Lecture 13

Lucky 13! Hooray!! Dr. Cirullo this Thursday! Dr. Kaplan next Tuesday!!...

I. ***Announcements*** **Quiz today covers CV physiology. Q?**

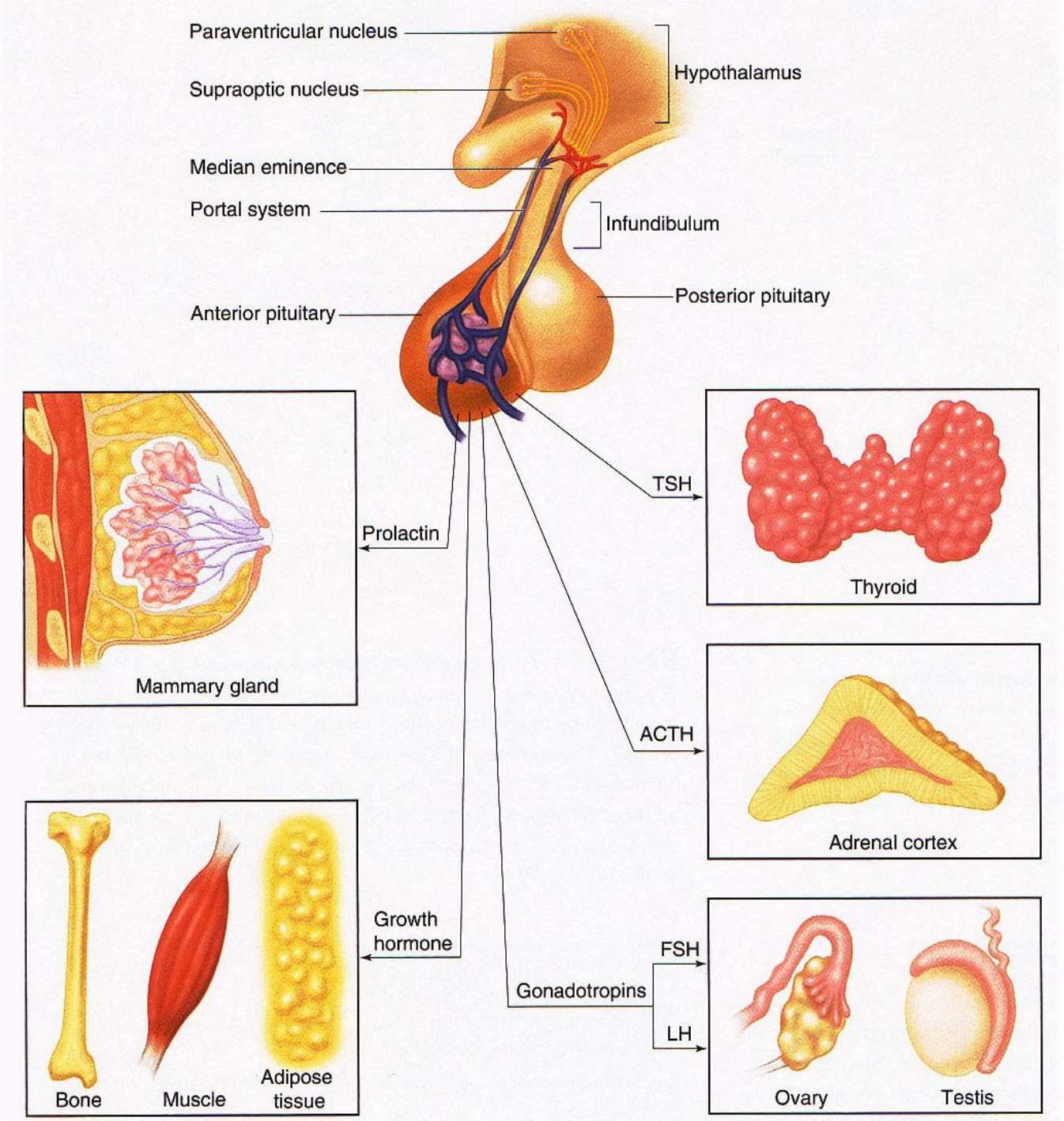
II. ***Endocrinology Connections*** **from Lecture 12**

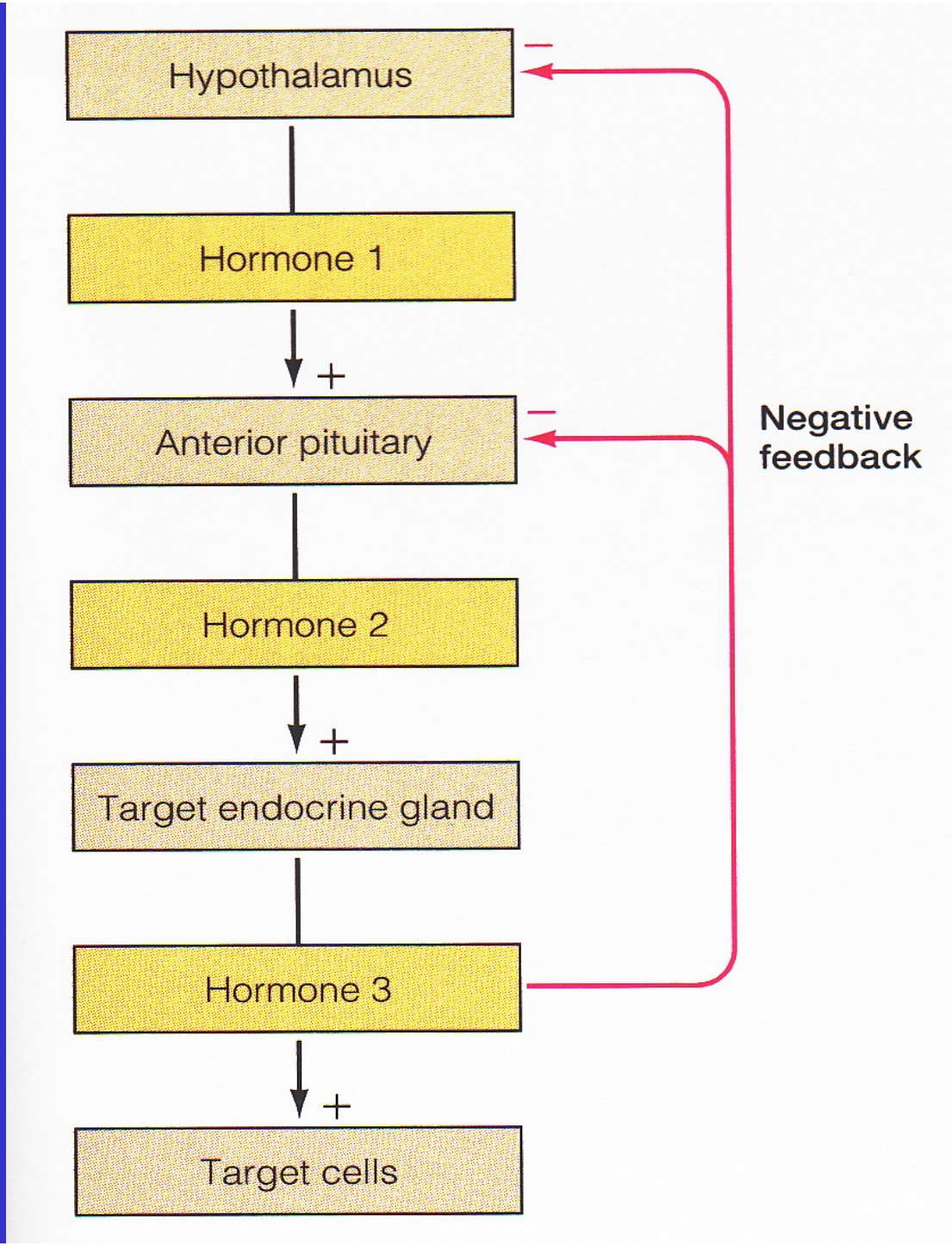
III. ***Med Physiol News*** **Sex Allergy? Mom's eggs execute dad's mitochondria? *Science News***

IV. ***Reproductive Physiology Primer*** **ch 81 + 80 G&H + LS +…**

- **A. Female reproductive system fig 81-1, 81-2**
- **B. Ovarian hormones +FB: estrogen & progesterone pp 991-4**
- **C. Follicle growth & ovulation mechanism fig 81-4, 81-5**
- **D. Plasma gonadotropin & ovarian hormone [ ] in female sexual cycle fig 81-3**
- **E. Female sexual cycle, menstruation fig 81-3, 81-8**
- **F. Estrogen [ ] throughout lifespan, menopause fig 81-12**
- **G. Birth control techniques L Sherwood + G&H**
- **H. Male reproductive system fig 80-1 A & B**
- **I. Sperm & development fig 80-2, 80-7, 80-3, 80-4, 80-5**
- **J. Feedback regulation in males fig 80-10**
- **K. Plasma testosterone [ ] throughout lifespan fig 80-9**

Fox 2008


Paraventricular nucleus
Supraoptic nucleus
Hypothalamus
Median eminence
Portal system
Infundibulum
Posterior pituitary
Anterior pituitary
Prolactin
TSH
Thyroid
Mammary gland
ACTH
Adrenal cortex
Growth hormone
Gonadotropins
FSH
LH
Bone
Muscle
Adipose tissue
Ovary
Testis


Hypothalamus
Hormone 1
+
Anterior pituitary
Hormone 2
+
Target endocrine gland
Hormone 3
+
Target cells
Negative feedback

LS 1991

GH, a Protein Hormone (191 AA)

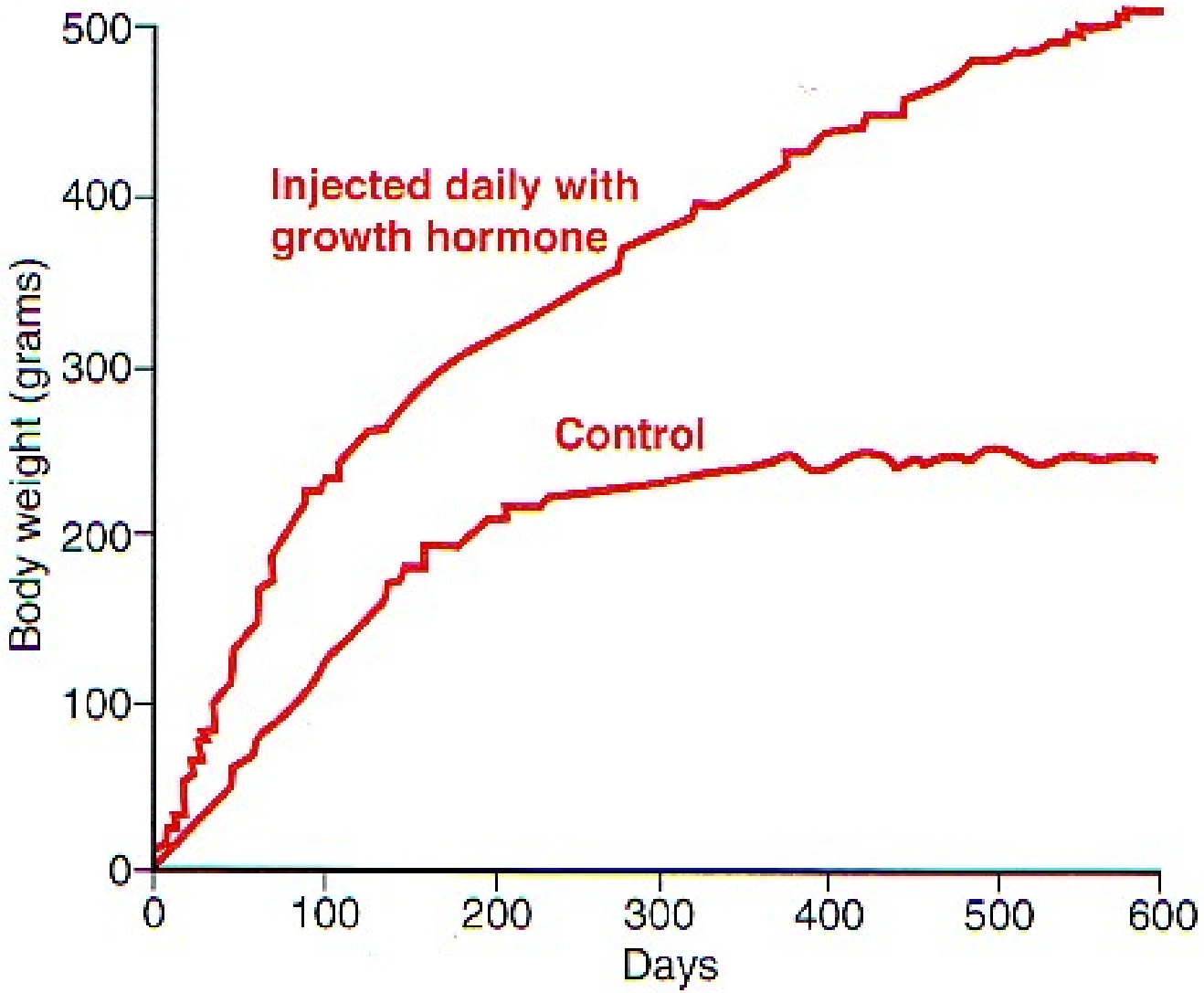


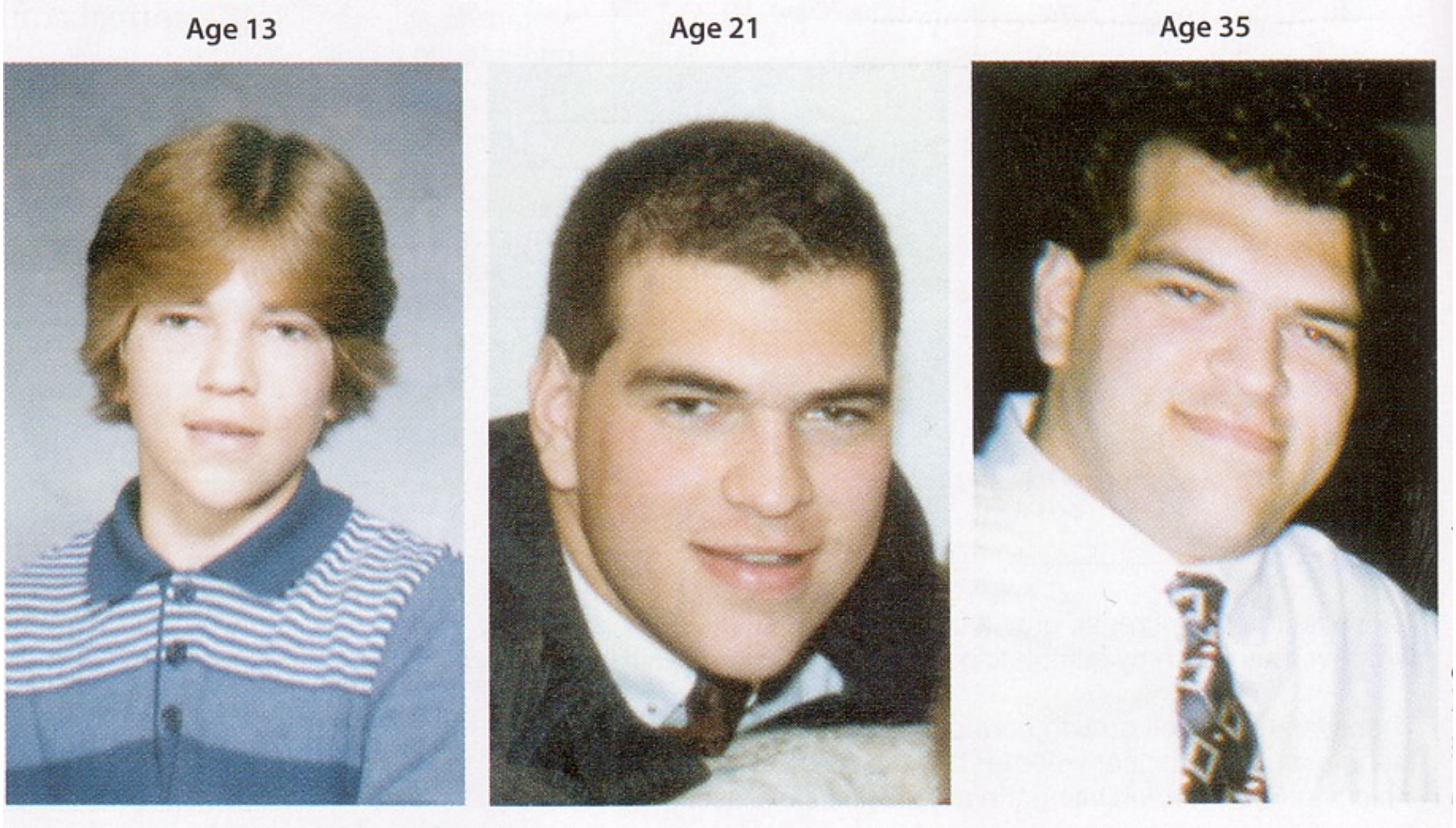
FIGURE 75–5

Comparison of weight gain of a rat injected daily with growth hormone with that of a normal littermate.

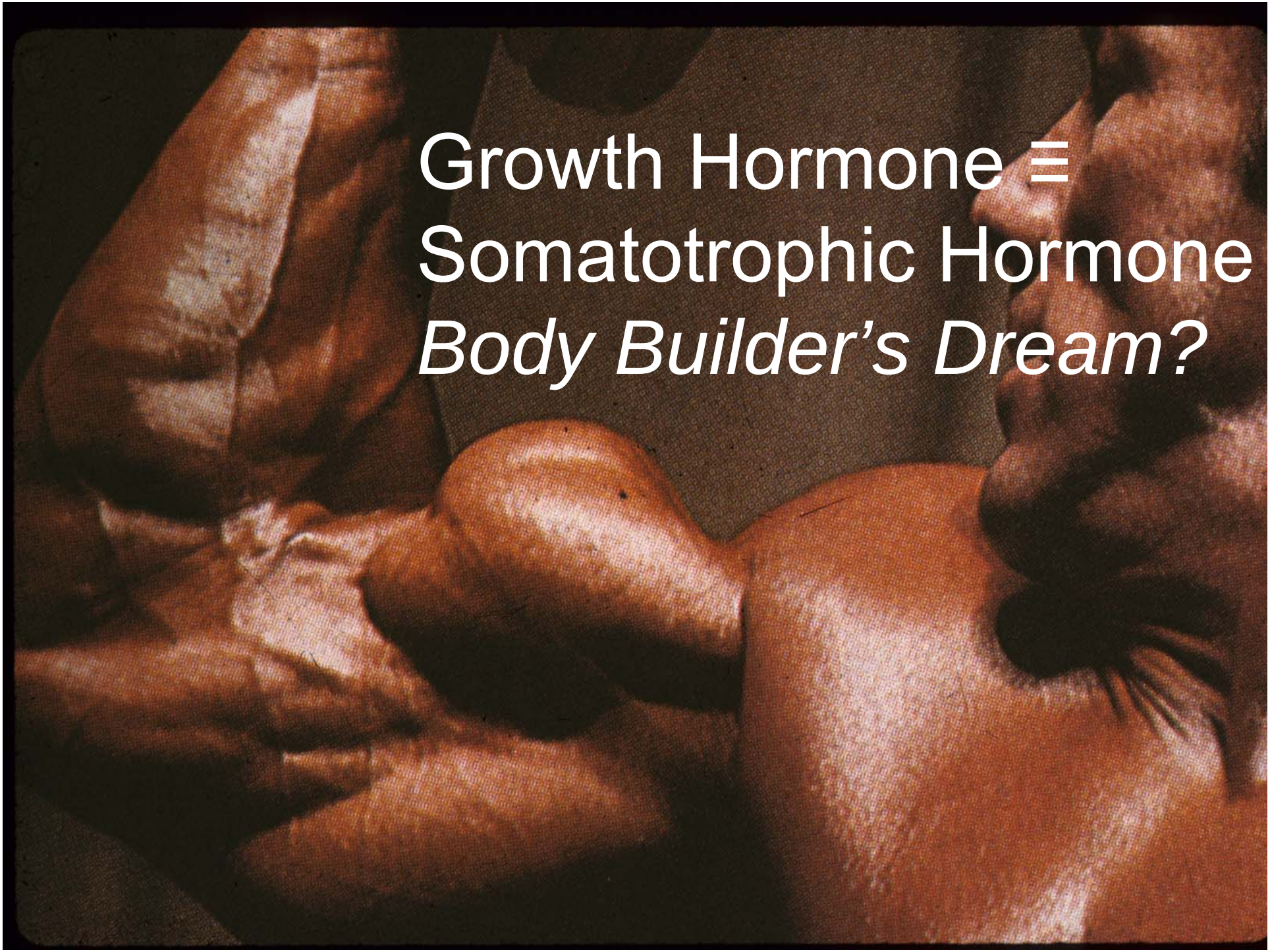
G&H 2006

LS2 2006

Progression & Development of Acromegaly



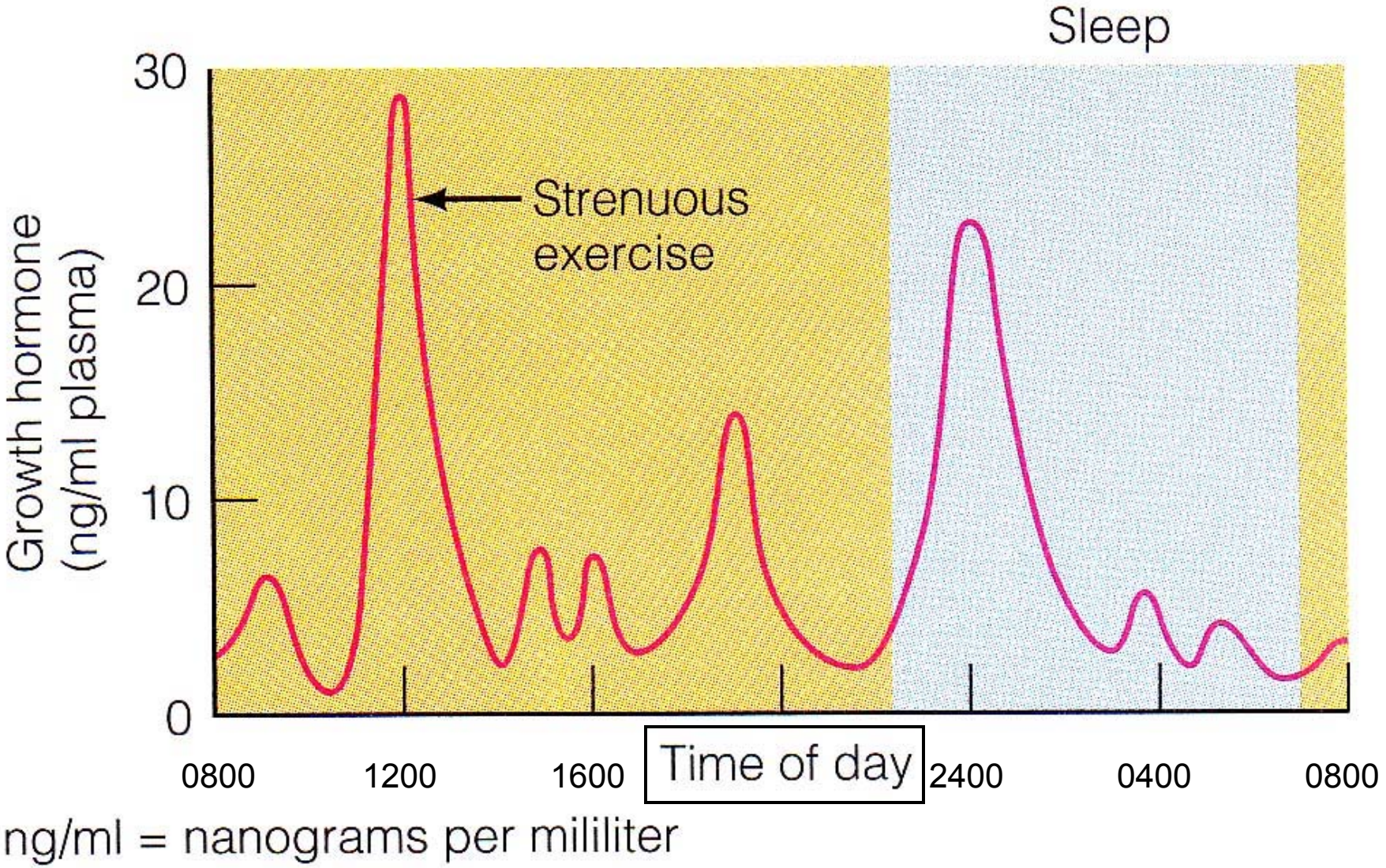
LS 2012 fig 17-11


Growth Hormone ≡
Somatotrophic Hormone
Body Builder's Dream?

GH/STH Effects: Insulin Resistance/Type II Diabetes?

- ↑ Amino acid uptake & protein synthesis
- ↑ Lipolysis & fatty acid mobilization
- ↓ Glucose uptake
  (skeletal muscle & adipocytes)
- ↑ Glucose production
  (liver glycogenolysis)
- ↑ Insulin secretion

Increase GH naturally with exercise & sleep!!



cf: G&H 2011 fig 75-6

Proinsulin with C-Connecting Peptide

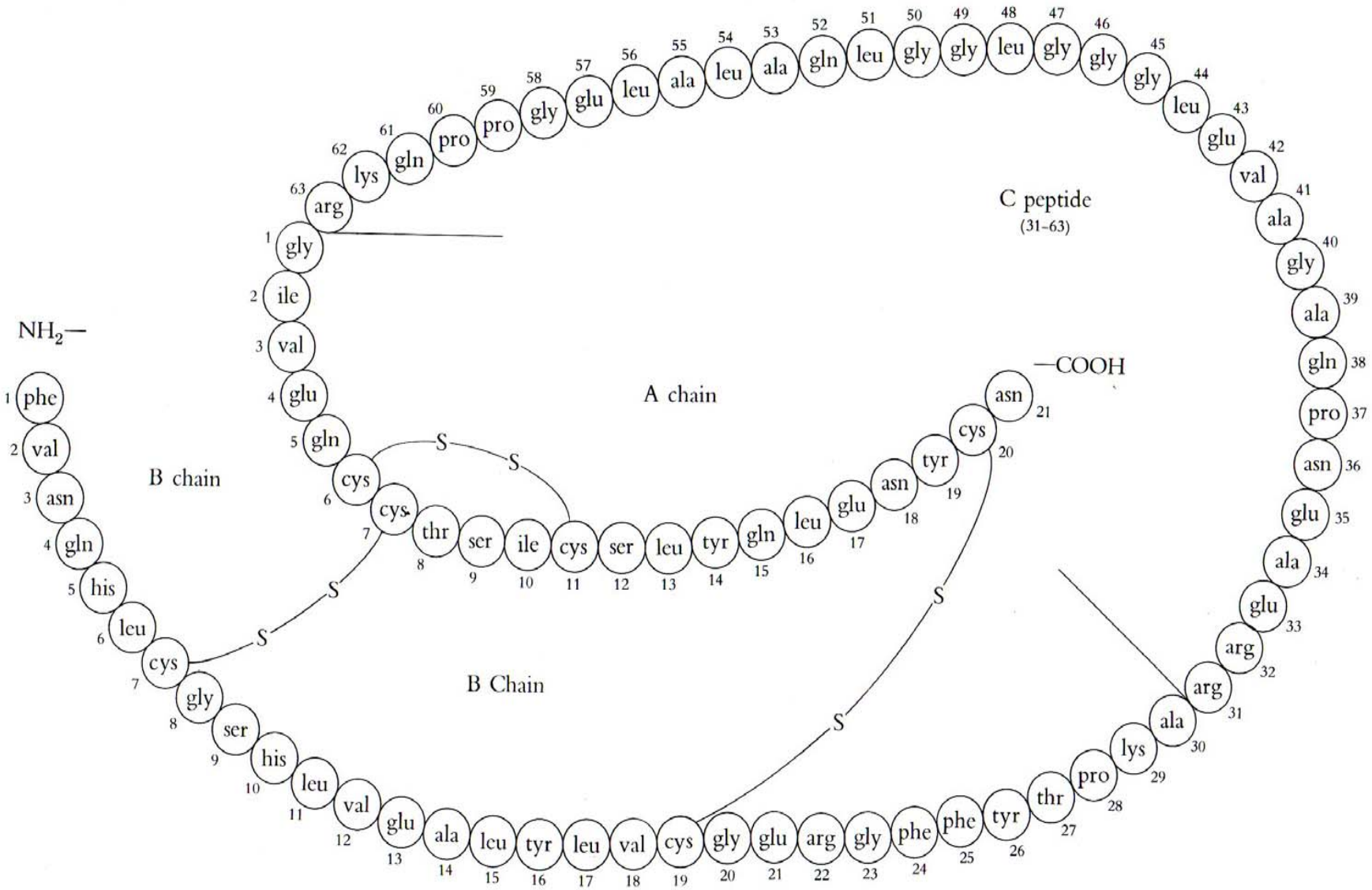
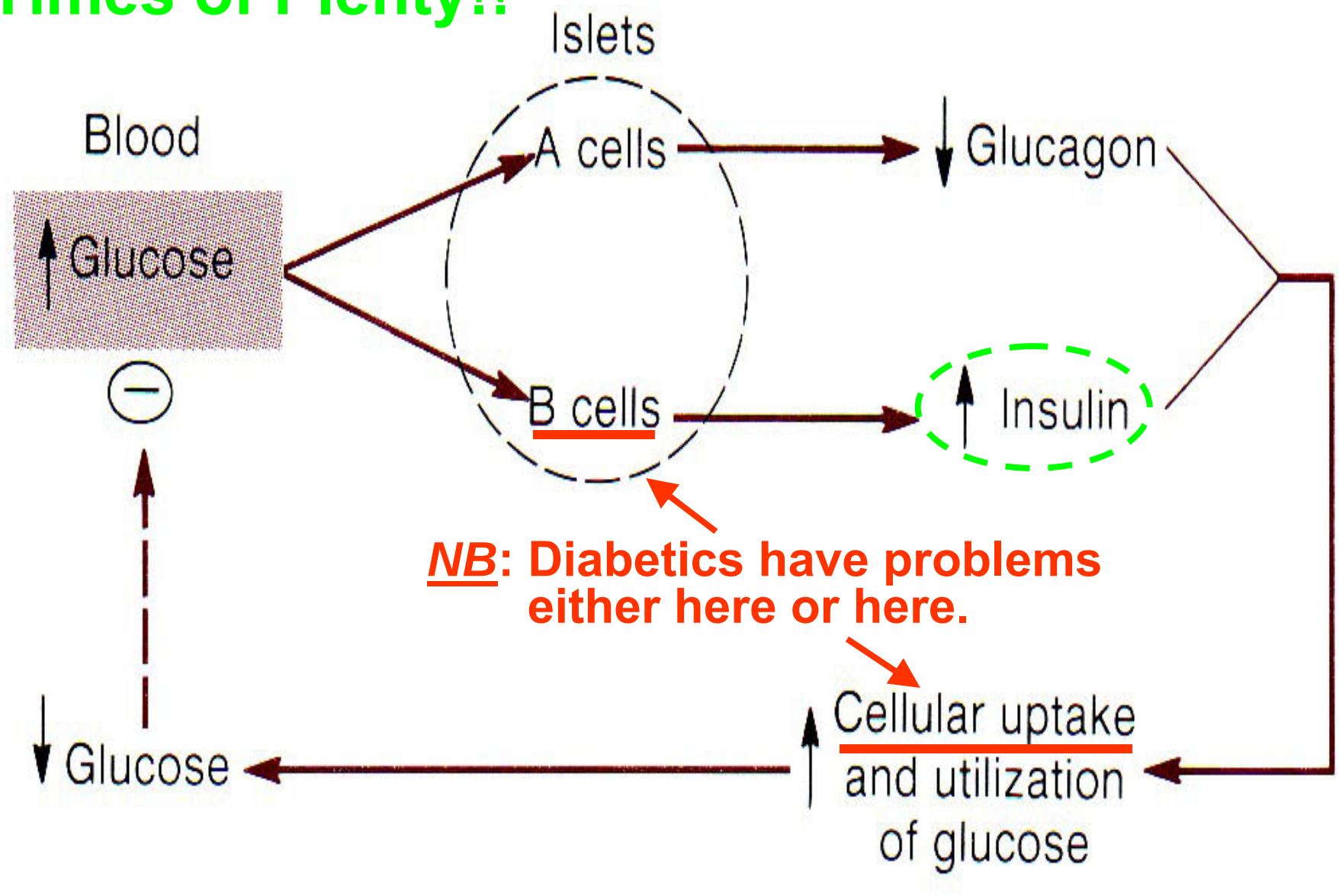


FIG. 10-4. Amino acid sequence of a mammalian proinsulin molecule. Note how the insulin molecule can be formed by cleaving this polypeptide chain at two locations to liberate the C peptide.

DO Norris 1980

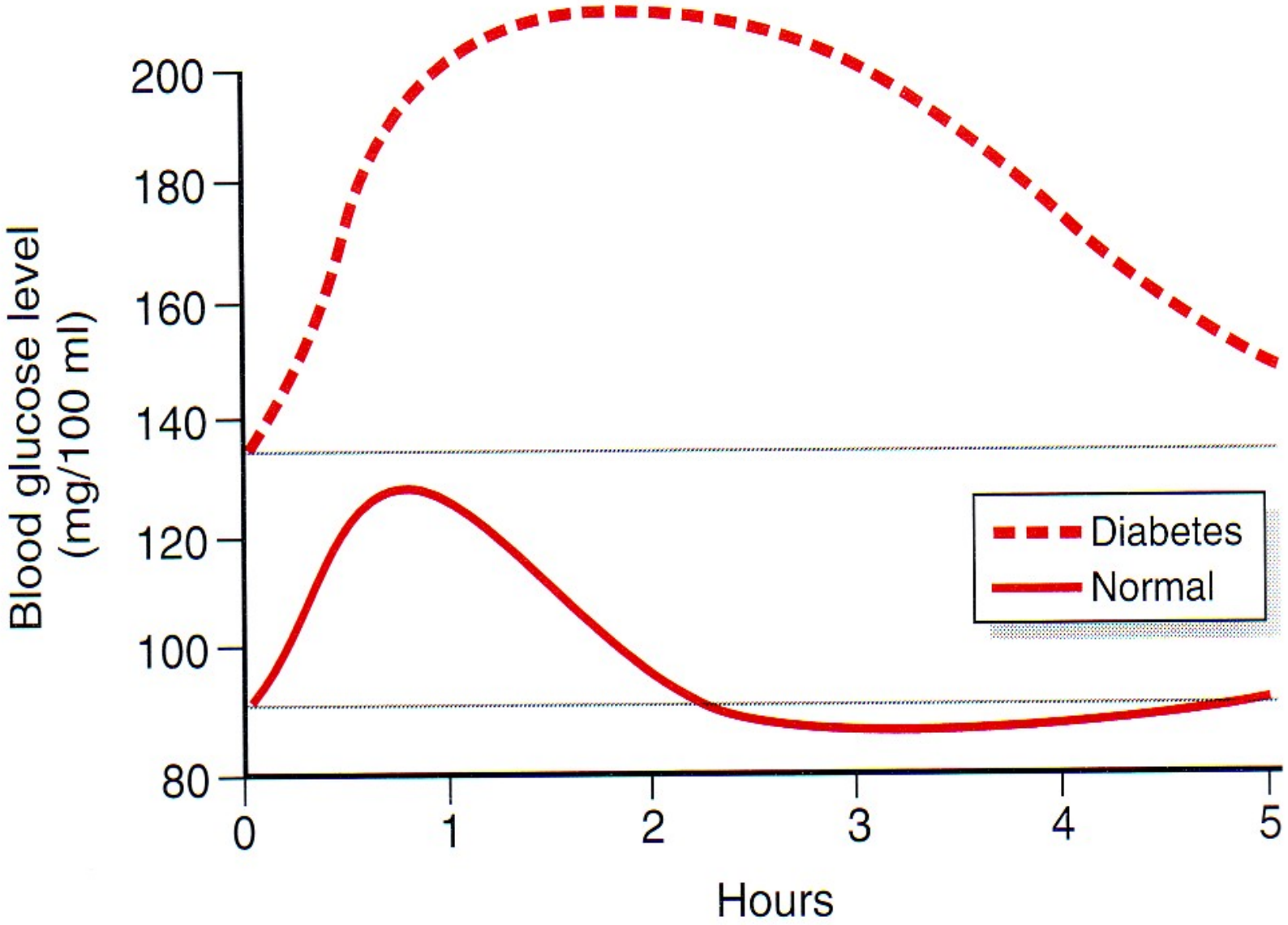
Times of Plenty!!



Fox 1987

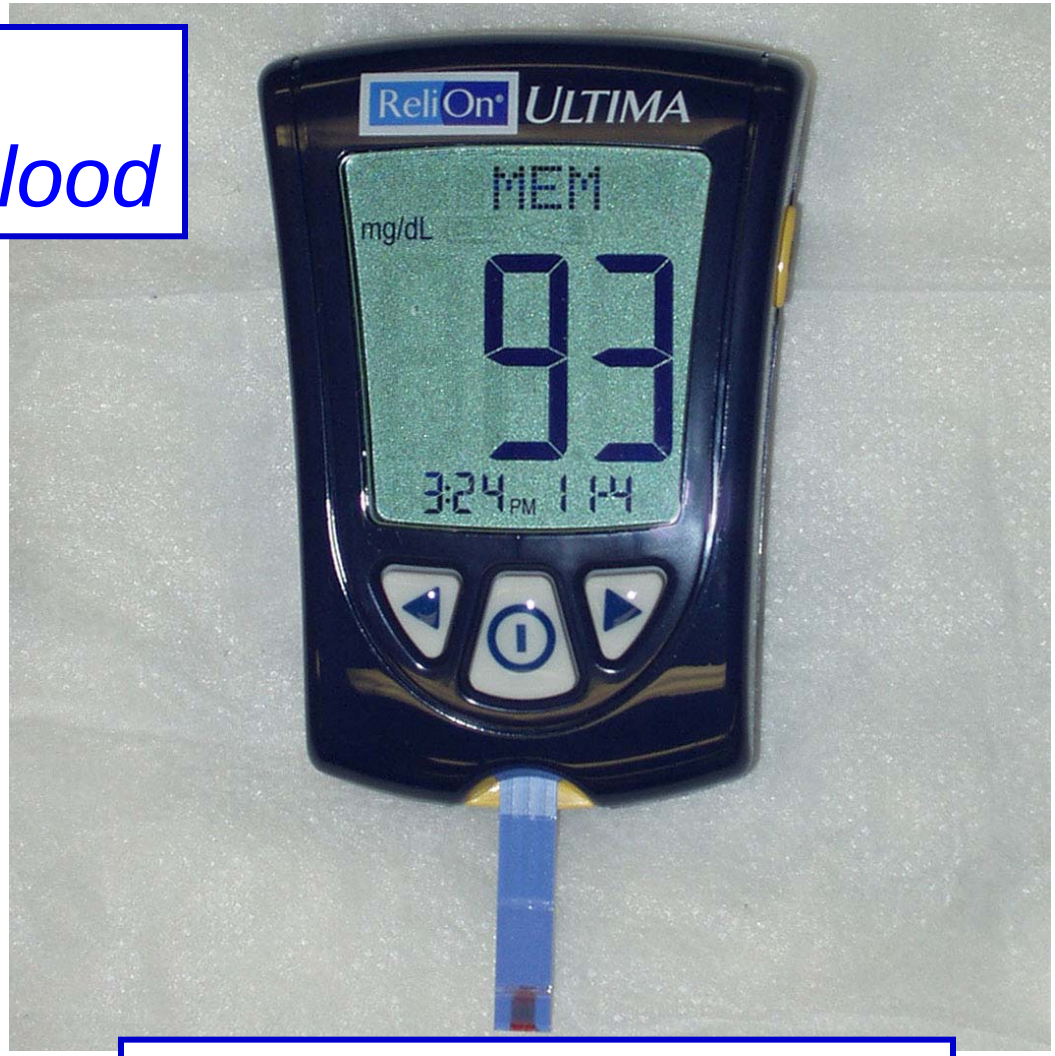
Store!

Diabetic & Normal Response to Glucose Load

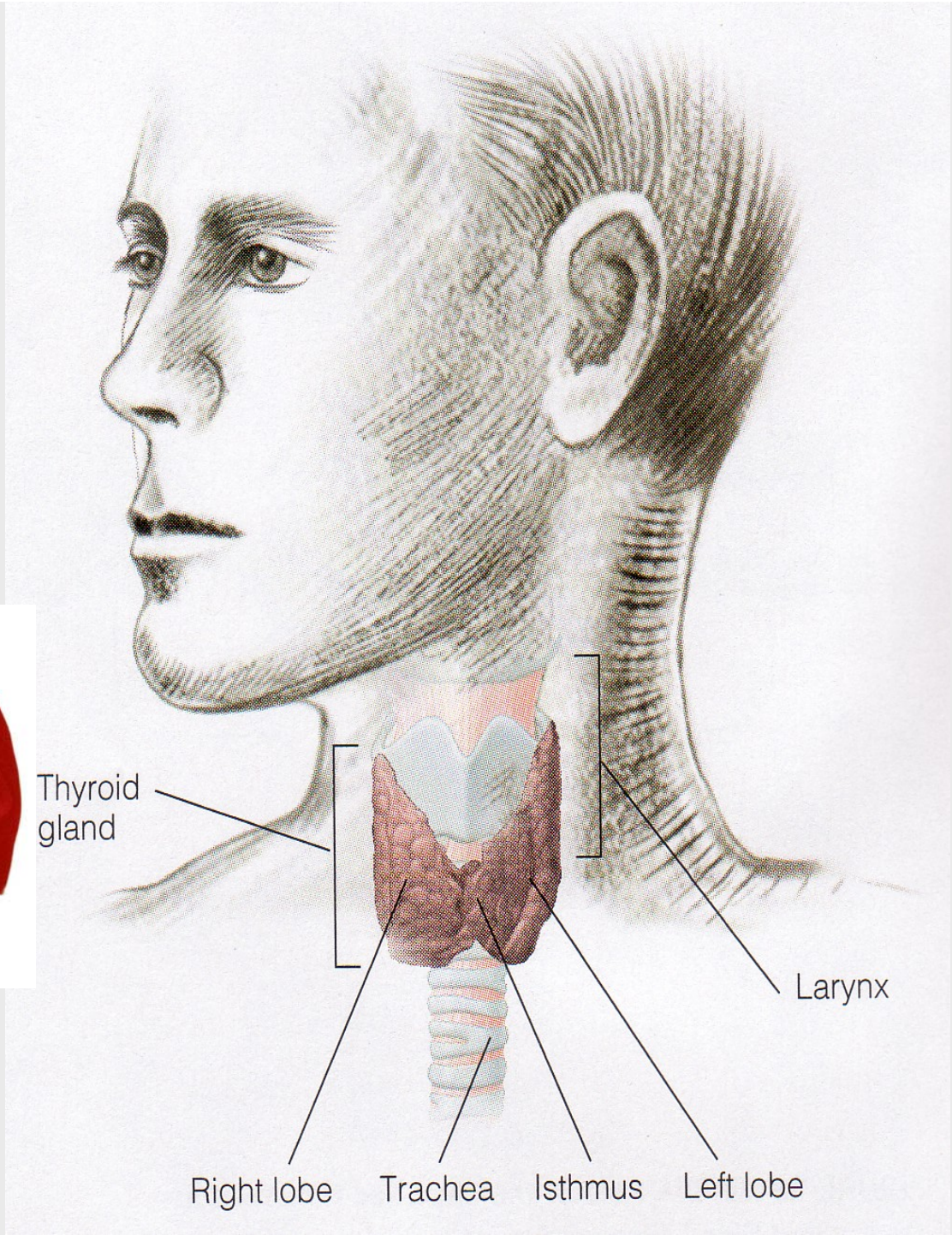


G&H 2000 cf: G&H 2011 fig 78-12

Glucose:
Sugar in Blood

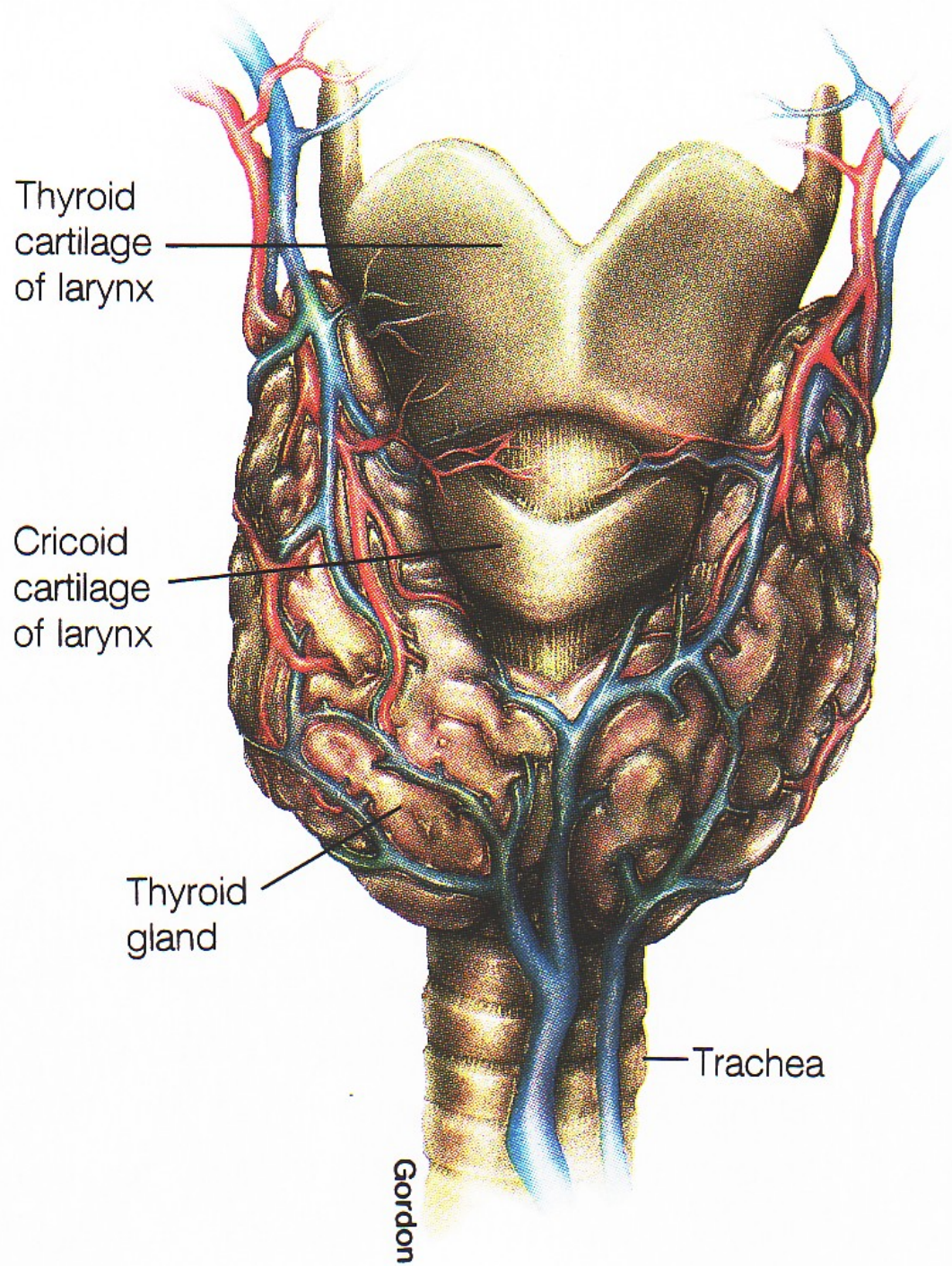


Normal: 70-99
Pre-Diabetes: 100-125
Diabetes: ≥ 126 mg/dL



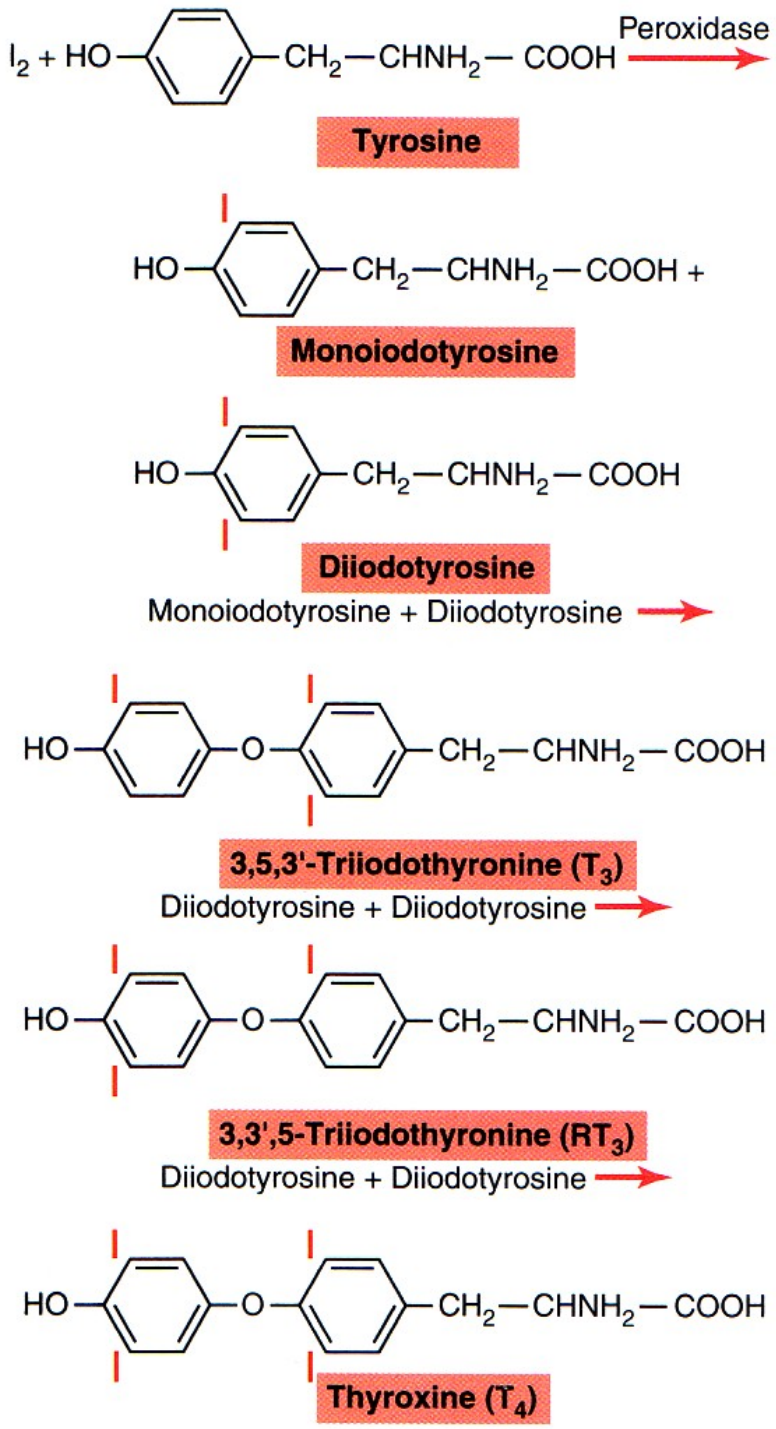
DC 2003


DC 2003

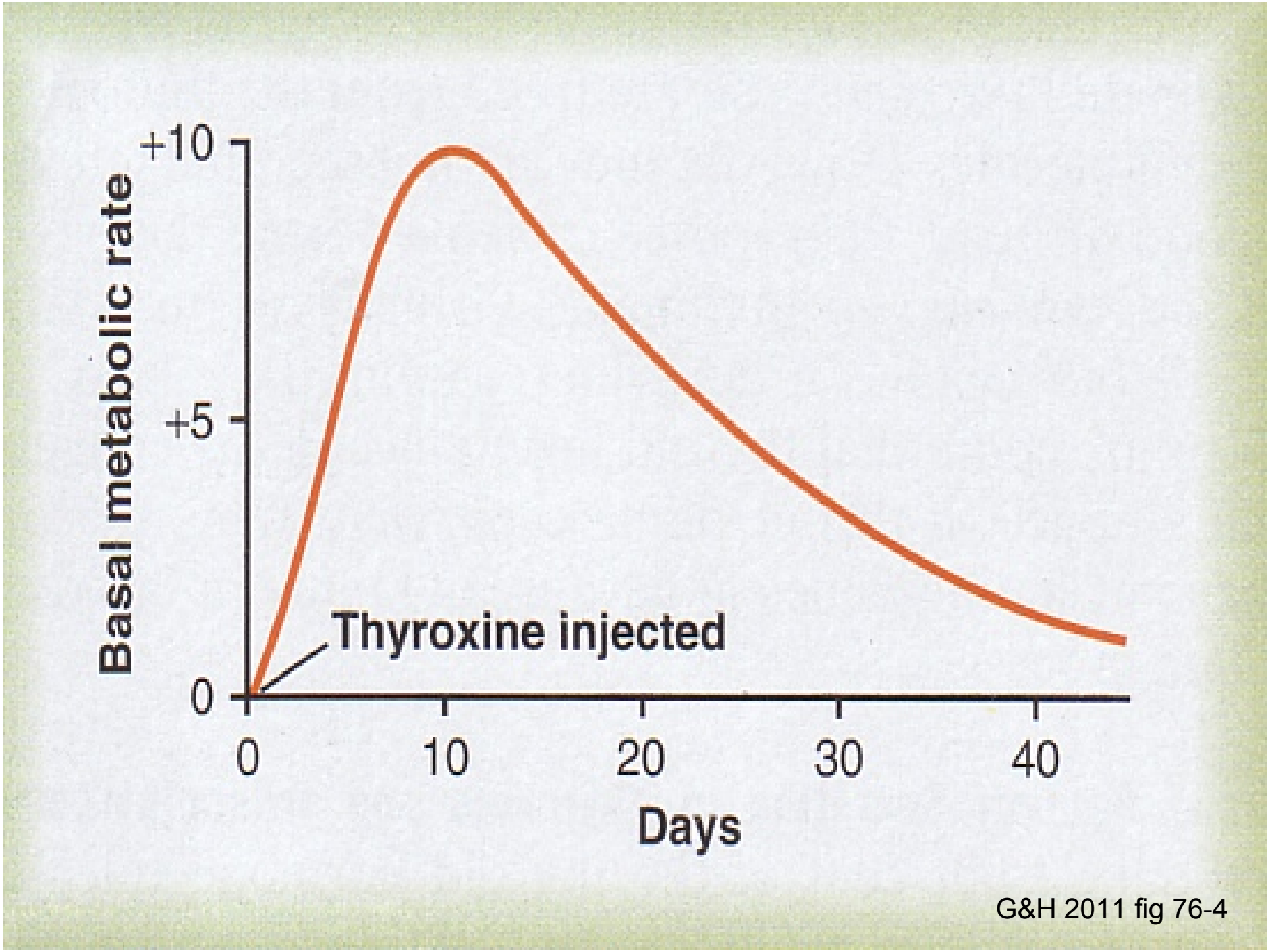

Thyroid cartilage of larynx
Cricoid cartilage of larynx
Thyroid gland
Trachea
Gordon

(a)

DC 2003



G&H 2011 fig 76-3



G&H 2011 fig 76-4

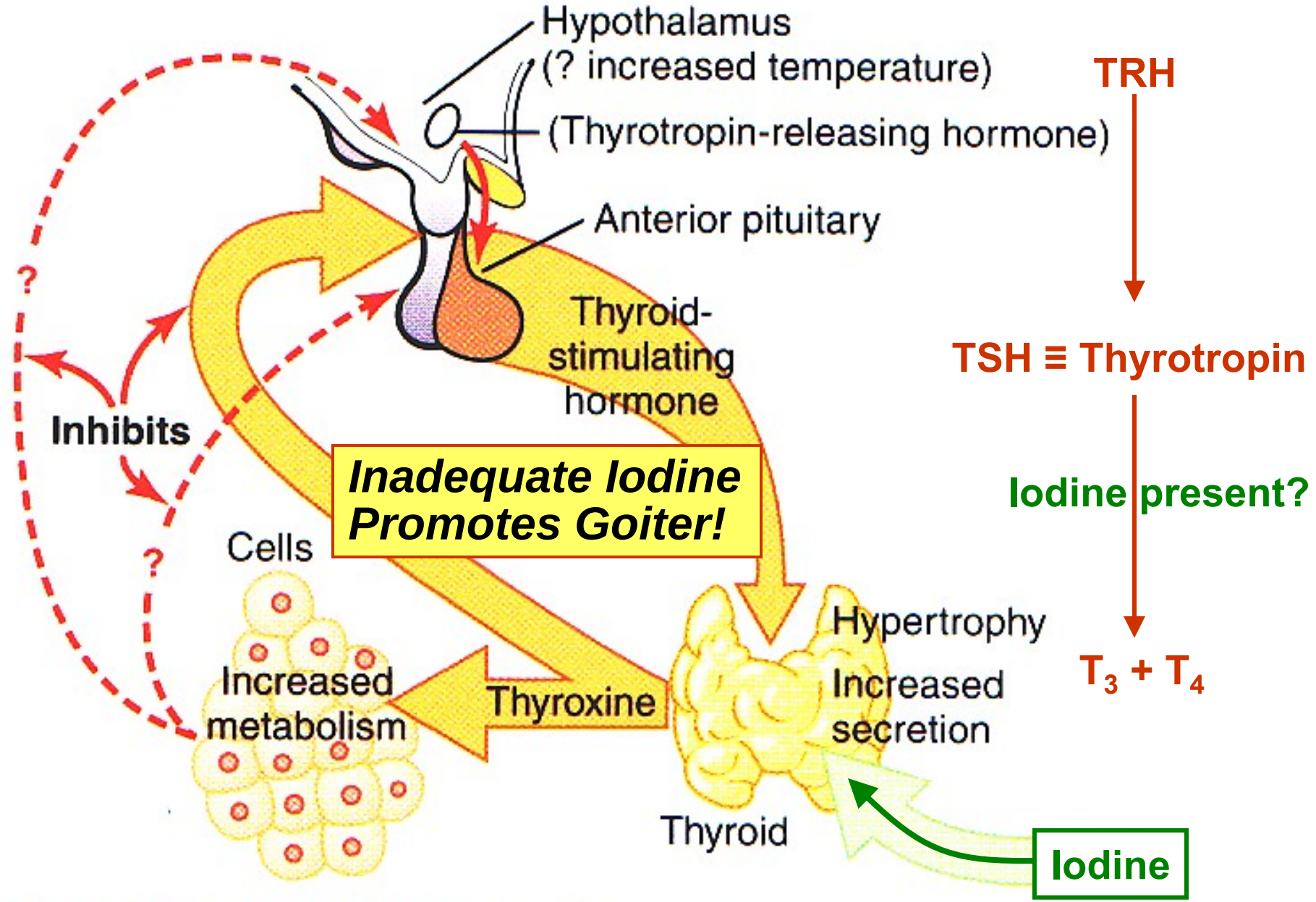


Figure 76-7 Regulation of thyroid secretion.

G&H 2011

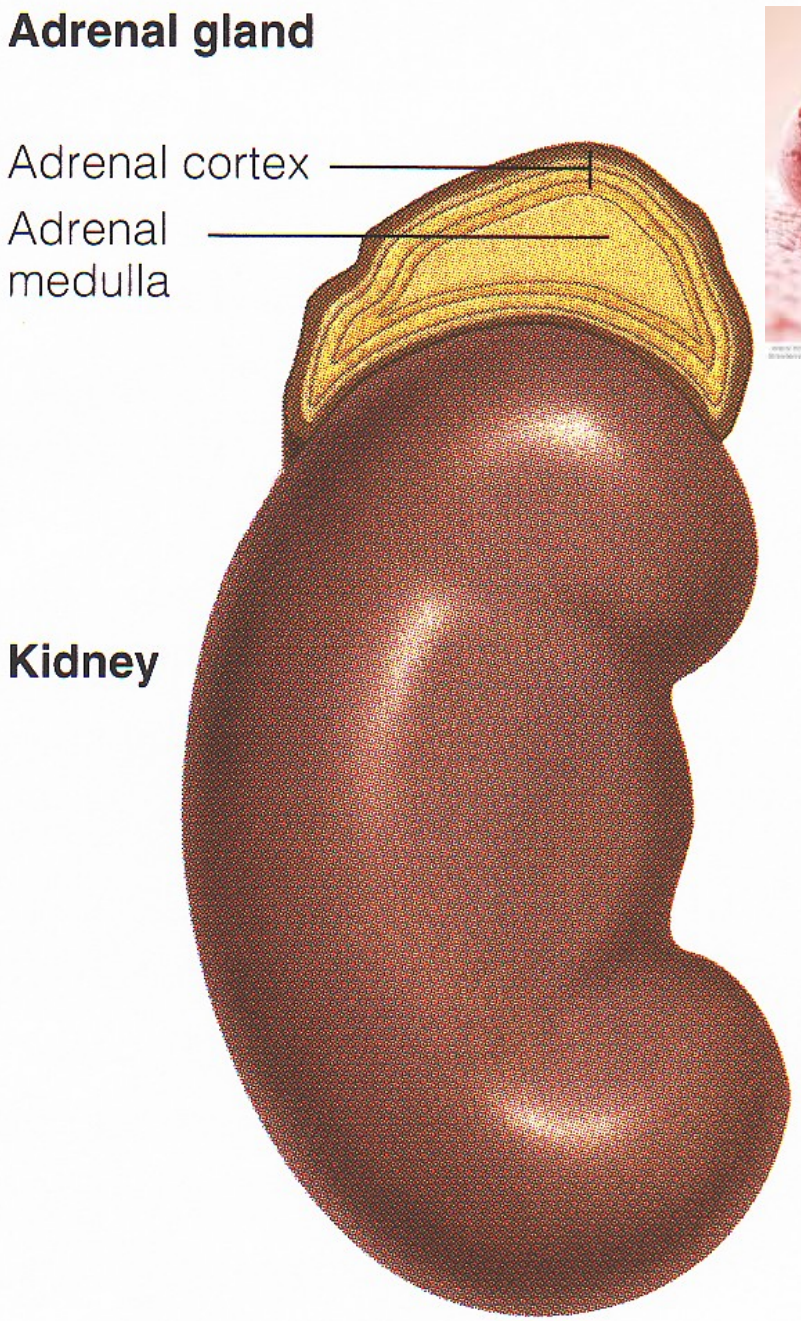
DC 2003


cf: G&H
2011
fig 76-8
DC
2003

Near absence of thyroid-hormone function + myedema

Figure 76–8. Patient with myxedema. (Courtesy of Dr. Herbert Langford.)

G&H 2006

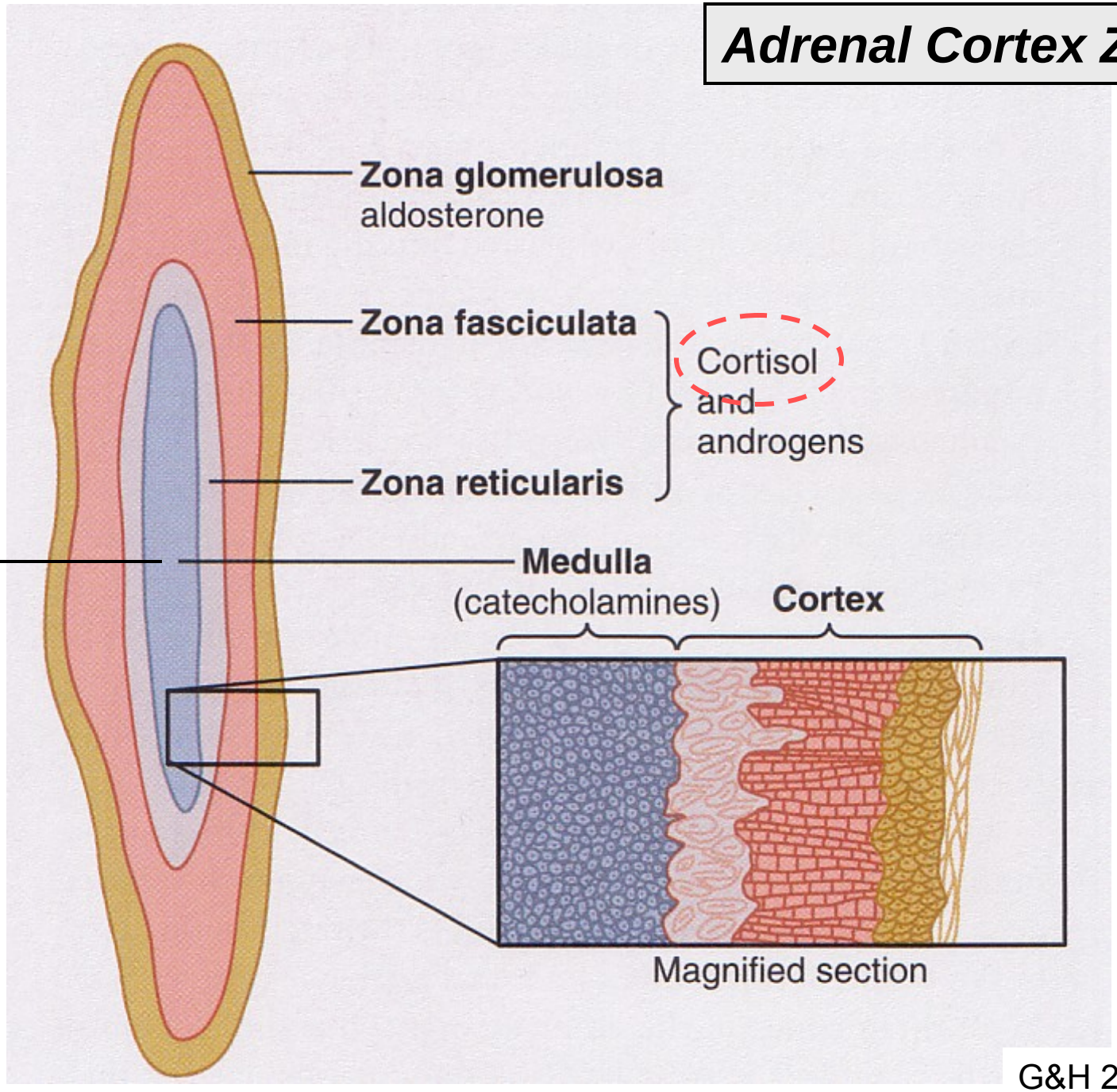


Scoop of ice cream on North pole!

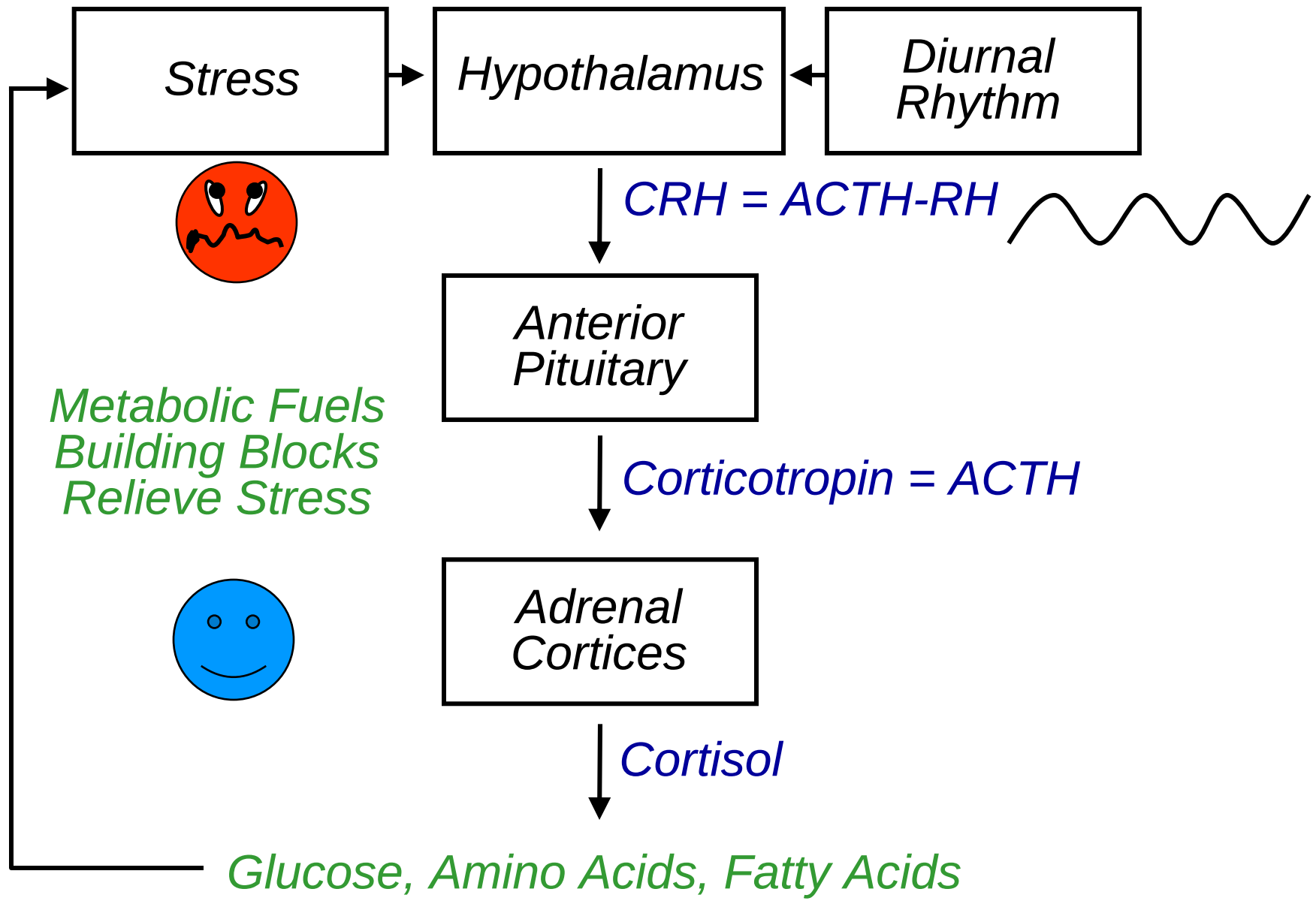
FIGURE 13-12
Adrenal Gland The adrenal glands sit atop the kidney and consist of an outer zone of cells, the adrenal cortex, which produces a variety of steroid hormones, and an inner zone, the adrenal medulla. The adrenal medulla produces adrenalin and noradrenalin.

DC 2003

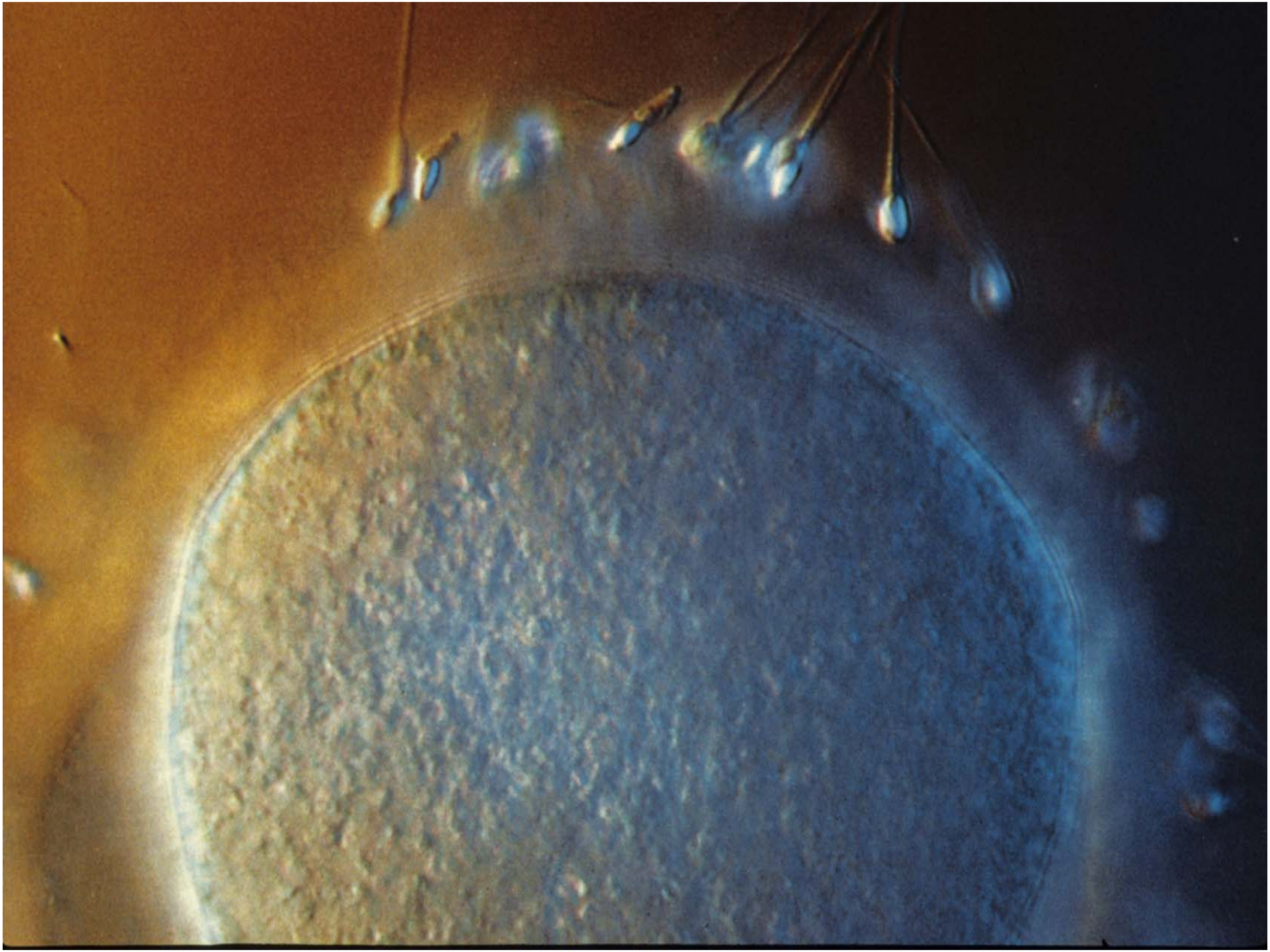
Adrenal Cortex Zones



G&H 2011 fig 77-1



SOURCE: Modified after D Chiras 2003



Biomedicine

Sex allergy: No laughing matter

The phrase "Not tonight, dear" may be a deadly serious matter for women who suffer from an allergy to their husband's seminal fluid, the liquid that carries sperm. In rare cases, such an allergic response can cause death.

The first case of an allergy to human seminal fluid was documented in 1958. Since then, the disorder has been diagnosed in a small number of cases. However, allergists believe the disorder is not readily recognized by gynecologists.

Some women with this condition report a dramatic, whole-body reaction to seminal fluid. Their symptoms include wheezing, vomiting, diarrhea, unconsciousness, or complete circulatory collapse. Other women experience a localized reaction, such as vaginal burning or swelling.

Researcher Jonathan A. Bernstein of the University of Cincinnati College of Medicine and his colleagues decided to study the prevalence of the disorder. They administered a questionnaire to 1,073 women who had reported symptoms consistent with the allergy.

Bernstein's team found that 12 percent of the women they studied met the diagnostic criteria for an allergy to seminal fluid. This result indicates that the disorder is much more common than previously suspected. The team reports its findings in the January ANNALS OF ALLERGY, ASTHMA, & IMMUNOLOGY.

Allergists can treat the condition, the researchers point out. Regular injections of purified seminal proteins can prevent the relationship-stopping symptoms, says Bernstein. —*K.F.*

Semen? G&H p 976

- **60% seminal vesicle fluid - mucoid, PGE_2, fructose, fibrinogen**
- **30% prostatic fluid - $NaHCO_3$, clotting enzyme, Ca^{2+}, profibrinolysin**
- **10% sperm + vas deferens fluid**

Mom's eggs execute Dad's mitochondria

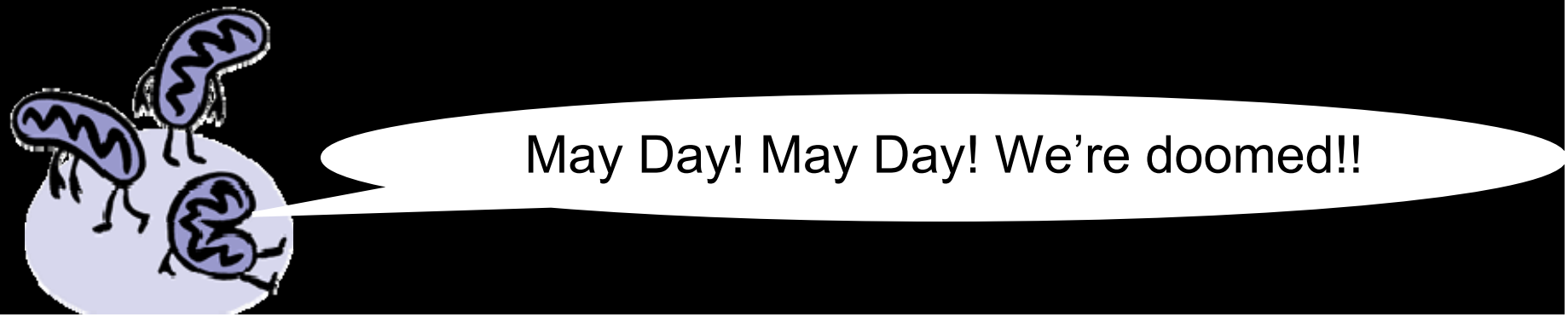
In "Hamlet," Rosencrantz and Guildenstern deliver a letter to the rulers of England that carries the ill-fated duo's own death sentence. Perhaps Shakespeare knew a bit about reproductive biology.

Scientists have now found that during a sperm's creation, its mitochondria—energy-producing units that power all cells—acquire molecular tags that mark them for destruction once the sperm fertilizes an egg. This death sentence, a protein called ubiquitin, may explain why mammals inherit the DNA within mitochondria only from their mothers, a biological curiosity geneticists have used to trace human evolution (SN: 2/6/99, p. 88). The finding may also have implications

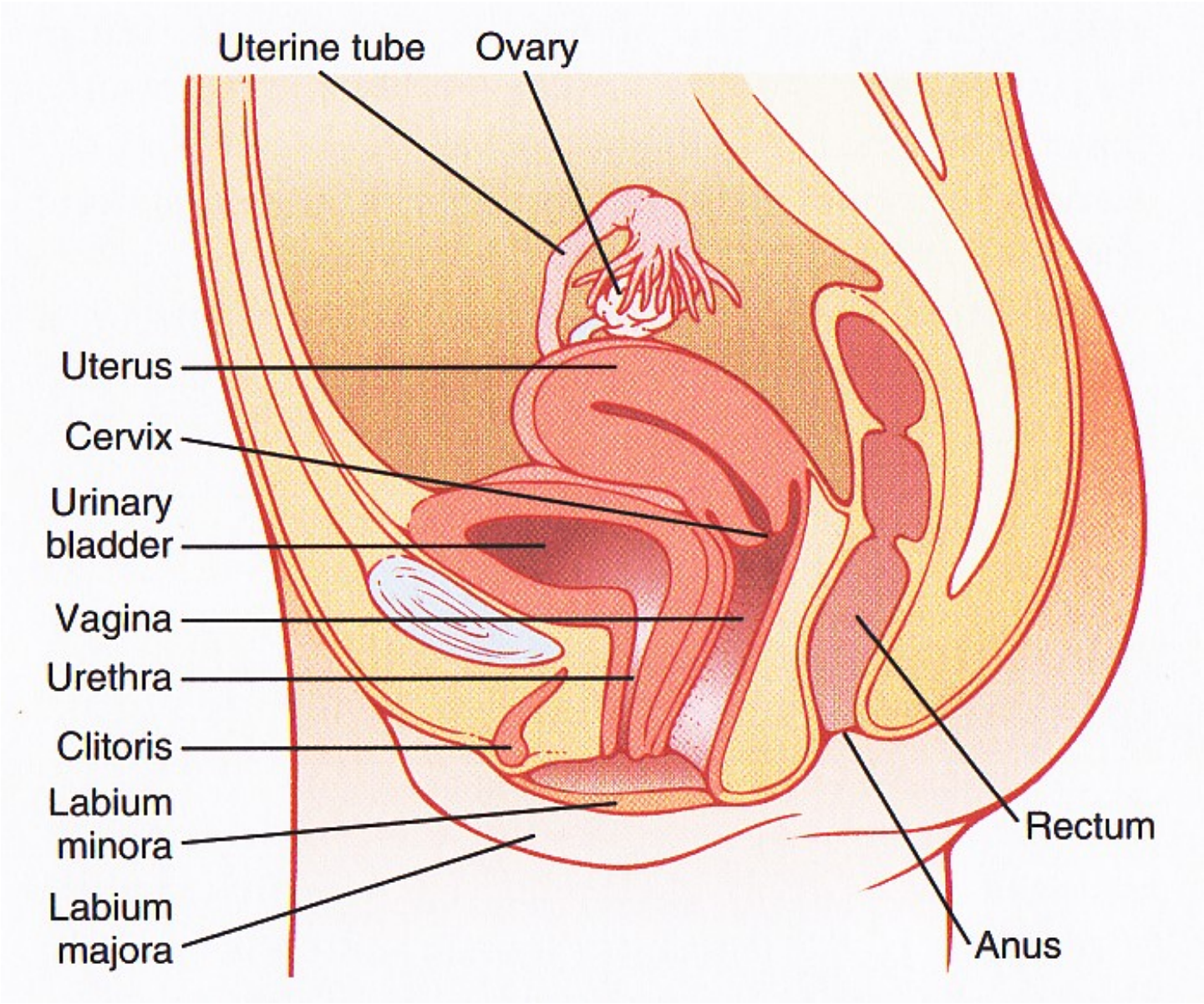
species mitochondrial inheritance. Sperm mitochondria sometimes avoid destruction when two different species of mice mate, and Schatten's team has shown this also holds true in cattle. It's hard to understand how an egg distinguishes between paternal mitochondria of closely related species, says Schon.

When paternal mitochondria escape destruction in normal mating, the resulting embryo may suffer. Schatten notes that a colleague has found sperm mitochondria in some defective embryos from infertility clinics.

The success of cloning may depend on an egg's ability to destroy foreign mitochondria. In the technique used to create

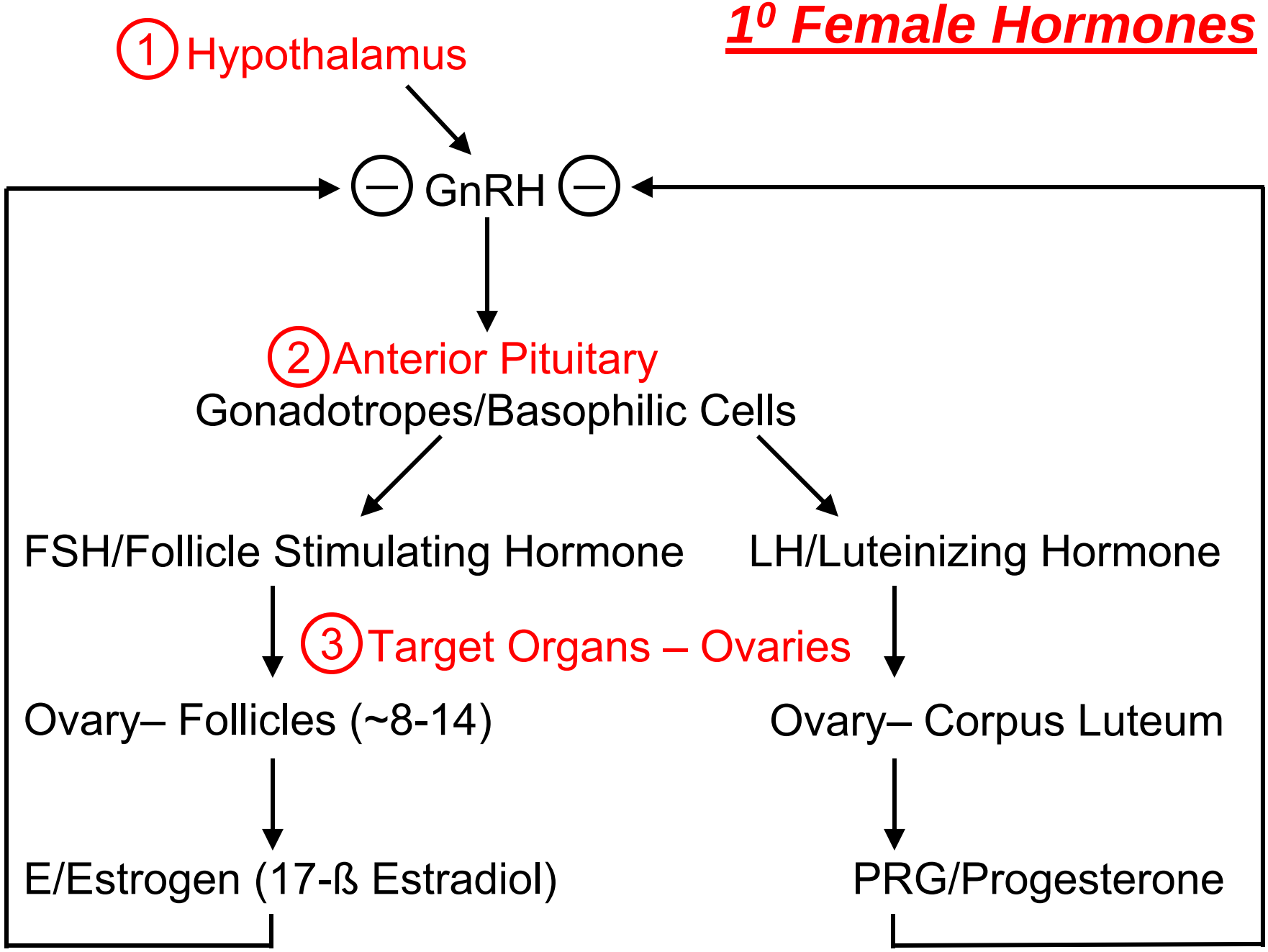


Female Reproductive System



G&H 2011 fig 81-1

1^0 Female Hormones

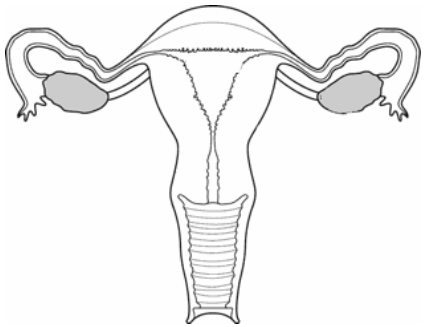


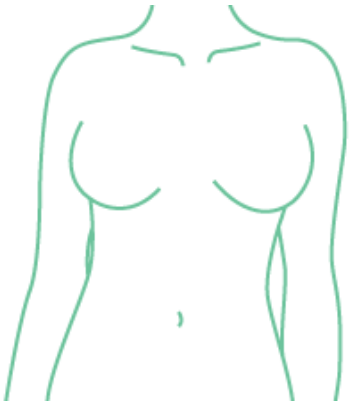
What Do Estrogen & Progesterone Do?

Estrogen – E

Growth & Development of:

1. Ovaries, fallopian tubes, uterus, vagina, external genitalia
2. Breasts stroma, ductile systems, adipocytes
3. Skeleton → osteoblastic activity



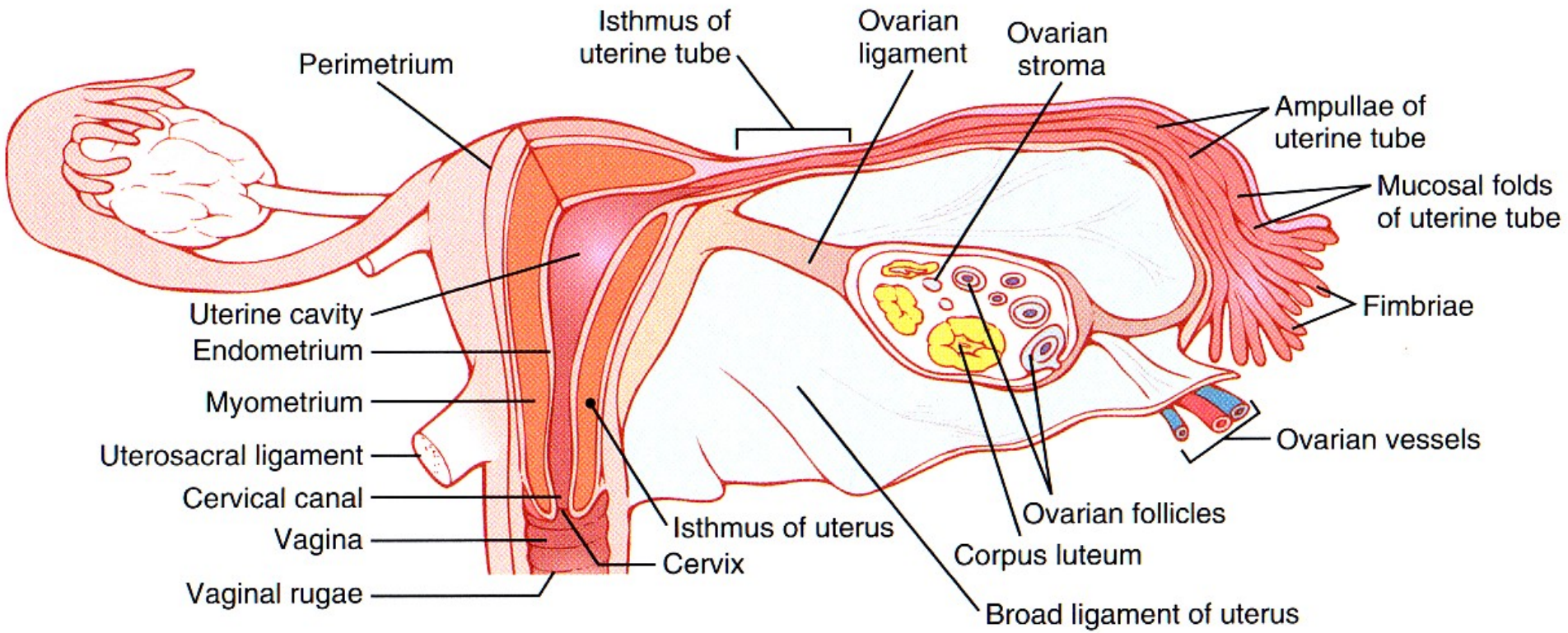


Progesterone – PRG

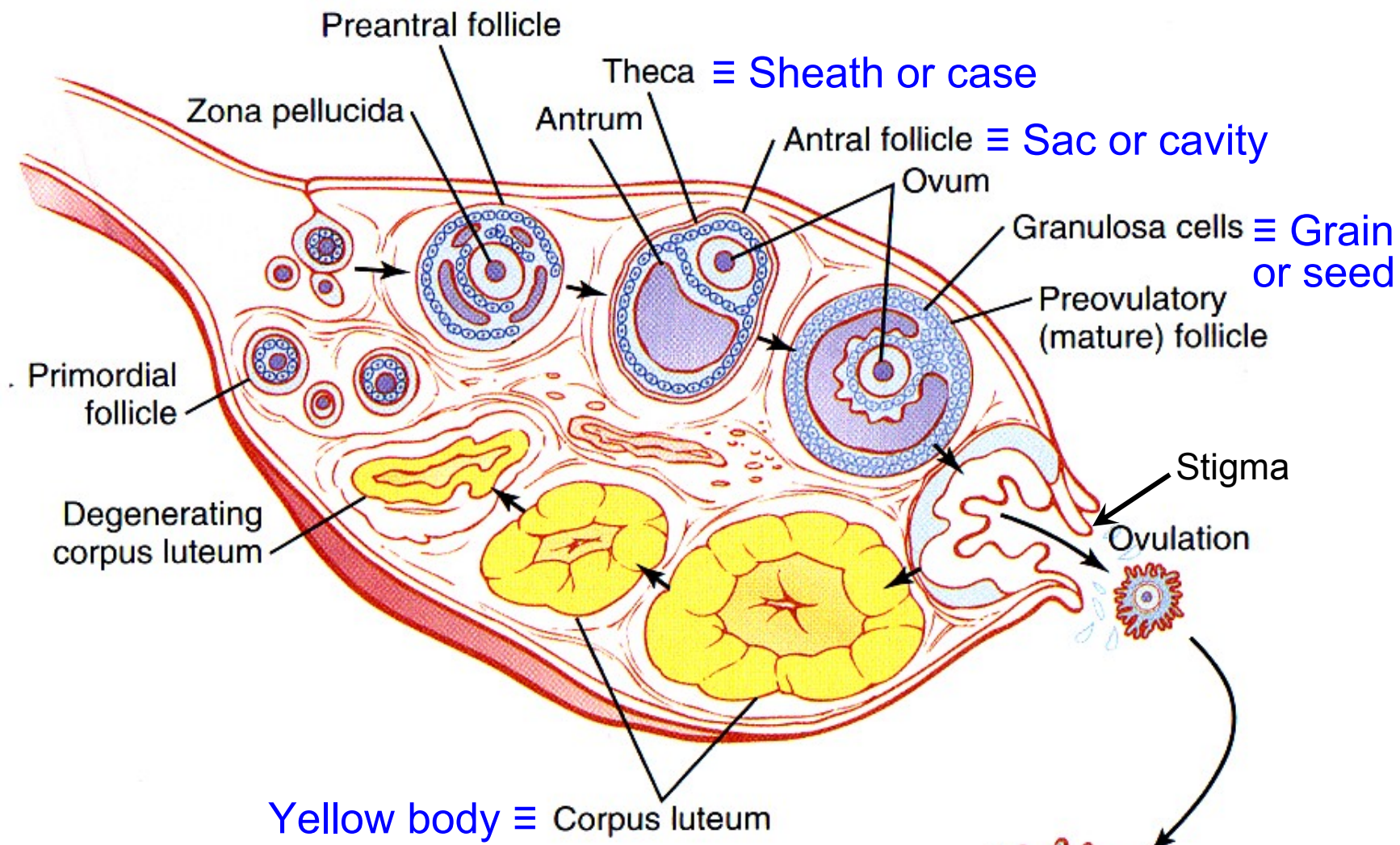
Promotes Progestation!

1. Uterus: endometrium Secretory Δ during last ½ of monthly cycle
2. Breasts: ↑ lobules & alveoli
3. Uterus: smooth muscle ↓ excitability & motility
4. Hypothalamus: ↑ body temp ~ 0.5 ^{0}F

Uterus, Ovary & Uterine/Fallopian Tube

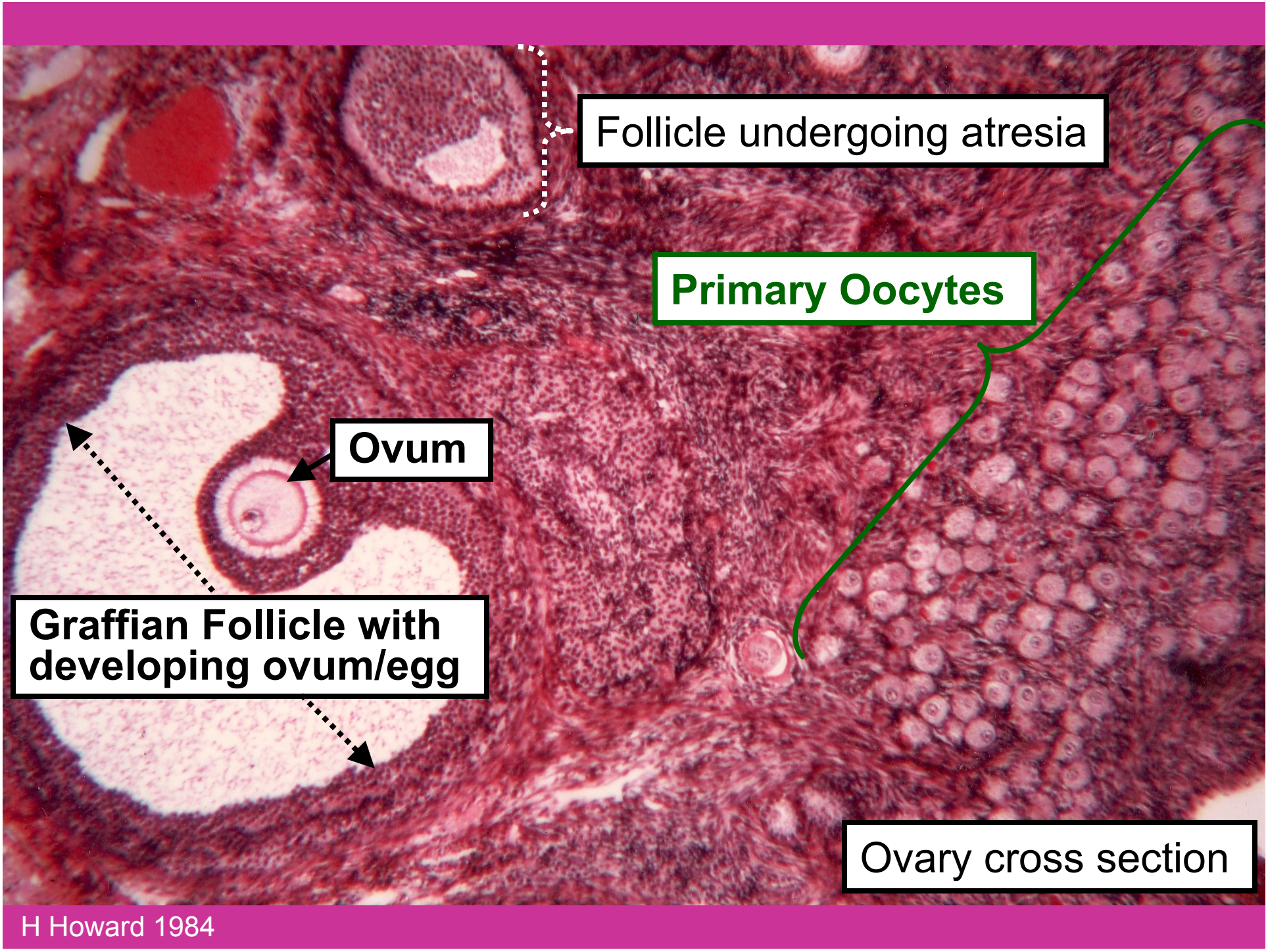


G&H 2011 fig 81-2



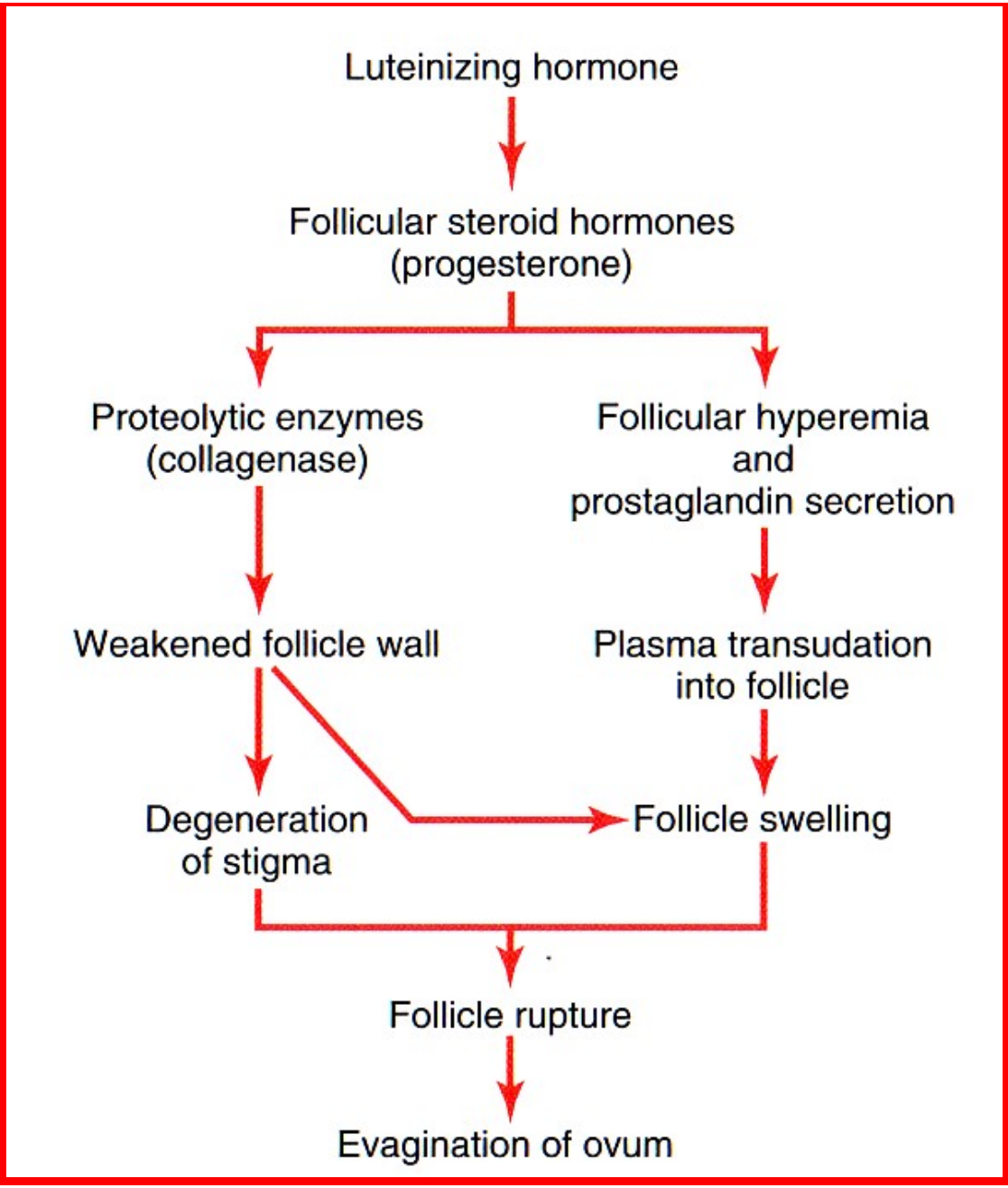
Ovary 1.5-3.0 cm
Ovum ~100 μ

G&H 2011 fig 81-4

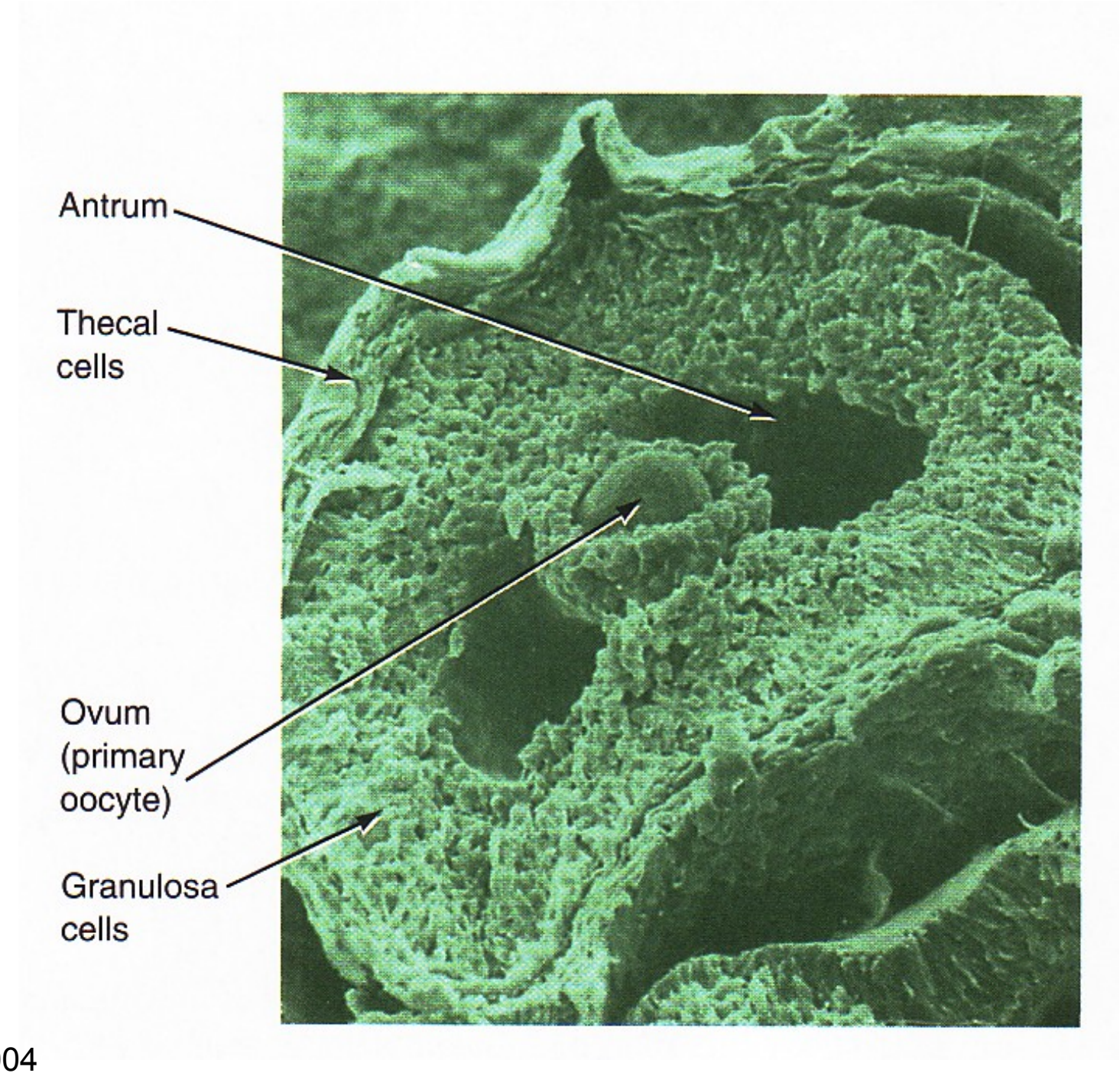


H Howard 1984

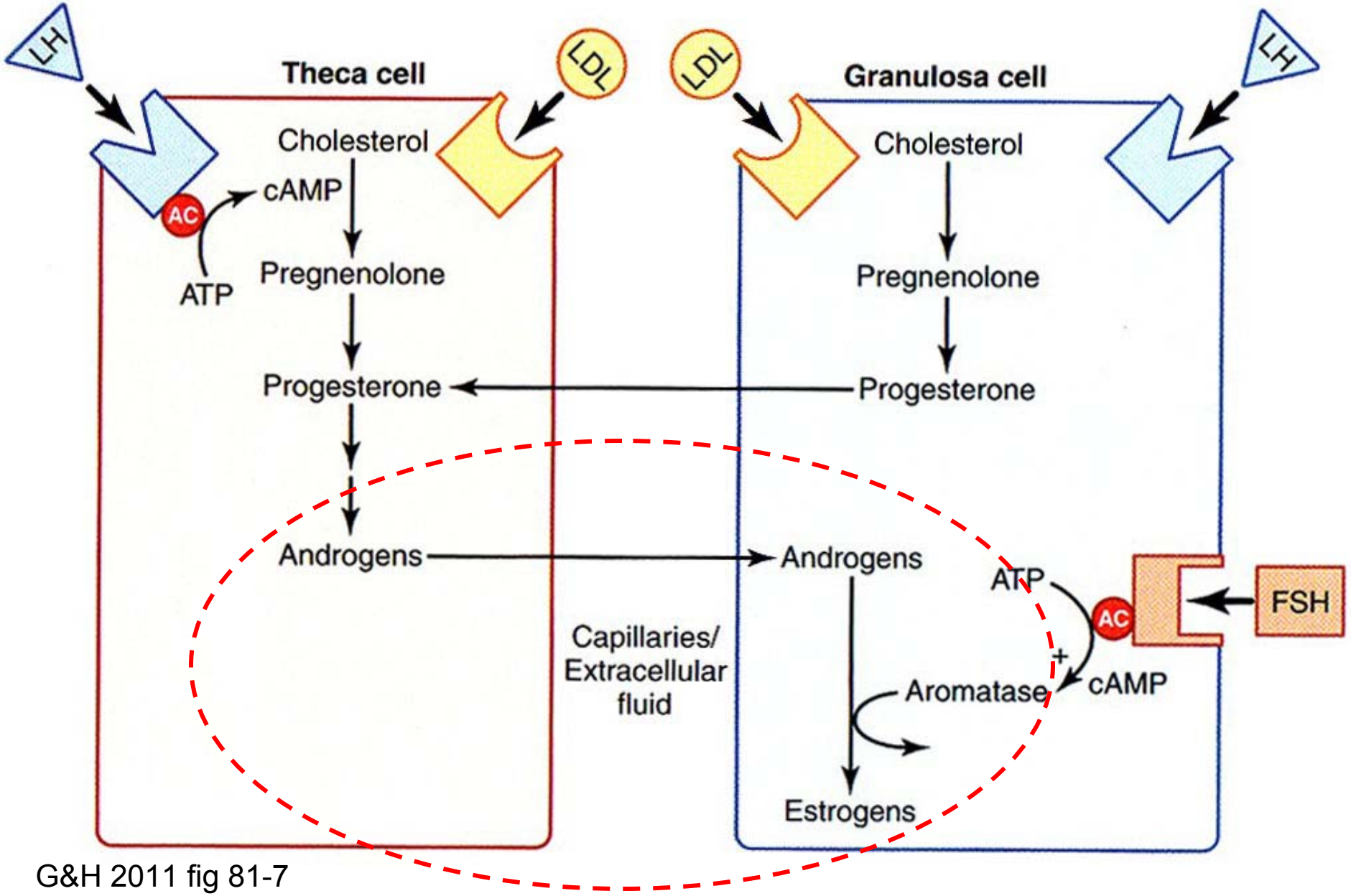
Proposed Ovulation Mechanism



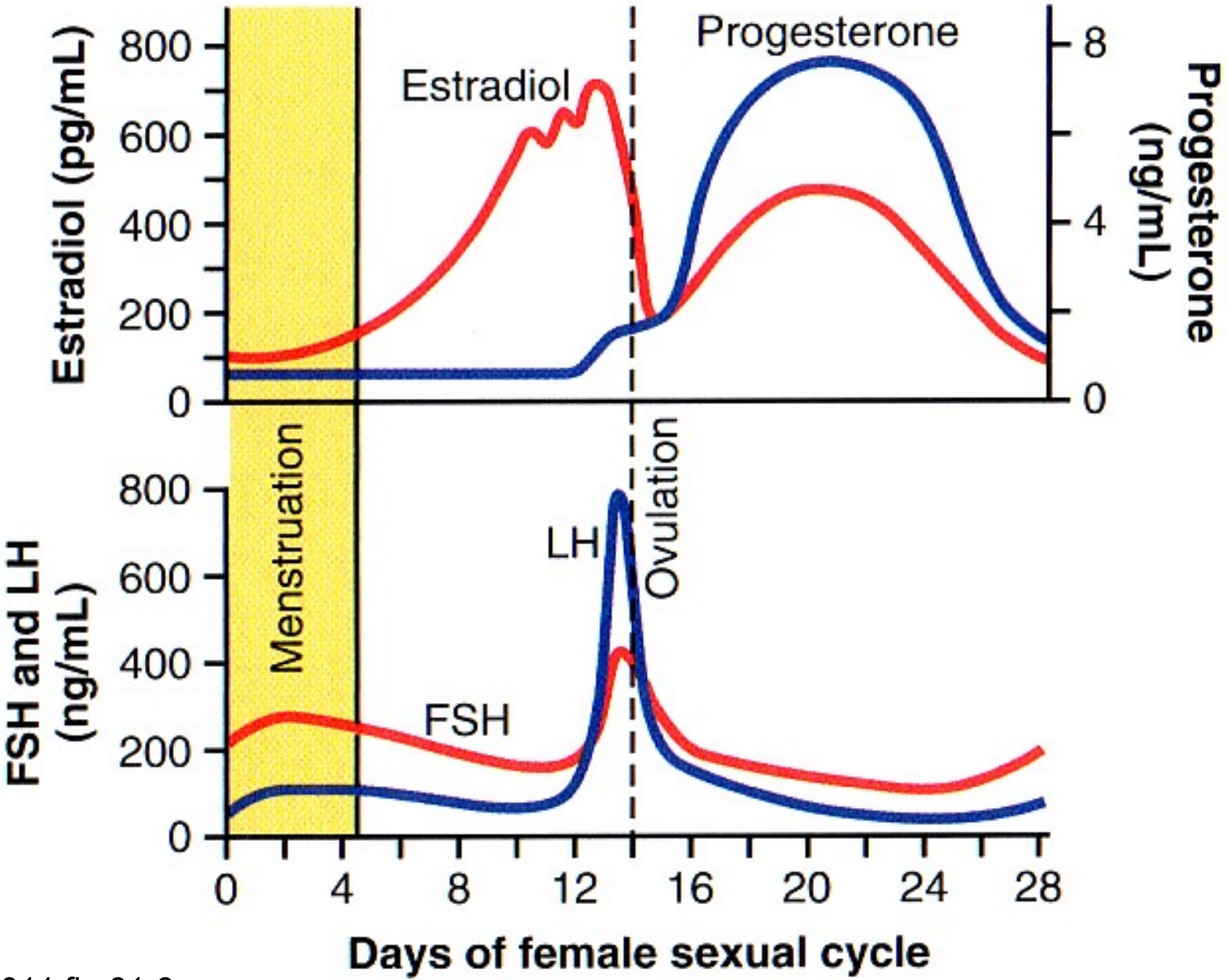
G&H 2011 fig 81-5


Antrum
Thecal cells
Ovum (primary oocyte)
Granulosa cells

Estrogen Production: Theca & Granulosa Cell Interaction



G&H 2011 fig 81-7



G&H 2011 fig 81-3

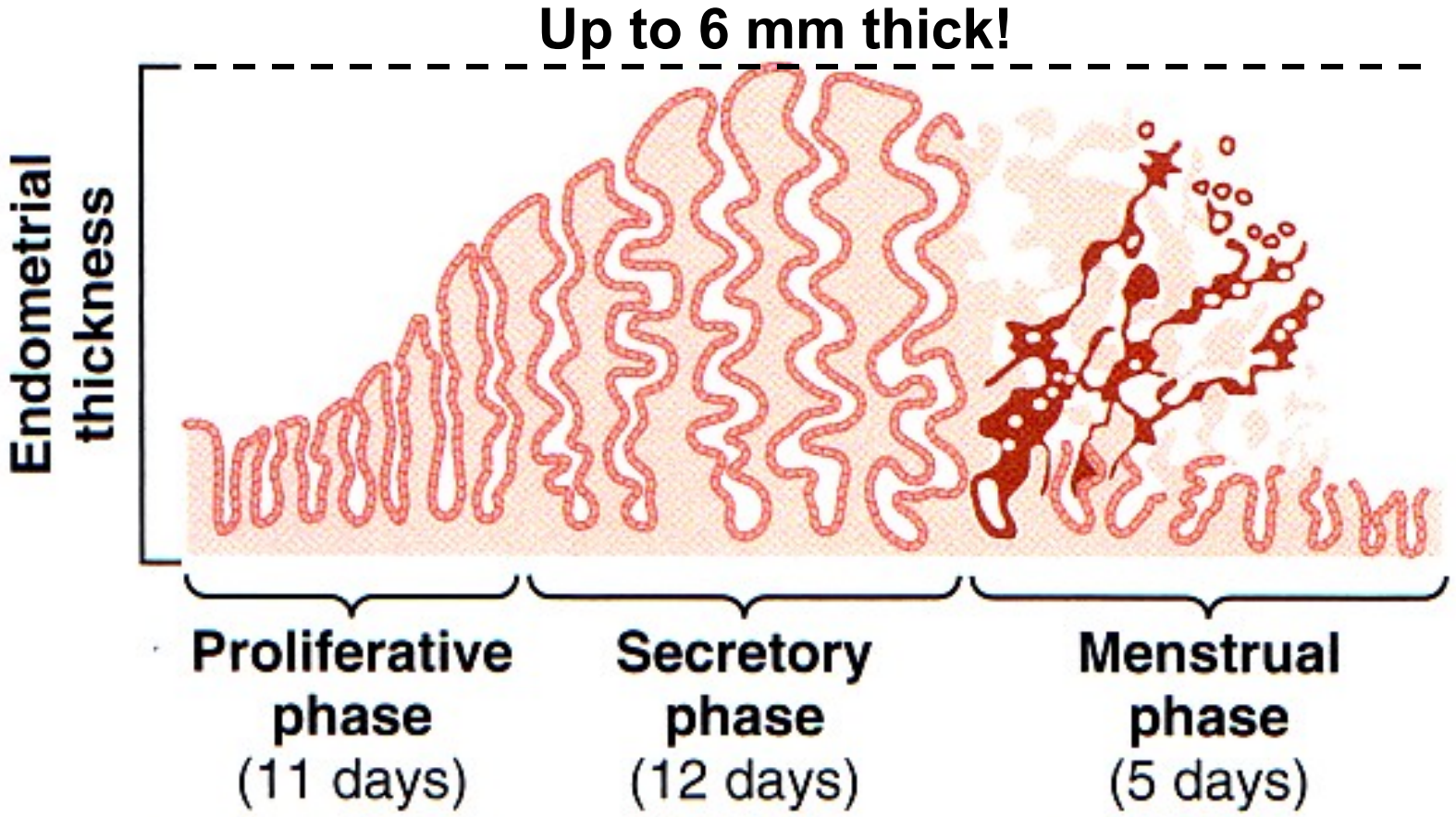
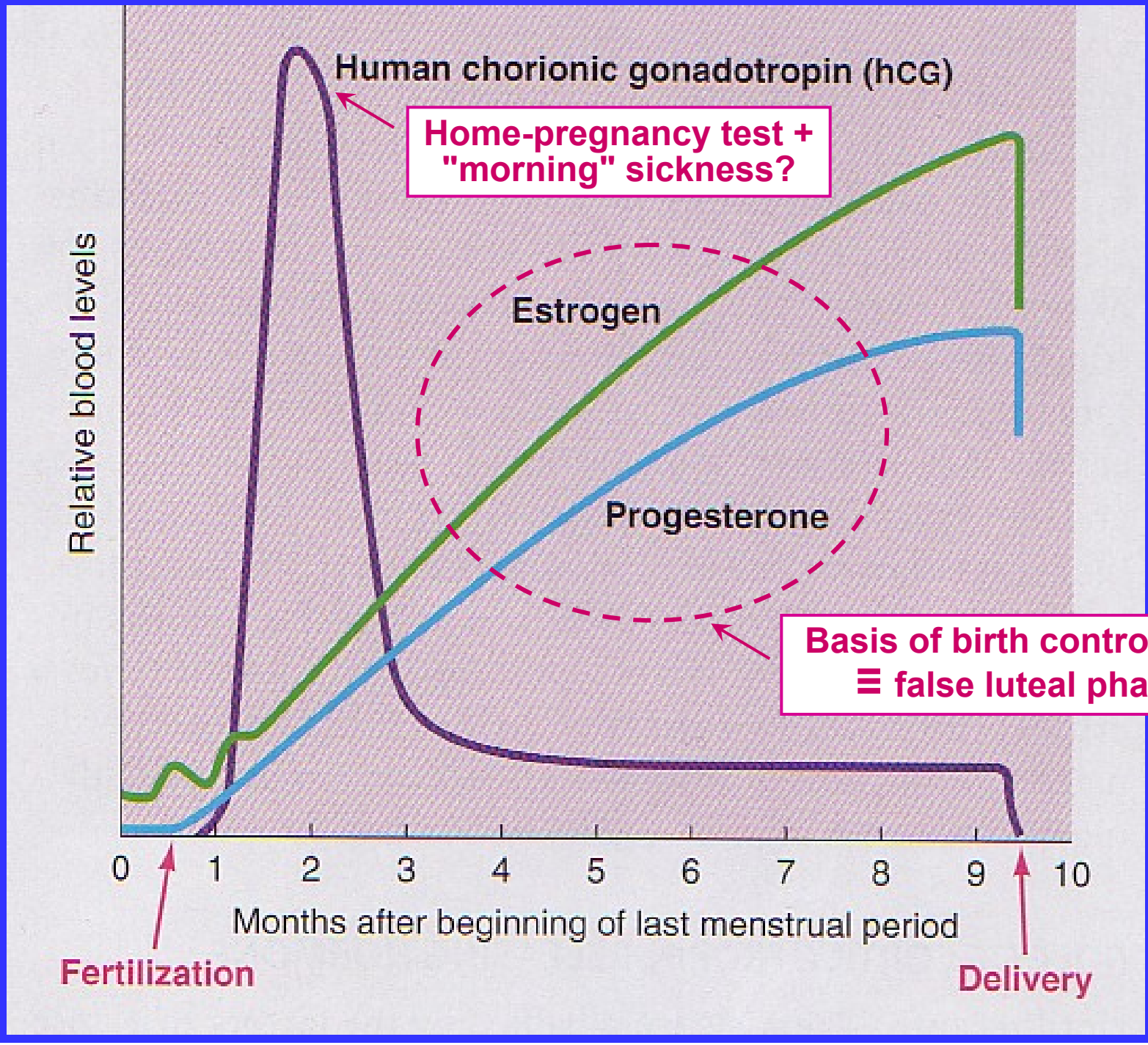
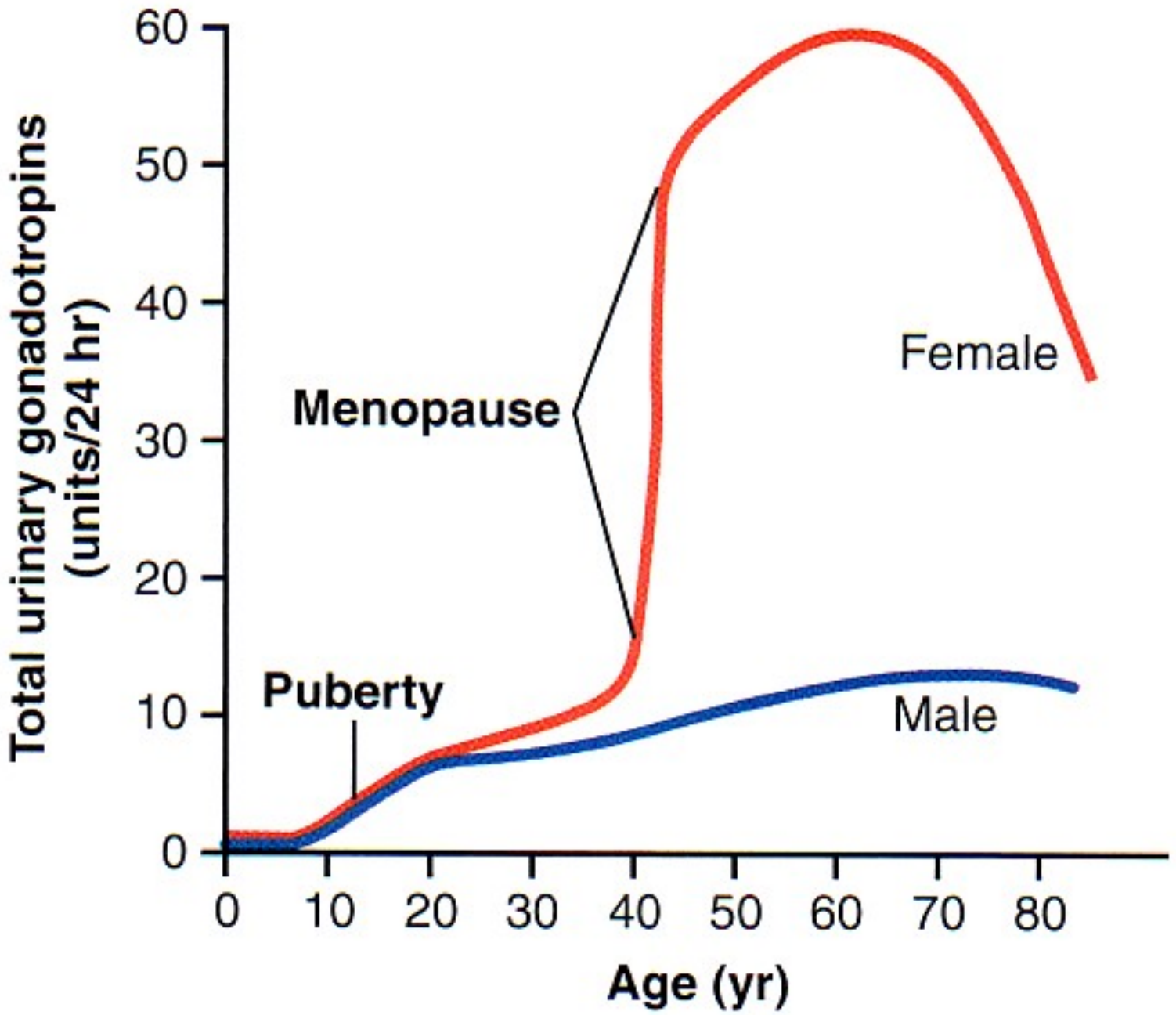


Figure 81-8 Phases of endometrial growth and menstruation during each monthly female sexual cycle.

G&H 2011


Human chorionic gonadotropin (hCG)
Home-pregnancy test +
"morning" sickness?
Estrogen
Progesterone
Basis of birth control pills
≡ false luteal phase
Relative blood levels
0
1
2
3
4
5
6
7
8
9
10
Months after beginning of last menstrual period
Fertilization
Delivery

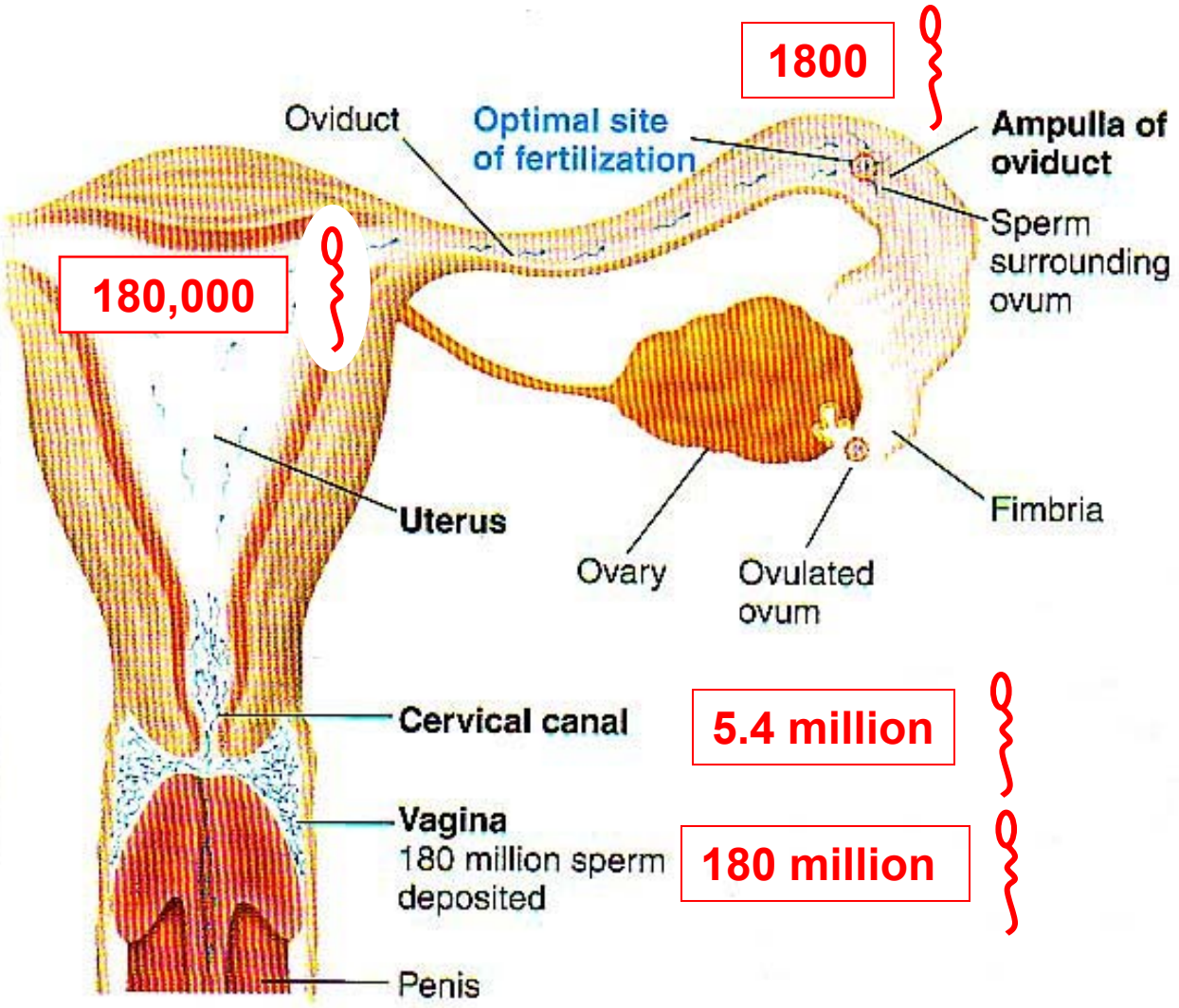
LS2
2008



G&H 2011 fig 81-11

Location	Time of appearance (min after ejaculation)	Percent of ejaculated sperm*
Fertilization site (upper third of oviduct)	30–60	0.001
Uterus	10–20	0.1
Cervical canal	1–3	3
Vagina	0	100

*Based on data from animals.
Sperm and ovum enlarged.



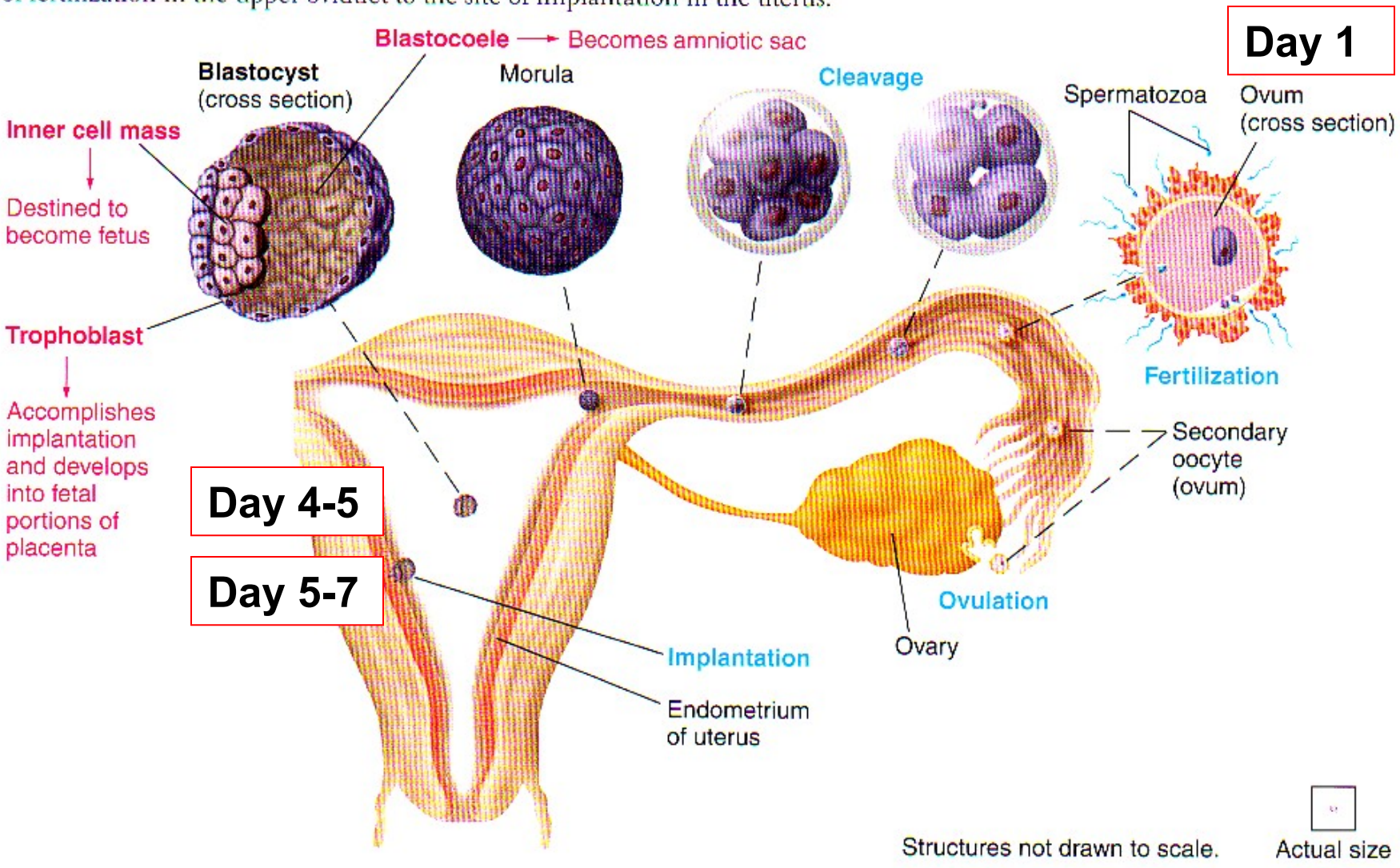
● FIGURE 20-20
Ovum and sperm transport to the site of fertilization

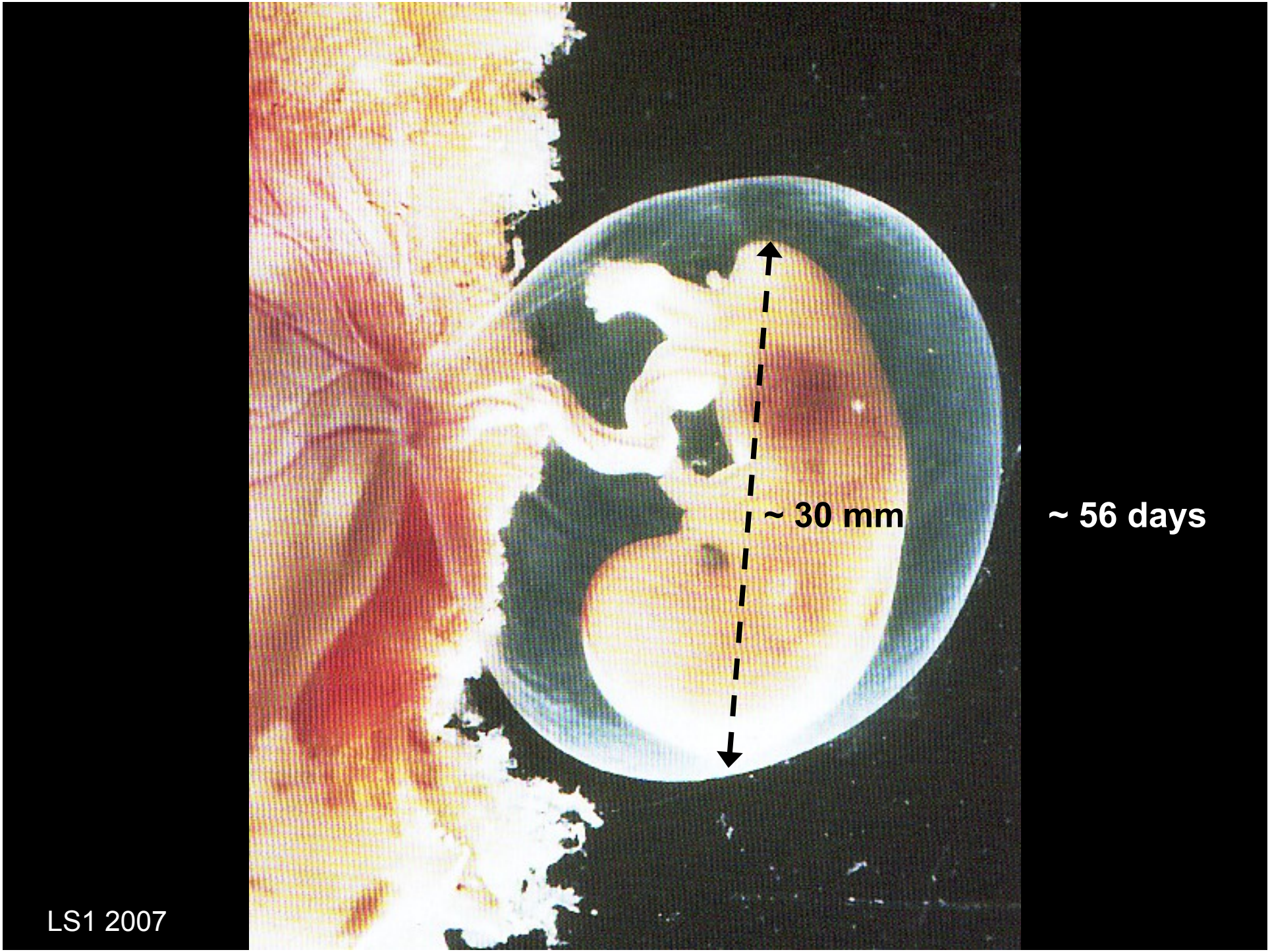
LS1 2004; LS2 2012

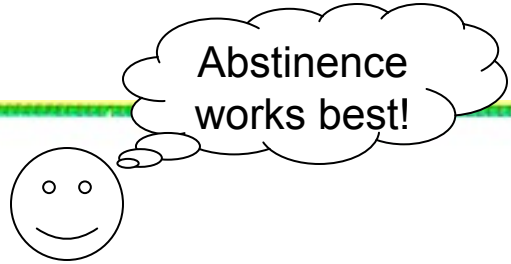
● FIGURE 20-23

Early stages of development from fertilization to implantation

Note that the fertilized ovum progressively divides and differentiates into a blastocyst as it moves from the site of fertilization in the upper oviduct to the site of implantation in the uterus.

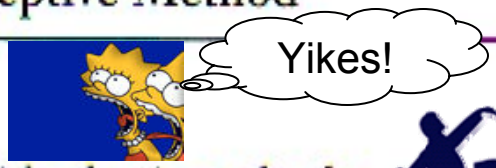


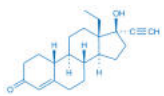

~ 30 mm
~ 56 days
LS1 2007

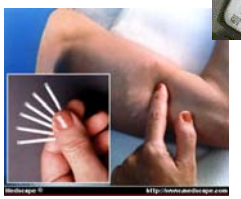


Average Failure Rate of Various Contraceptive Techniques

Contraceptive Method	Average Failure Rate (annual pregnancies/ 100 women)
None	90
Natural (rhythm) methods	20–30
Coitus interruptus	23
Chemical contraceptives	20
Barrier methods	10–15
Oral contraceptives	2–2.5
Implanted contraceptives	1
Intrauterine device	4





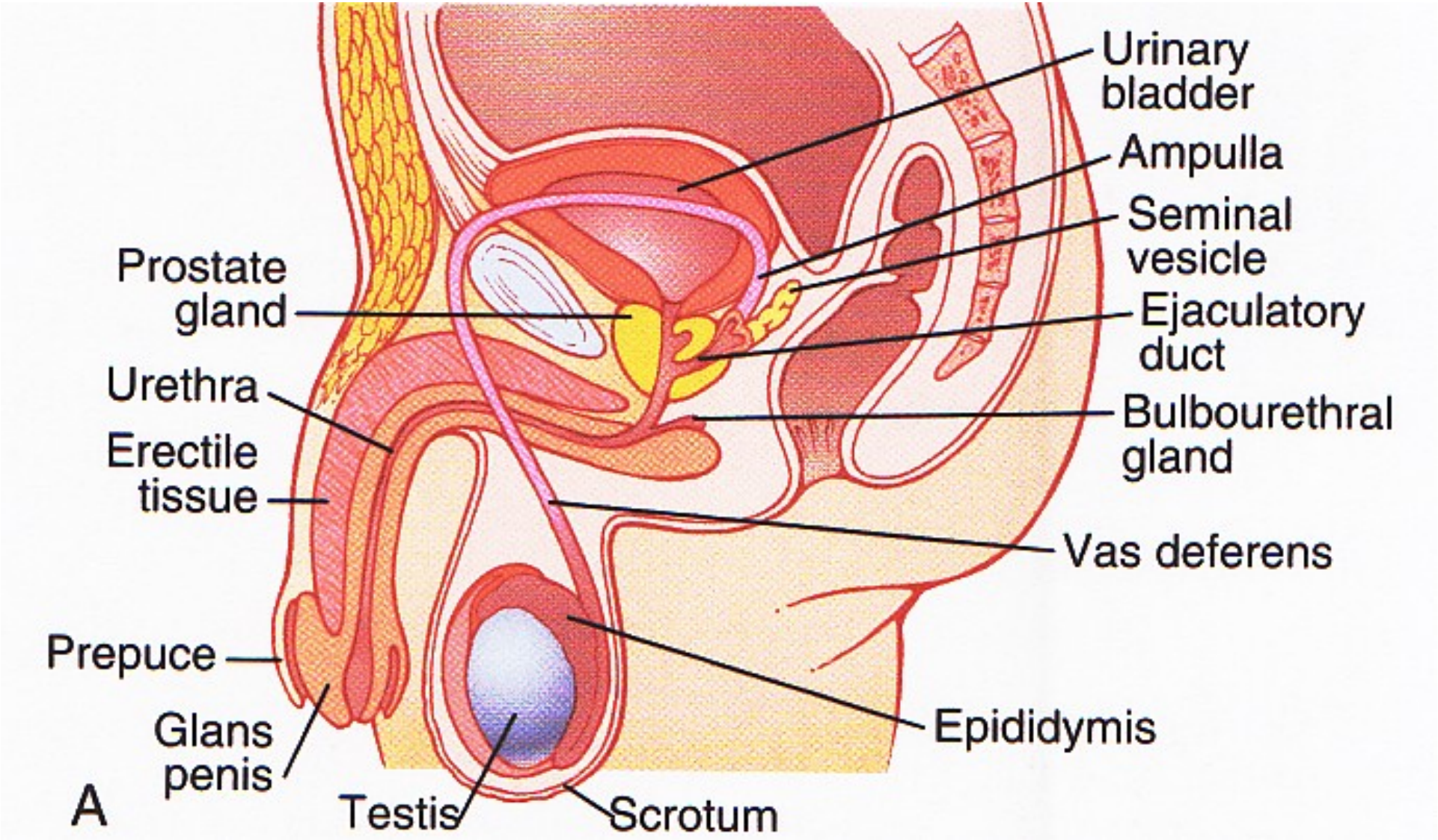


Important Facts

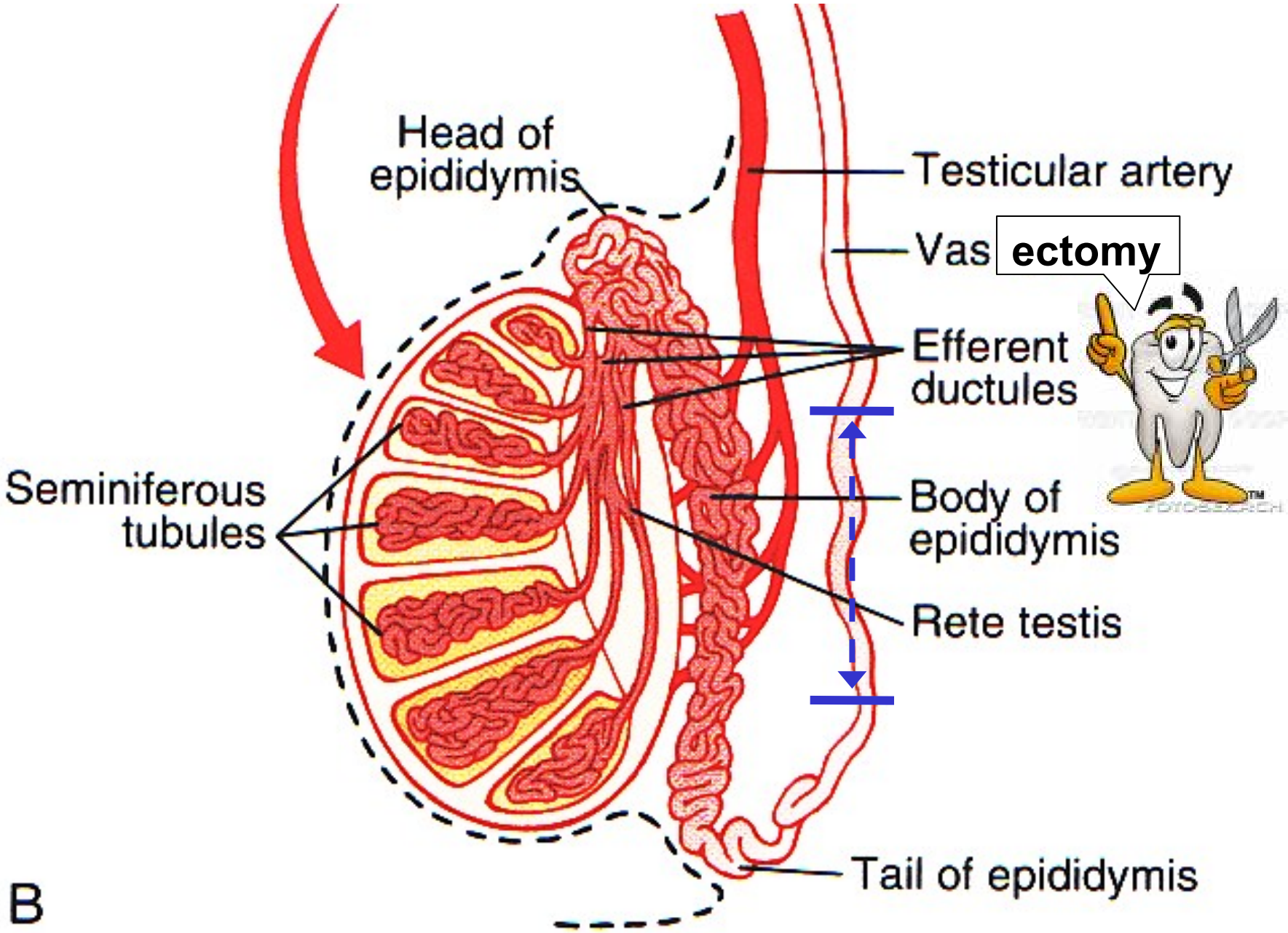
- 6.4 Million pregnancies, ½ unwanted in US/yr
- 1.6 Million end in abortion
- Sperm survive for 48 hr to 5 d in female reproductive tract
- Eggs start to disintegrate 12-24 hr > ovulation
- Ovulation varies & may be tough to predict…

http://www.cdc.gov/nchs/fastats/births.htm
http://www.who.int/reproductivehealth/en/
http://www.kinseyinstitute.org/research/index.html
http://www.kinseyinstitute.org/resources/FAQ.html

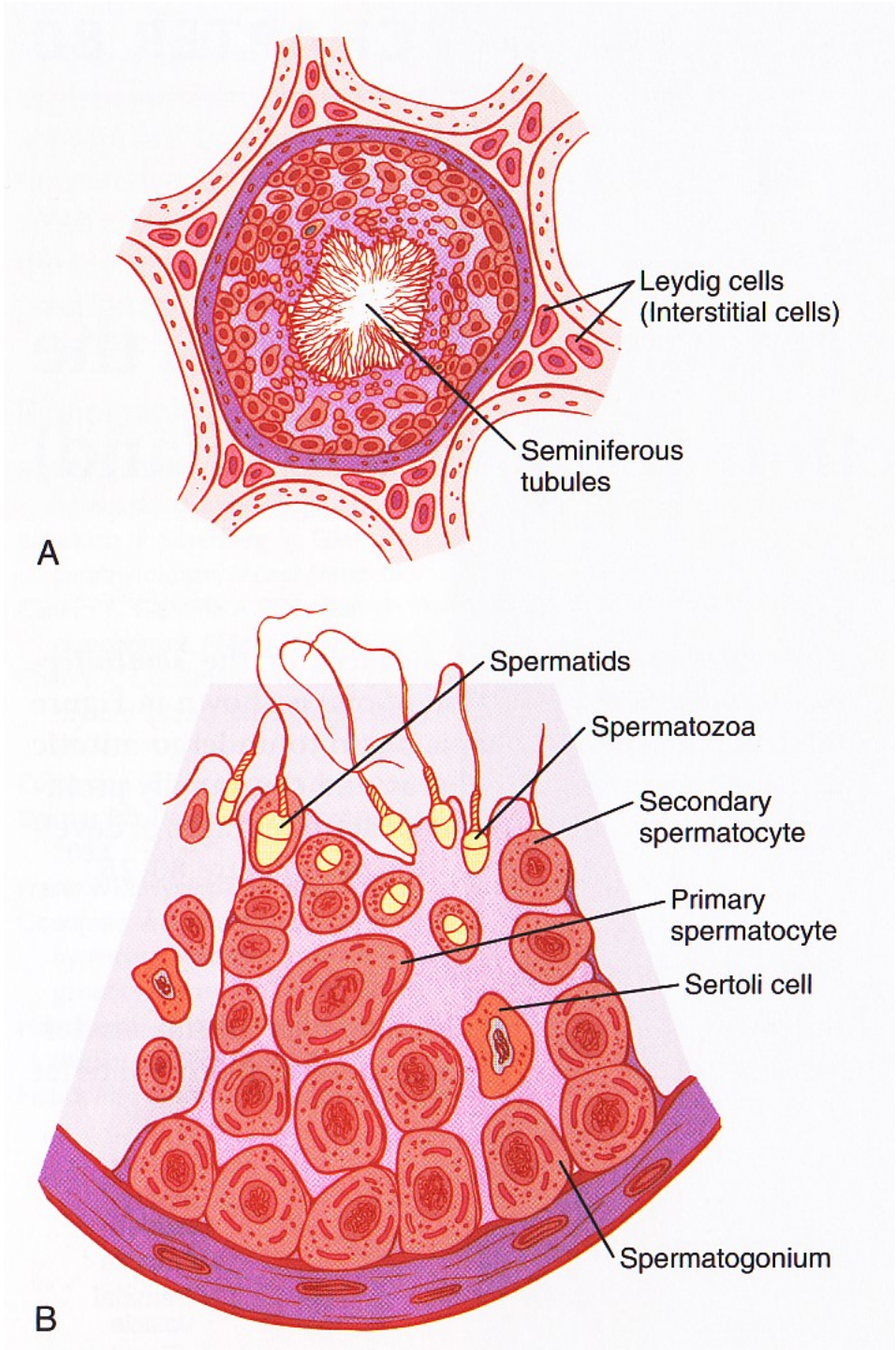
Male Reproductive System



G&H 2011 fig 80-1 A



G&H 2011 fig 80-1 B



G&H 2011 fig 80-2

→ T ≡ Testosterone

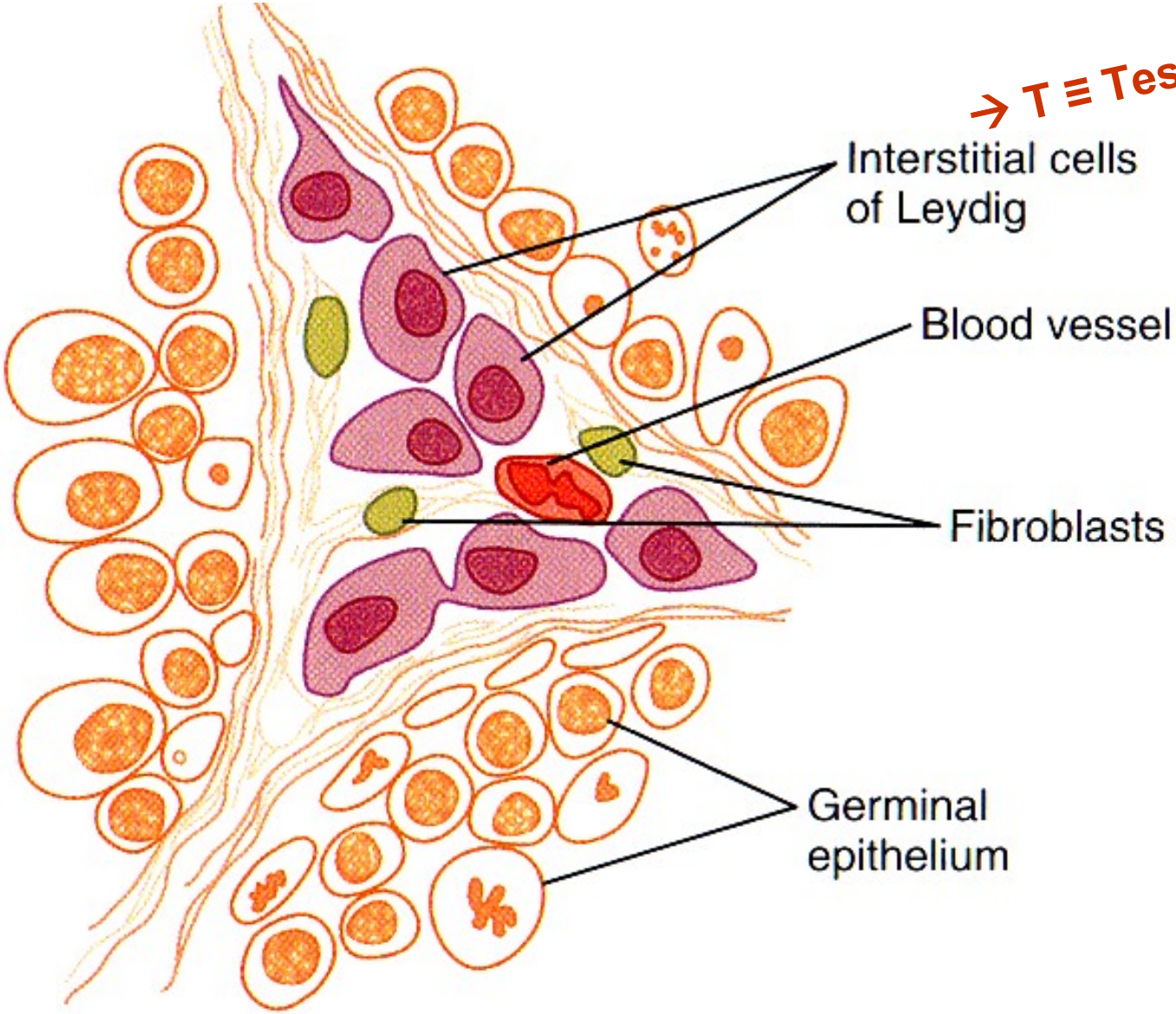
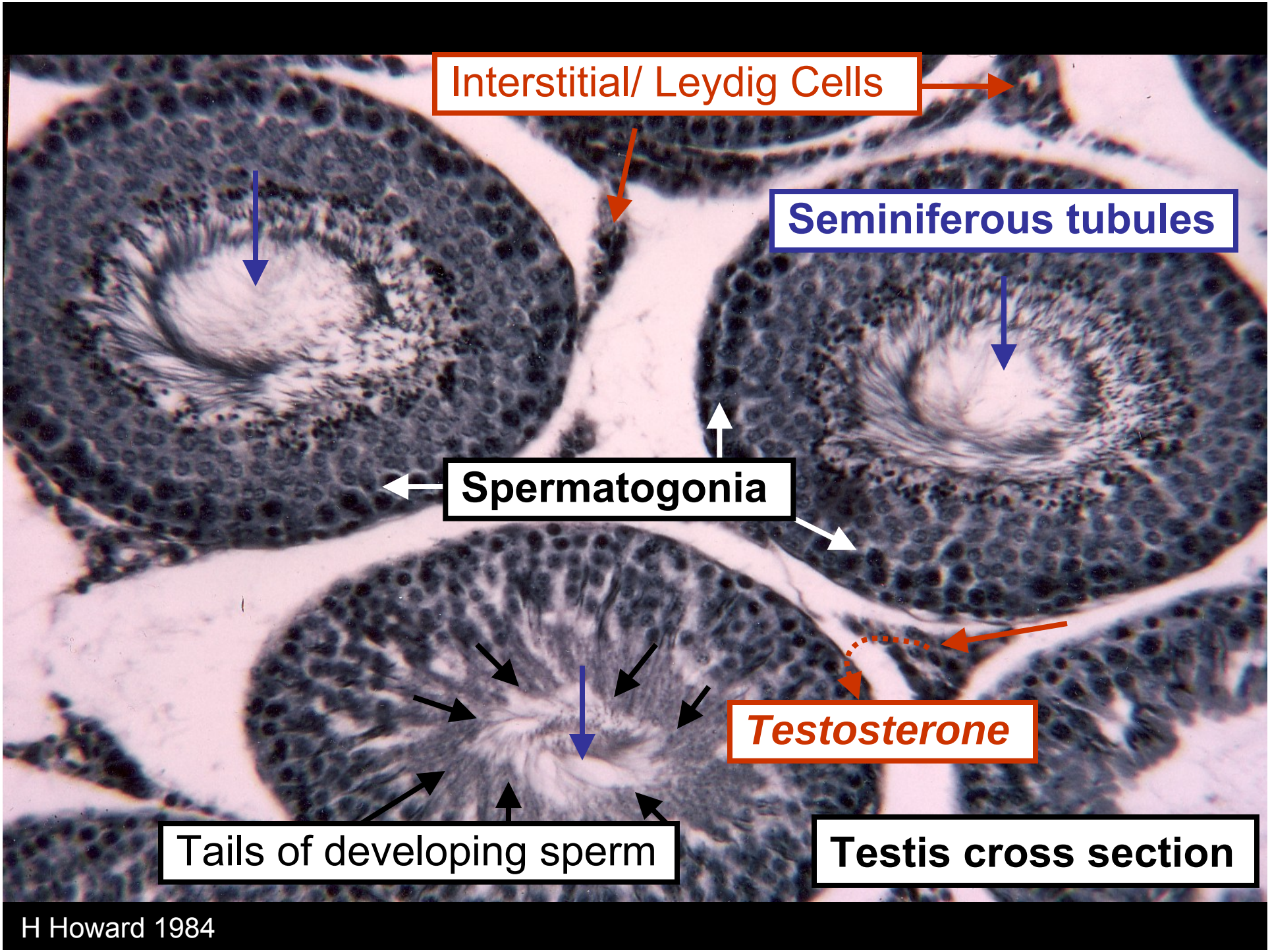


Figure 80-7 Interstitial cells of Leydig, the cells that secrete testosterone, located in the interstices between the seminiferous tubules.


Interstitial/ Leydig Cells
Seminiferous tubules
Spermatogonia
Testosterone
Tails of developing sperm
Testis cross section
H Howard 1984

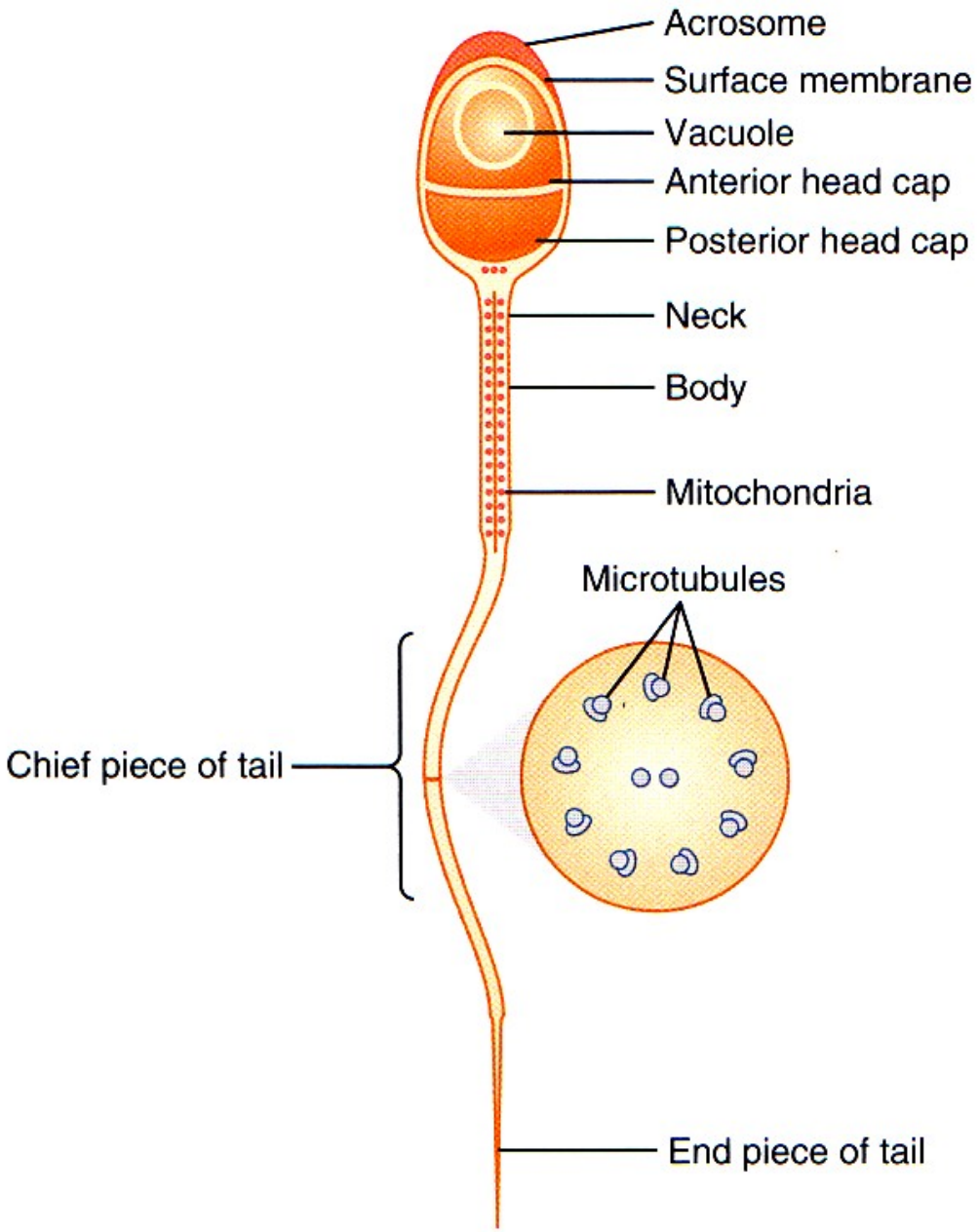


Figure 80-4 Structure of the human spermatozoon.

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LS1 2007

LS1 2007

Figure 80-5 Abnormal infertile sperm, compared with a normal sperm on the right.

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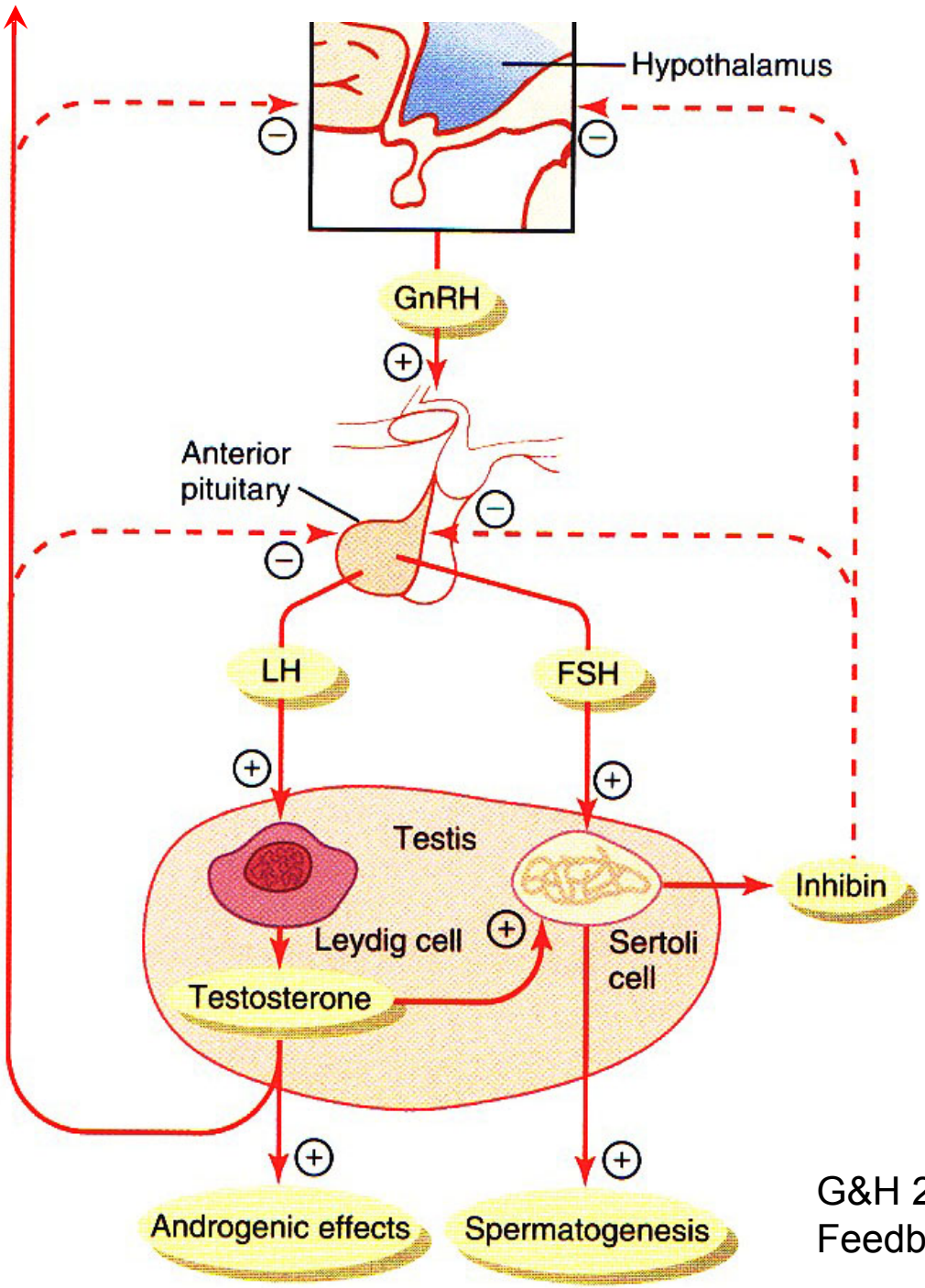
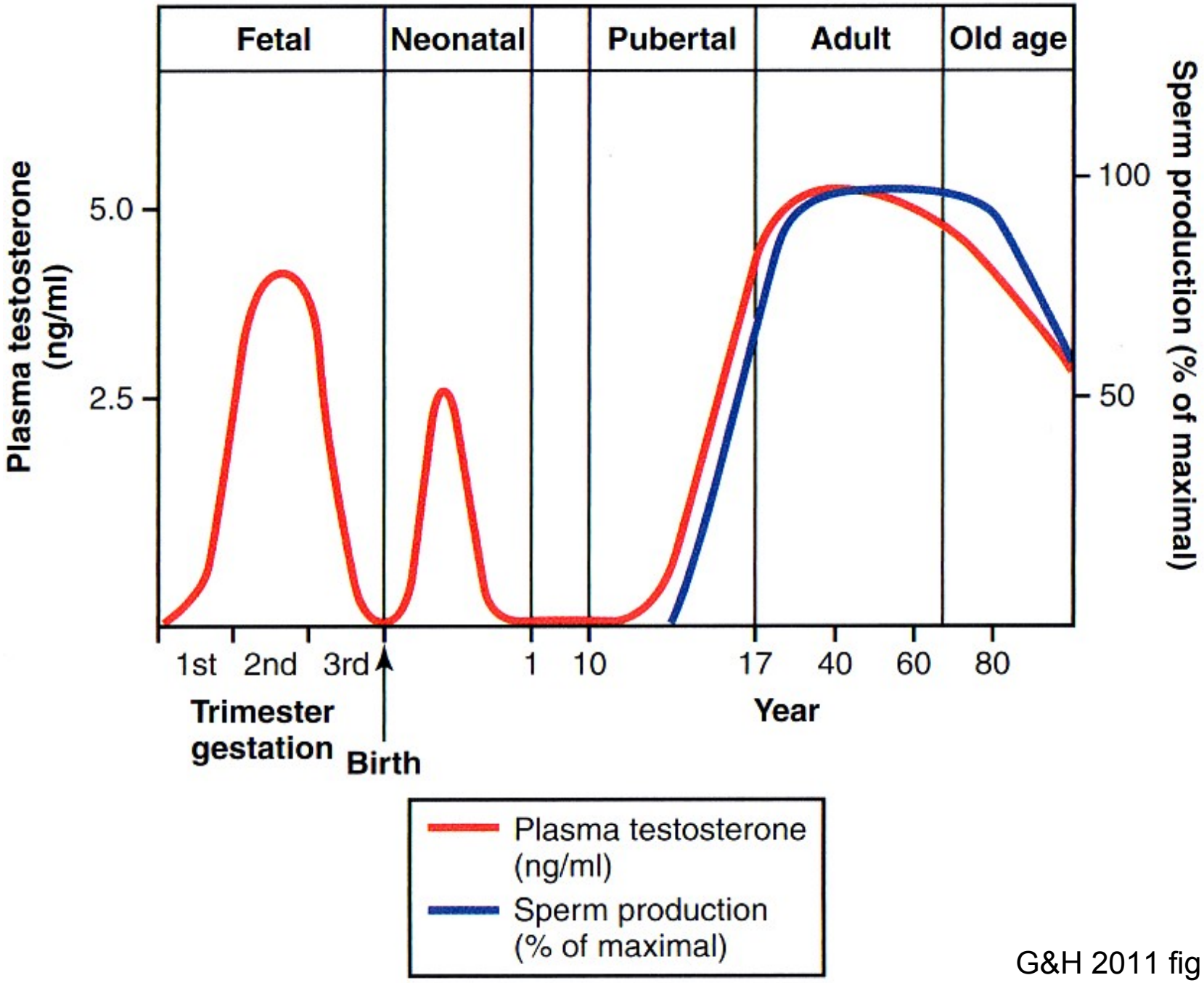


G&H 2011 fig 80-10
Feedback regulation in males



G&H 2011 fig 80-9