone protein by immunological methods.
Detection thresholds: 20 mIU/ml to 100 mIU/ml hCG protein (depending on the brand).

Ab#1 – monoclonal anti-hCG1
Ab#2 – polyclonal anti-hCG2
Ab#3 – anti-anti-hCG1

(Ab = antibody)
Pregnancy tests II. - Modern tests

Evaluation of the pregnancy test result:

- **control window**
- **pregnancy window**
- **input window**

<table>
<thead>
<tr>
<th>Lines</th>
<th>Result</th>
</tr>
</thead>
</table>
| 2 lines | Positive result  
PREGNANT |
| 1 line  | Negative result  
NO PREGNANCY |
| No line  | INVALID TEST  
Repetition of the test is needed |
Contraception

- **Progestogen only pill** (contains only progestogen)
- **Combined oral contraceptive pill** (oestrogen and a progestogen)
- **Post-coital emergency contraceptive pill** (contains only progestogen, but in a much higher dose)
Combined oral contraceptives

Two methods are used for the dosage of these pills:

1) "one phase" dosage: dose of the pills are the same during the menstruation cycle

2) "combination" dosage: pills contain the hormones in 2 or 3 different doses to mimic natural hormone level fluctuations occur during the menstruation cycle

Regardless of the way of the dosage, pack may contain 21 or 28 pills. In the latter case, only 21 or 24 pills contain hormones while 7 or 4 pills contain only placebo or sugar.
Termination of early pregnancy

Ru486 (mifepristone)

- this is the compound of the "abortion pill"
- pregnancy can be terminated in the first two months by this pill
- smaller doses can be used as emergency contraceptive
- receptor antagonist at the progesterone receptor as well as at the glucocorticoid receptor
- to evoke abortion, prostaglandine is also applied with Ru486
- usage of this compound is highly controversial and it is not legal in several countries