

PHYSIOLOGY OF REPRODUCTION

Life is a dynamic system with focused behavior, with

autoreproduction, *characterized by flow of substrates,*

energies and information.

Reproduction in mammals (humans)

- 1) Sexual reproduction
- 2) Selection of partners
- 3) Internal fertilization
- 4) Viviparity
- 5) Eggs, resp. embryos – smaller, less, slow development, placenta
- 6) Low number of offspring, intensive parental care

Pregnancy (days)	
Mouse	20
Rat	23
Rabbit	31
Dog	63
Cat	65
Lion	107
Pig	114
Sheep	149
Human	260 - 275
Cow	285
Rorqual	360
Elephant (Indian)	609

High investment, low-volume reproduction strategy !

Reproduction in humans – gender comparison

- 1) Both male and female are born immature (physically and sexually)
- 2) Sex hormones are produced in men also during prenatal and perinatal periods,
not in women!
- 3) Reproduction period significantly differs – puberty, climacterical
- 4) Character of hormonal changes significantly differs – cyclic vs. non-cyclic

Men

vs.

Women

hypothalamus-hypophysis-gonads

- Prenatal differentiation of reproductive organs
- Prenatal and perinatal T production

- Onset of puberty
- After puberty: „stable“ T production

- The end of fertile age is not definitively determined

- Prenatal differentiation of reproductive organs
- Final number of oocytes

- Onset of puberty
- After puberty: cyclic changes

- Fertile age is clearly determined

CRITICAL DEVELOPMENTAL PERIODS

- 1) Birth
- 2) Weaning
- 3) Puberty (adolescence)
- 4) Climacterical (menopause)

Critical body mass (critical amount of adipose tissue/nutritional state)

Puberty

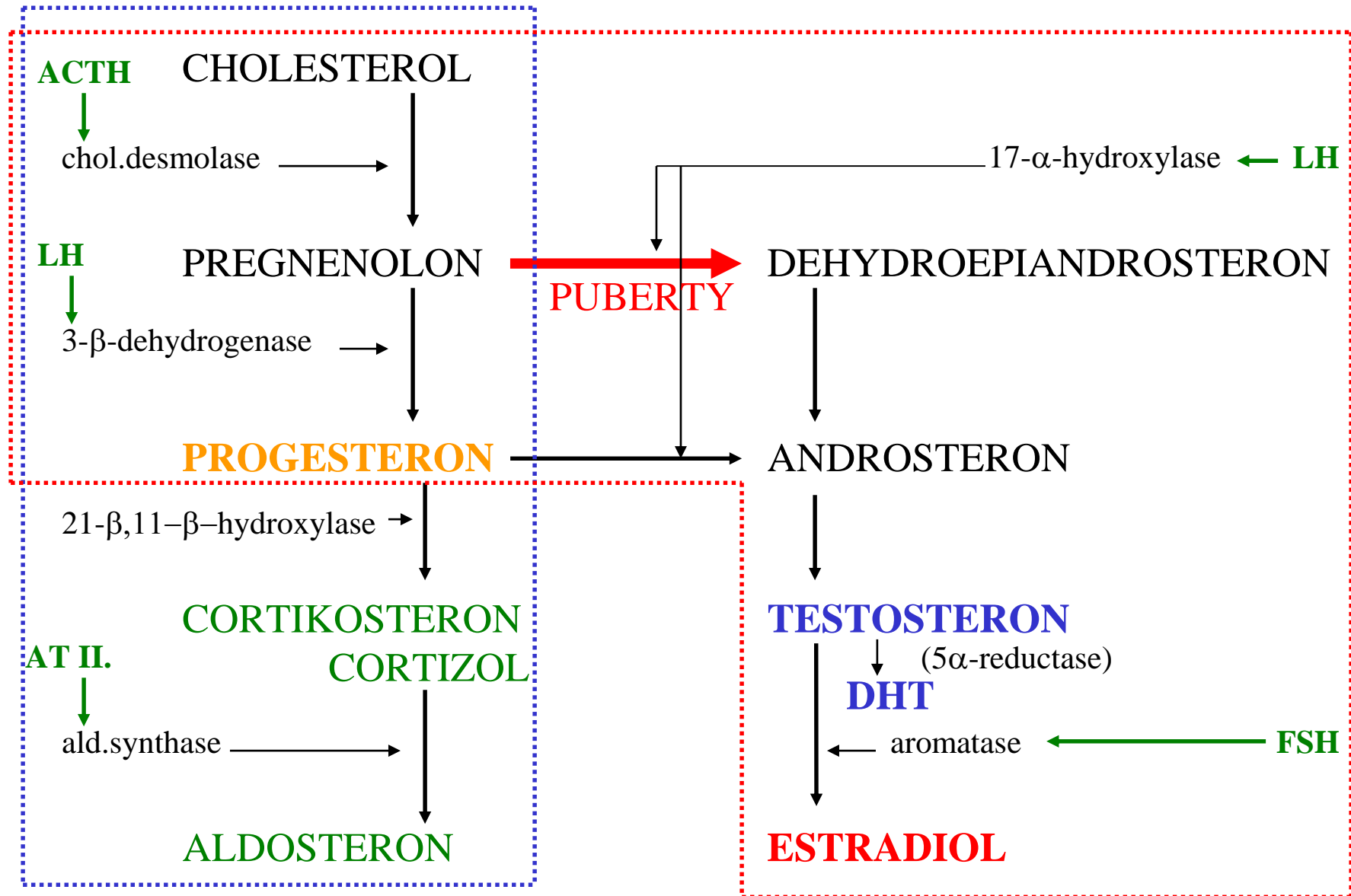
- *Adrenarche*
- *Pubarche*
- *Telarche*
- *Menarche*

Pubertas praecox (central)
Pseudopubertas praecox (peripheral)

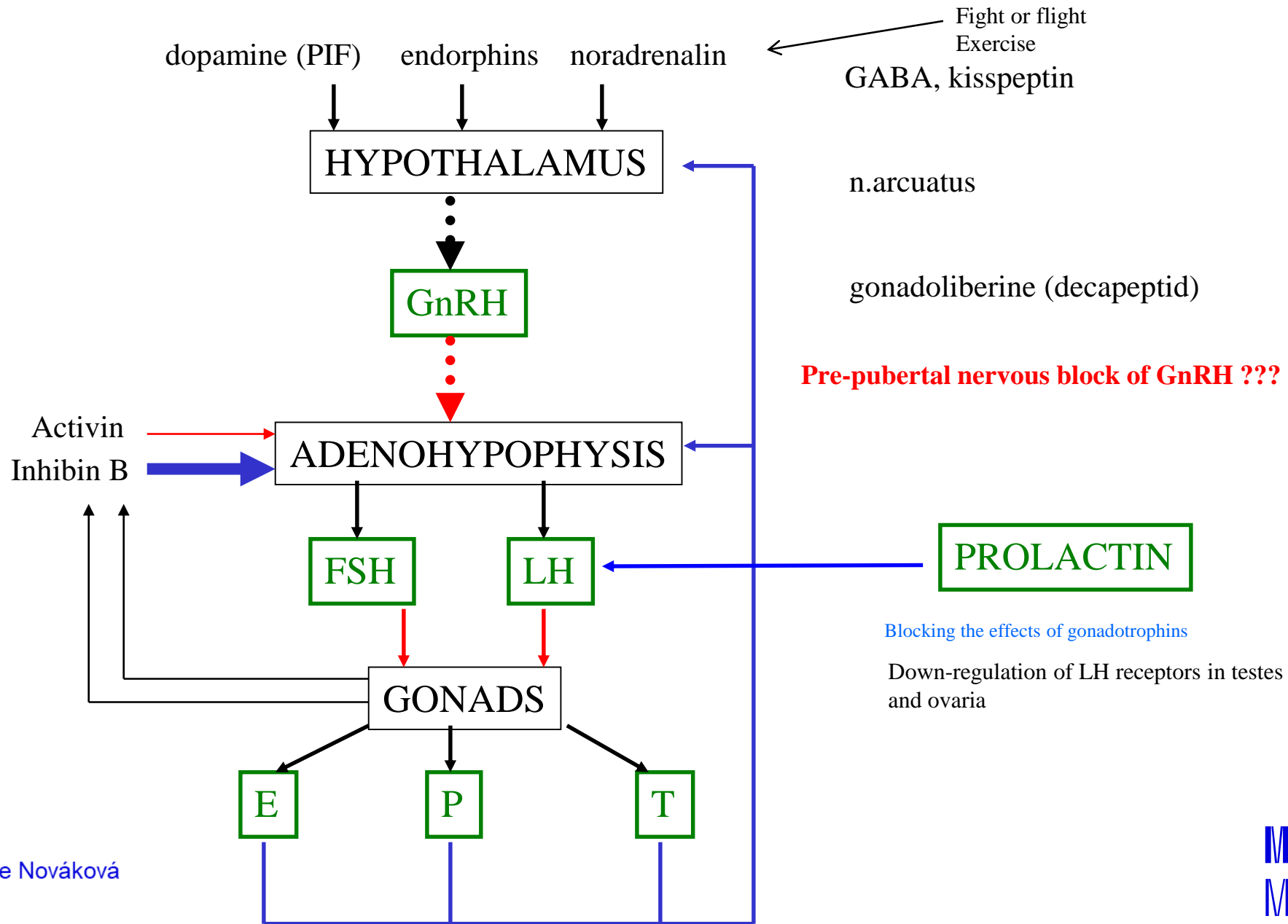
Late puberty

- Meiosis occurs only in germ cells and gives rise to male and female **GAMETES**
- Fertilization of an oocyte by an X- or Y-bearing sperm establishes the zygote's **GENOTYPIC SEX**
- Genotypic sex determines differentiation of the indifferent gonad into either an **OVARY** or a **TESTIS**
- The testis-determining gene is located on the Y chromosome (testis-determining factor, sex-determining region Y)
- Genotypic sex determines the **GONADAL SEX**, which in turn determines **PHENOTYPIC SEX** (fully established at puberty)
- Phenotypic differentiation is modified by endocrine and paracrine signals (testosterone, DHT, AMH)

BIOSYNTHESIS OF STEROID HORMONES



CONTROL OF SEX HORMONES SECRETION – simplified scheme

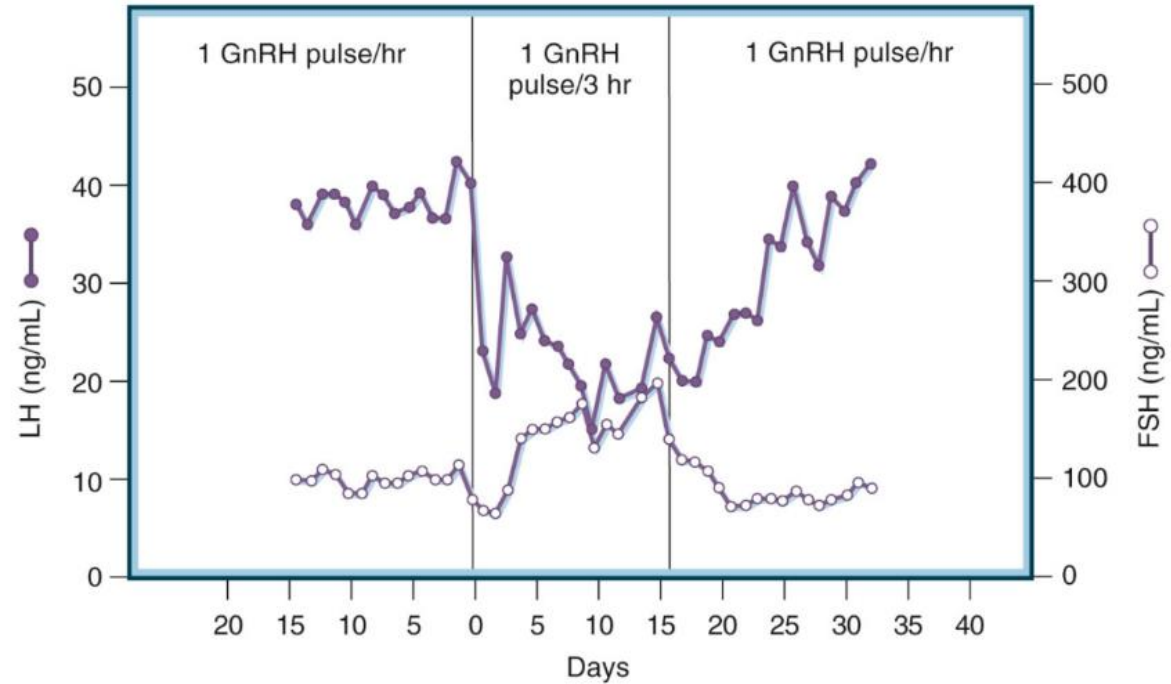


GONADOLIBERIN (GnRH, GONADOTROPIN-RELEASING HORMONE)

- Specific origin of GnRH neurons
- GnRH-I, GnRH-II, (GnRH-III)
- Important up and down regulation (steroidal hormones, gonadotrophs)
- **Down regulation** – malnutrition, lactation, seasonal effects, aging, continual GnRH
- **Up-regulation** – effect of GnRH on gonadotrophs (menstrual cycle)

Hypothalamo-hypophyseal axis

- FSH, LH
- Significance of GnRH pulse frequency (glycosylation)
- Menstrual cycle, puberty and its onset



ACTIVINS and INHIBINS

Inhibins

- dimeric peptides
- circulating hormones produced by gonads
- inhibin **A** – dominant follicle, corpus luteum
- inhibin **B** – testes, luteal and early follicular phase of ovarian cycle

Activins

- dimeric peptides
- FSH stimulation
- autocrine/paracrine effects

Follistatin

- monomeric polypeptide
- FSH inhibition

- „supplementary“ regulation of FSH and LH secretion
- activins = regulation of transcription
- follistatin and inhibins = inhibition of activins through appropriate activin-receptor binding

FSH and LH - functions

FEMALES

FSH

- Growth and development of follicular cell (maturation)
- Biosynthesis of estradiol
- Regulation of inhibin synthesis during follicular phase
- Upregulation of LH receptors (preovulatory follicles)
- Selection of dominant follicle
- Recruitment of follicles for next cycle

LH

- Stimulation of estrogen synthesis at various levels (theca)
- Oocyte maturation (preovulatory follicle)
- Rupture of ovulatory follicle, ovulation
- Conversion of follicle wall to corpus luteum

MALES

FSH

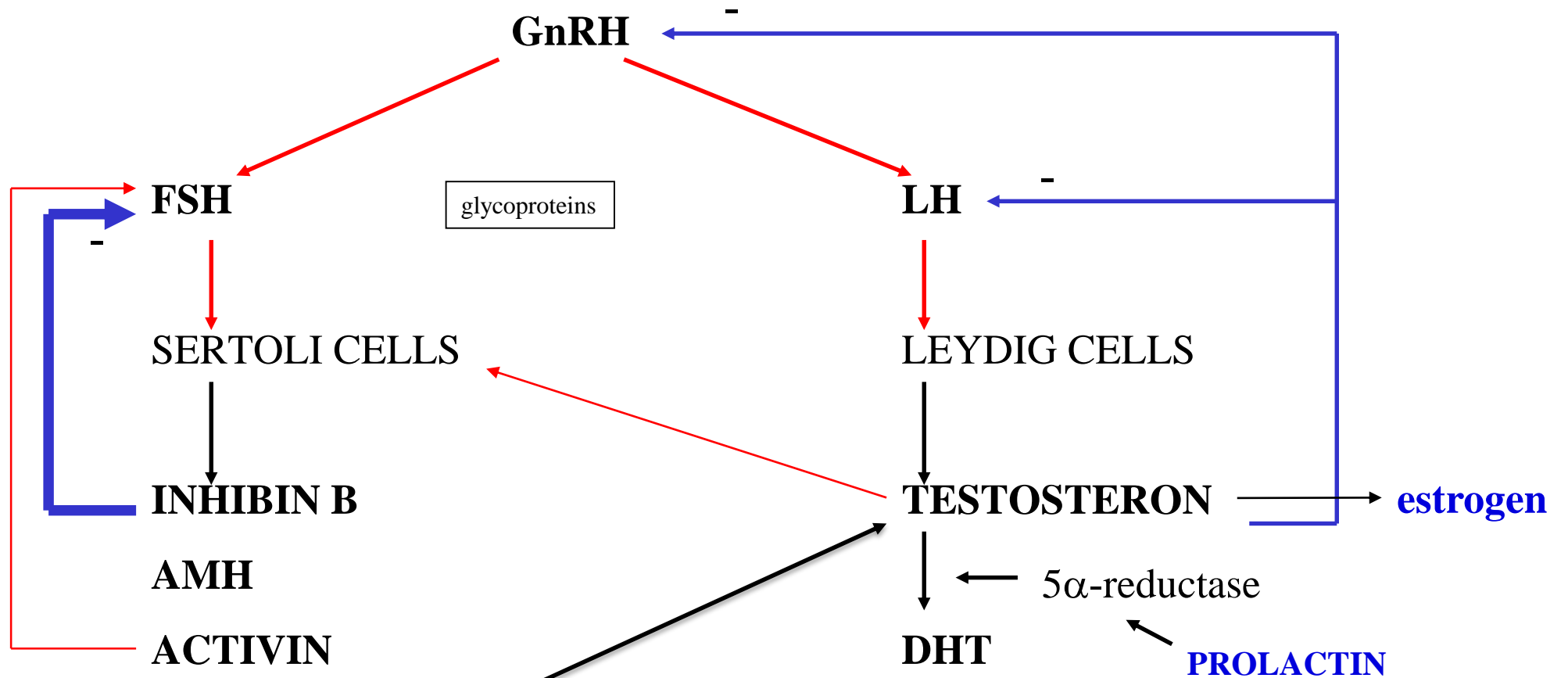
Spermatogenesis (Sertoli cells)

LH

Intratesticular synthesis of testosterone (Leydig cells)

MALE REPRODUCTION SYSTEM

HUMOURAL CONTROL OF REPRODUCTIVE FUNCTIONS IN MAN



TESTOSTERON PRODUCTION:

- Embryonic – sex differentiation, development of generative organs
- Perinatal – descensus testis (?)
- Fertile period – LH pulsation
- Ageing – decrease of sensitivity to LH

FEMALE REPRODUCTION SYSTEM

O O G E N E S I S

DEVELOPMENT:	6-8 weeks	GERMINAL EPITH.
hormonally independent	O O G O N I A mitotic division	F O L L I C L E P R I M O R D I A L
24 weeks	O O C Y T E S I .	7×10^6
birth	1. meiosis prophase	2×10^6
hormonally dependent (cyclic)	puberty	O O C Y T E S I I . haploid 2. meiosis metaphase O V U M
		3×10^5 D O M I N A N T A T R E T I C G R A A F O V U L A T I O N
	2. meiosis – end	
	climacterical	0

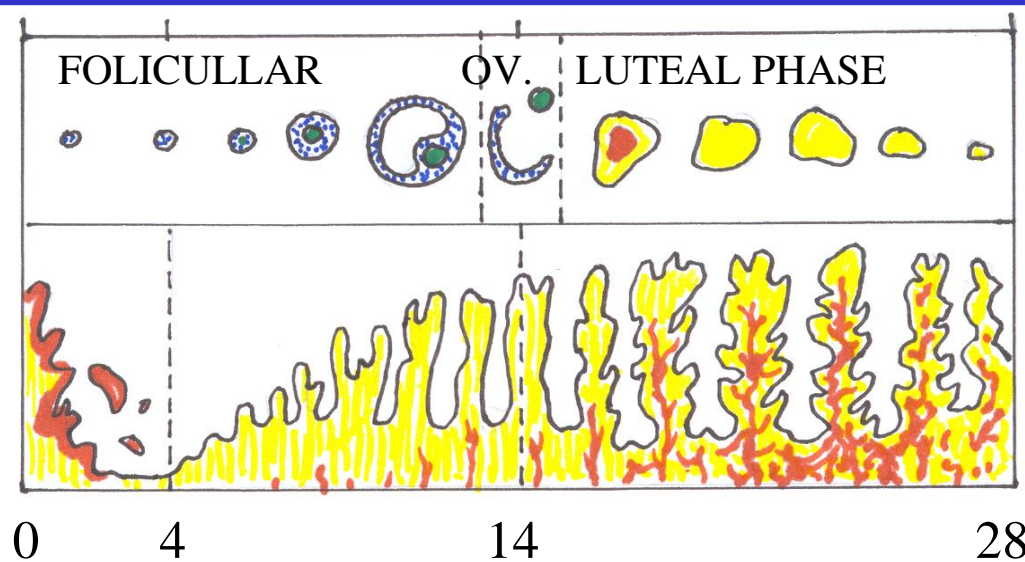
CYCLIC CHANGES

ovarian

uterine

+ vagina/cervix uteri

+ mamma



MENS. PROLIPHER. SECRETORY PHASE

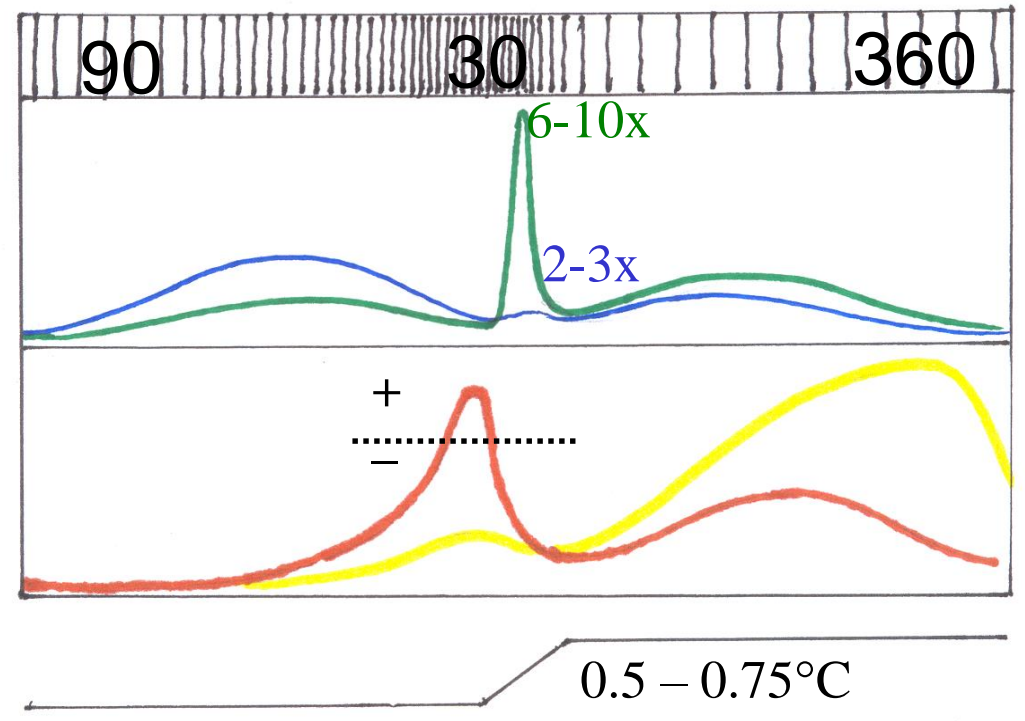
GnRH

FSH, LH

estradiol

progesteron

basal temper.



VESICULAR FOLLICLE

PRIMARY FOLLICLE - FSH

Growth acceleration of primary follicle – change into vesicular follicle:

1) estrogens released into follicle stimulate granul. cells



UP REGULATION of **FSH receptors** and **intrinsic positive feedback** (higher sensitivity for FSH!!!)

2) **UP REGULATION** of LH receptors (estrogens and FSH) – another acceleration of growth due to „higher sensitivity“ to LH (**positive feedback**)

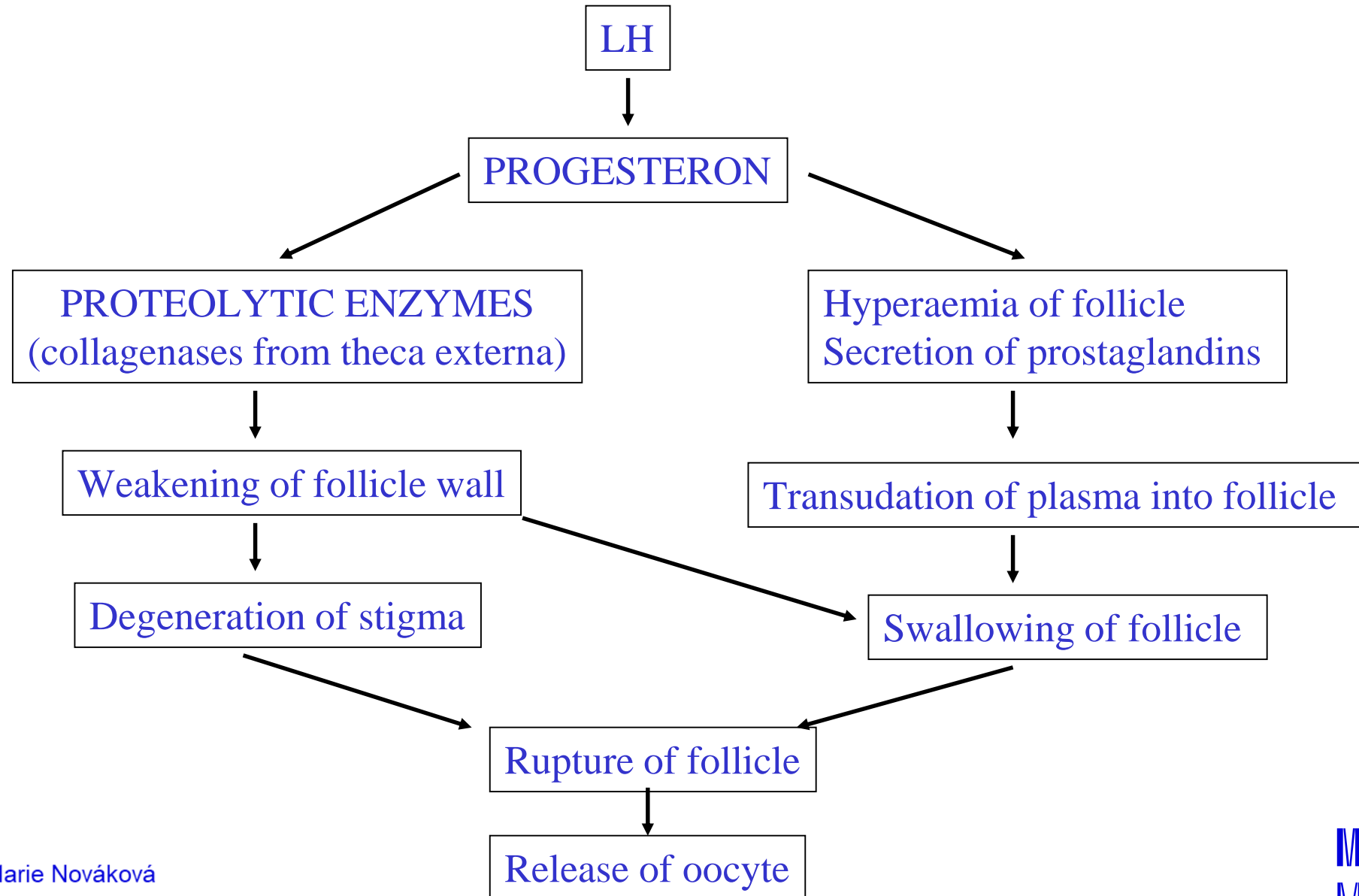
3) Increased estrogens and LH secretion accelerates growth of theca cells, secretion is increased

→ **explosive growth of follicle**

DOMINANT FOLLICLE

1. High levels of **oestrogens** from the fastest-growing follicle
2. **Negative** feedback on FSH production from adenohypophysis
3. Gradual decrease in **FSH** secretion
4. „**Dominant** follicle“ continues in growing due to **intrinsic positive** feedback
5. Other follicles grow slowly and subsequently become **atretic**

MECHANISMS OF OVULATION



EFFECTS OF OVARIAN HORMONES

E

Secondary sexual signs +

Adipose tissue: store (predilection), (critical amount)

Bone tissue: **absorption**

closure of fissures

development of pelvis

Total water retention: +

Sexual behaviour: +

P

-

-

-

-

-

+

-

Ovaries: **maturation of follicles**

Hysterosalpinx: **motility**

Uterus: **proteosynthesis**

vascularisation and proliferation of endom.

motility

Cervix: **colliquation of „plug“**

Vagina: **cornification of epithelium**

Mamma: **growth of terminals**

motility

proteosynthesis

secretion of endom. glands

glycogen

motility

creation of „plug“

proliferation of epithelium

growth of acines