Physiology of reproductive system

Organization and regulation of reproductive function. Male reproductive system. Female reproductive system – ovulatory cycle.

Compendium of Physiology – autumn 2020

Tibor Stračina

 Department of Physiology, Faculty of Medicine, Masaryk University, Brno

Reproduction

- High investment, low-volume reproduction stategy

- Sexual reproduction

Differentiation of the reproductive system

- Genetic determination (XX vs. XY)

- AMH (+ T)

Puberty

- Onset (GnRH)
- Men:
  - adrenarche
- Women:
  - Pubarche
  - Telarche
  - Menarche

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Differences in the reproductive function

MEN

- T release – also prenatal + perinatal
- Fertile age longer - onset of puberty, andropause)
- Non-cyclic hormonal changes

WOMEN

- No release of the gonadal hormones before puberty
- Fertil age shorter - onset of puberty, menopause)
- Cyclic hormonal changes

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Differences in the reproductive function

MEN WOMEN

Common characteristics:

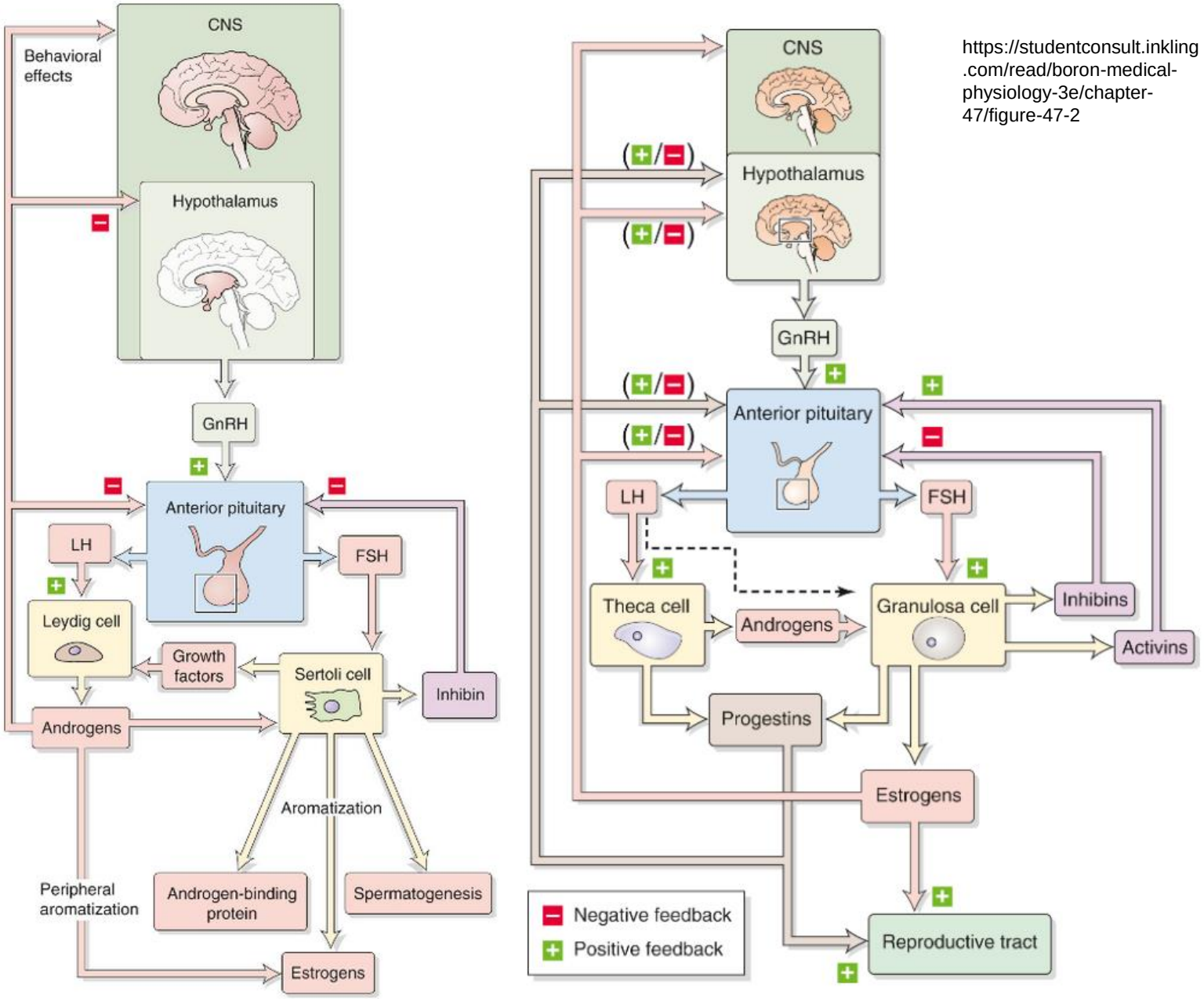
- Postnatal maturation of reproductive system (both structural and functional)
- Regulatory axis: hypothalamus – hypophysis – gonads

Regulatory axis

Hypothalamus

Hypophysis

Gonads



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Regulation of sex hormone release

Hormone	Regulation		
	Autocrine	Paracrine	Endocrine
GnRH	GnRH I (-)	GnRH II (+), IGF-I (+), kisspeptin (+)	testosterone (-), estrogens (-), progesterone (-), norepinephrine (+), dynorfine (-), leptin (+)
FSH	-	activin (+), follistatin (-)	GnRH (+), estrogens (-), progesterone (-), activin (+) inhibins (-)
LH	-	activin (+), follistatin (-)	GnRH (+), testosterone (-), estrogens (-), progesterone (-)
Testosterone	-	IGF-I (+), GH (+), TGF-β (-)	LH (+)
Estrogens	-	-	FSH (+), LH (+)
Progesterone	-	-	LH (+)

Adopted from: NIEDERBERGER, Craig S., ed. An introduction to male reproductive medicine. Cambridge: Cambridge University Press, 2011.

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Function of FSH and LH

MEN

FSH
- Spermatogenesis (Sertoli cells)

LH
- Intratesticular synthesis of testosterone (Leydig cells)

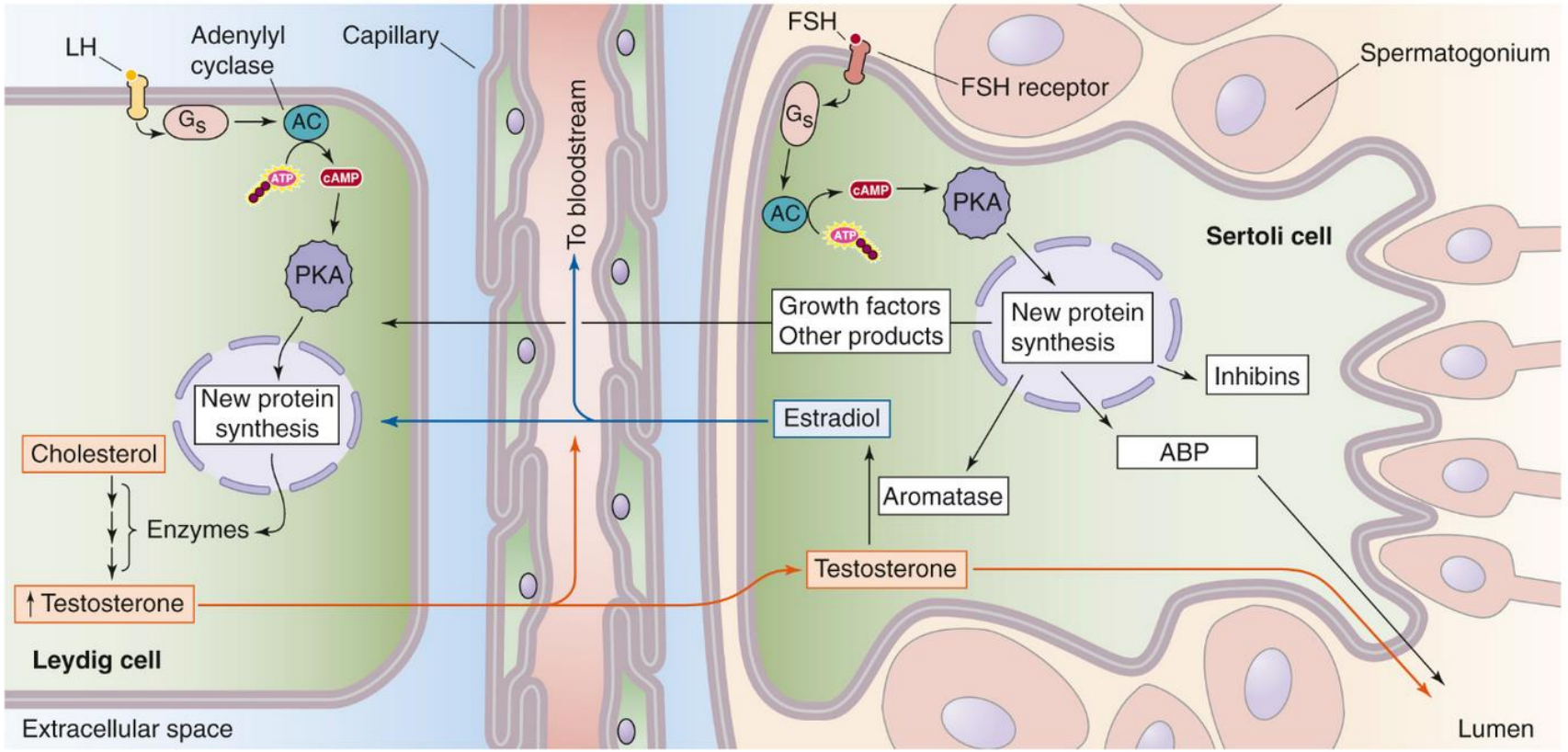
WOMEN

FSH
- Maturation of follicular cells
- Synthesis of estradiol
- Upregulation of LH receptors (preovulatory)
- Selection of dominant follicle
- Recruitment of follicles for the next cycle

LH
- Estrogens synthesis (theca cells)
- Maturation of oocyte (preovulatory)
- Ovulation (rupture of the follicle)
- Luteinisation of the follicle (development of the corpus luteum)

Gonadal steroid hormones: MEN

- Testes
- **L**eydig cells (**L**H)
  - testosterone
- **S**ertoli cells (F**S**H)
  - ABP
  - p450 aromatase (T→E)
  - inhibin
  - growth factors



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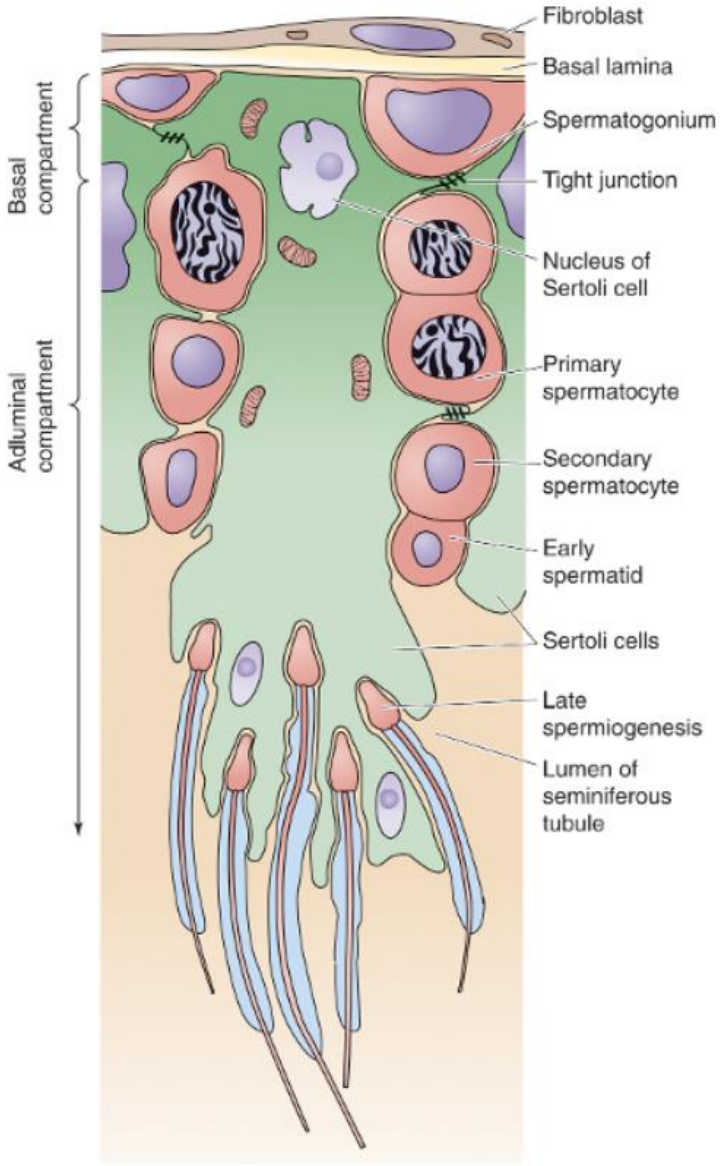
Testosterone

- Development of male secondary sex characteristics
  - growth of (male) genitals
  - growth of prostate
  - body hair growth
  - voice deepening
  - musculoskeletal development
- Spermatogenesis
- Increase of libido
- Changes in behaviour
- Erythropoiesis, thrombopoiesis and immune functions are also directly affected

Spermatogenesis, semen

Spermiogram (Normal parameter values for semen)	
Volume of ejaculate	2-6 mL
Viscosity	liquefaction in 1 h
pH	7-8
Sperm cell count	more than 20 mil./mL
	more than 20 mil. in total
Viability	min. 75%
Motility	min. 50% (25%)
Morphology	min. 60% (30%)



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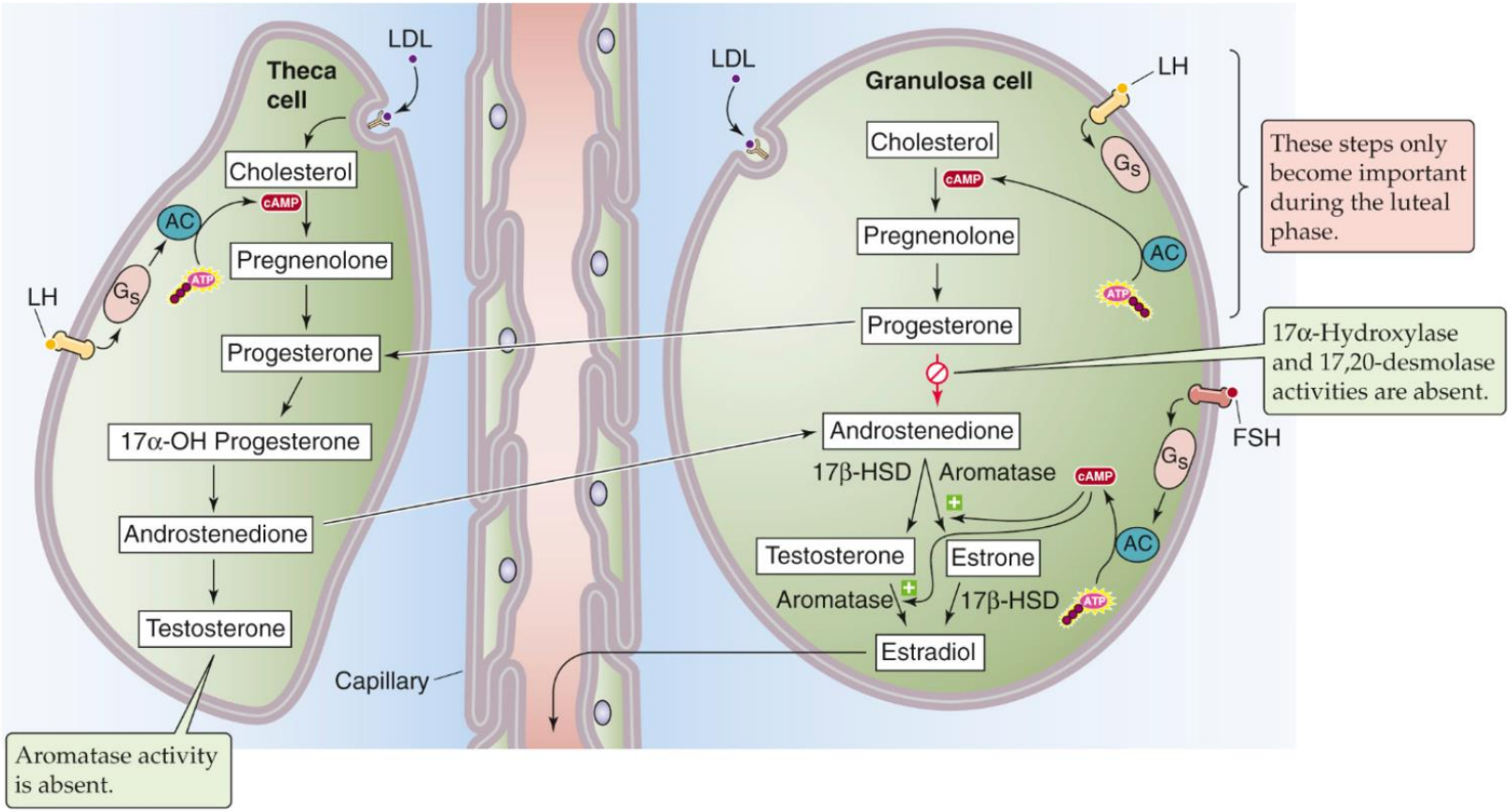
Gonadal steroid hormones: WOMEN

- Ovaries
- Theca cells (LH)
  - progesterone, (testosterone)
- Granulosa (folicullar) cells (FSH, LH)
  - progesterone, estradiol



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Estrogens (Oestrogens)

- Development of female secondary sex characteristics
  - enlargement of breasts (+ growth of ducts)
  - distribution of body fat in hips, thighs, gluteal area, and breasts
  - musculoskeletal development – widening of hips
  - growth of genitals
- Folliculogenesis, uterine cycle
- Increase uterine growth (proteosysthesis) and vaginal wall thickness
- Increase of motility in tubes and uterus
- Increase of libido, changes in behaviour
- Effects on bone resorption, cardiovascular and immune system

Progesterone

- „Hormone of pregnancy“

- Increase of motility in fallopian tubes
- Decrease of motility in uterus
- Transformation of endometrium – secretion of endometrial glands
- Brest development – lobuloalveolar growth
- Overall retention of water (in co-operation with estrogens)
- Changes in behaviour

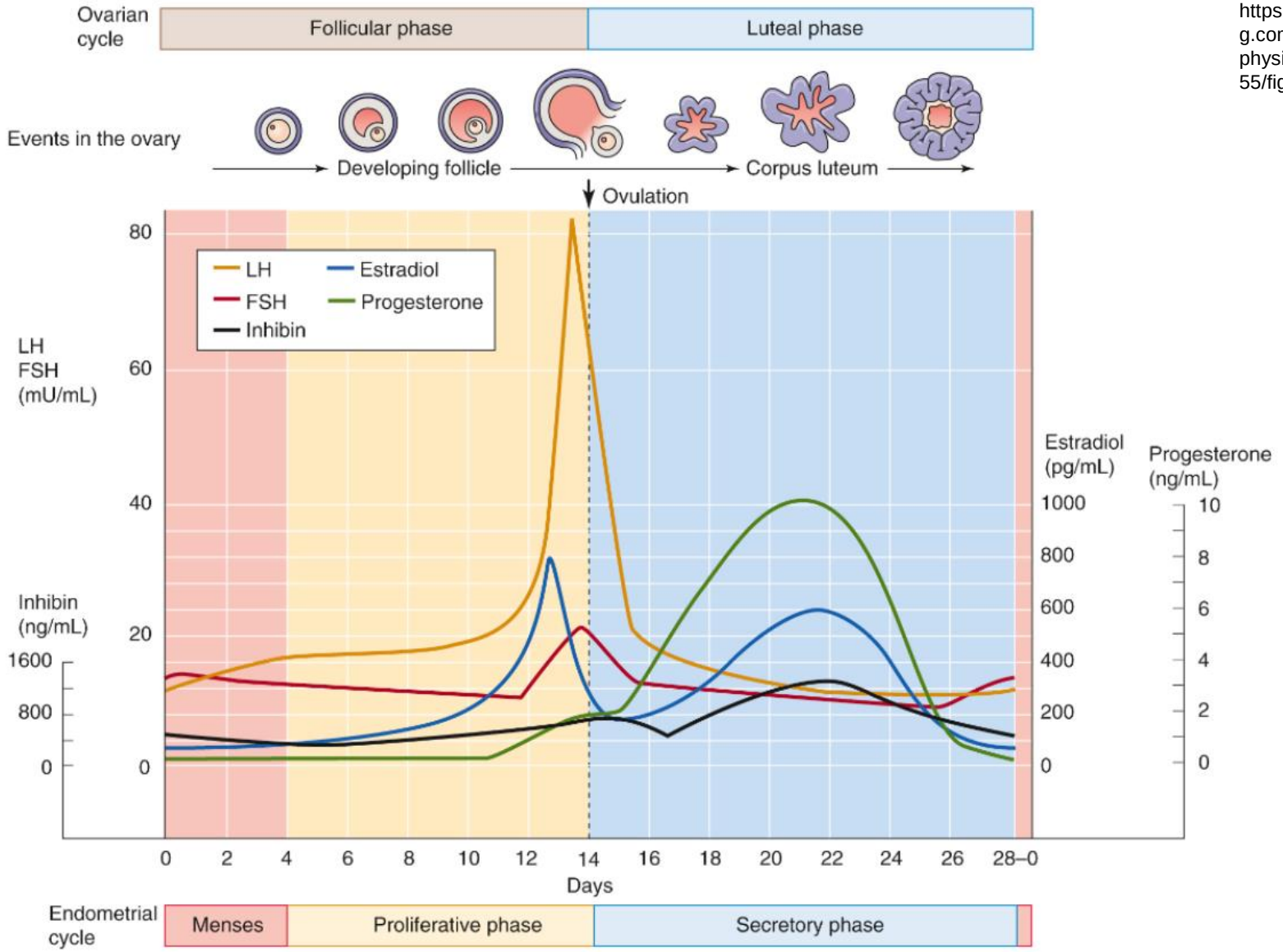
Ovarian cycle

- Development of matured oocyte
- Cyclic changes of hormonal levels
- 3 phases: follicular, ovulation, luteal
- Circa 28 days

Draw hormonal profile of ovarian cycle

- Estrogens, progesterone
- FSH, LH
- GnRH

Ovarian cycle



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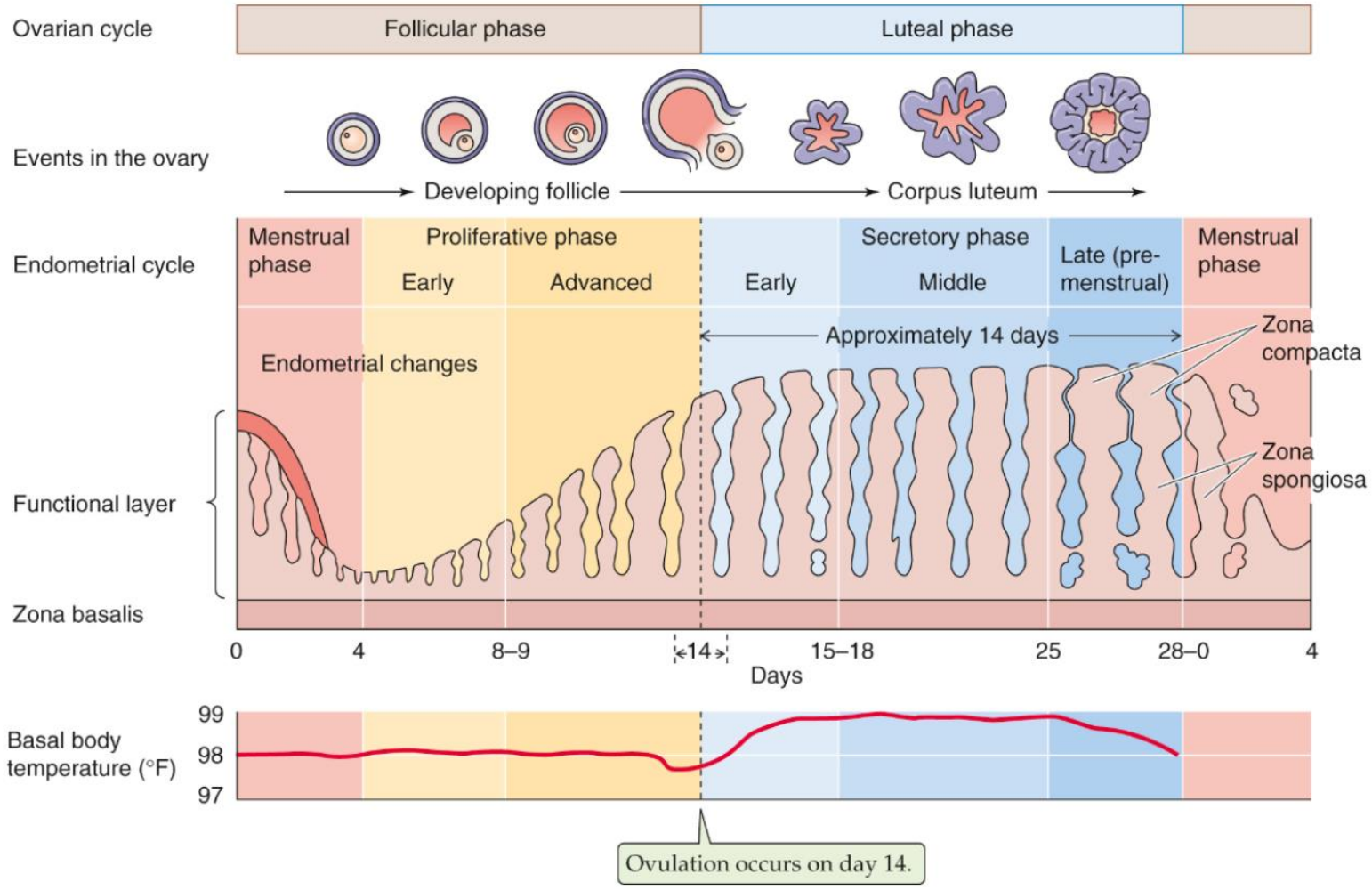
Uterine (Endometrial) cycle

- Cyclic changes of endometrium
- 3 phases: menstrual (menses), proliferative, secretory
- Cyclic changes of genitals and breasts
- And other somatic changes

Uterine cycle



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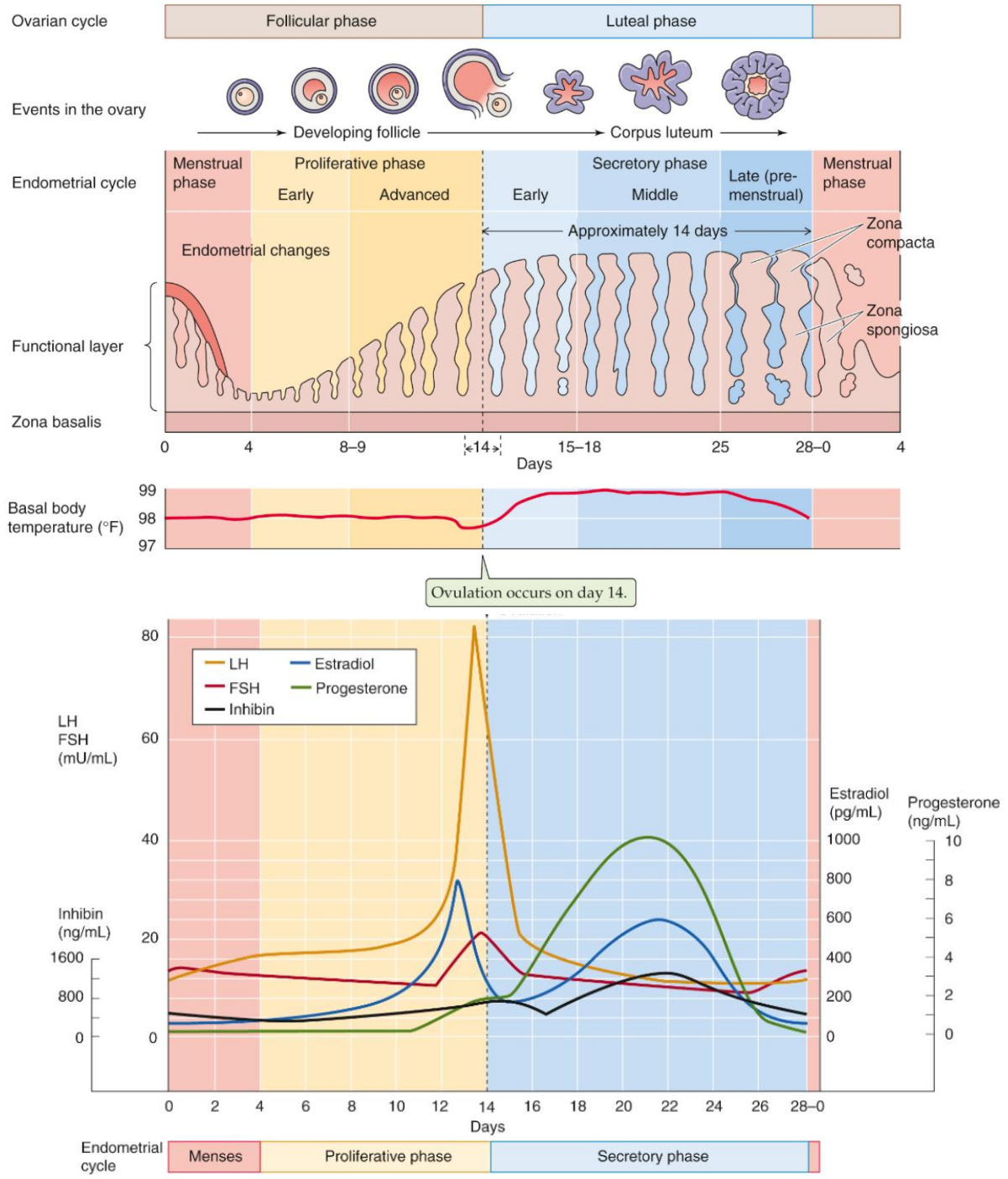

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Corpus luteum, corpus luteum graviditatis

- Follicular cells after ovulation → corpus haemmorhagicum
- LH
- corpus haemmorhagicum → corpus luteum (c. l.)

- decrease of LH + **no hCG** → involution of c. l.
- decrease of LH + **hCG** → proliferation of CL → c. l. graviditatis