

Pituitary gland



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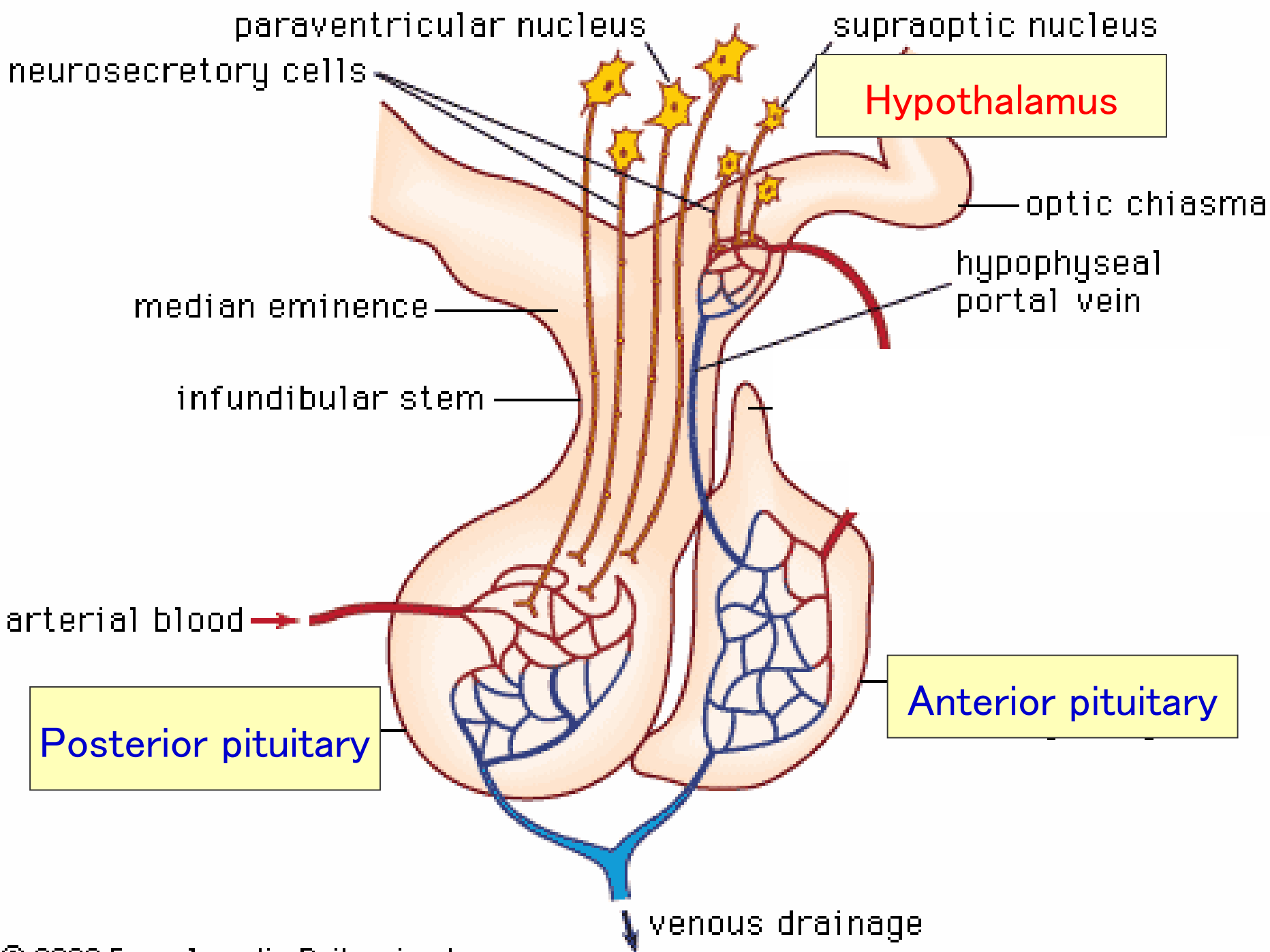
Pituitary gland

3 lobes

1. Anterior lobe

2. Intermediate lobe - Rudimentary in humans

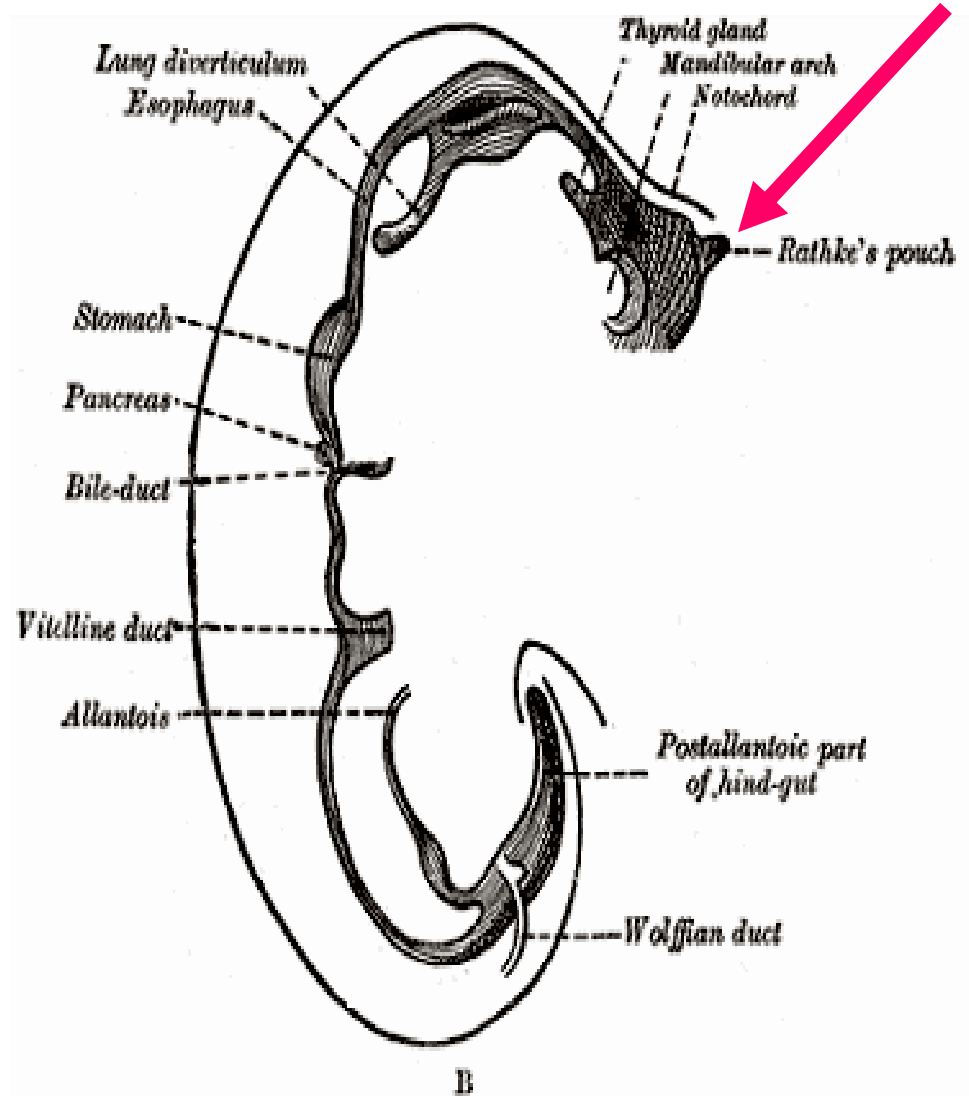
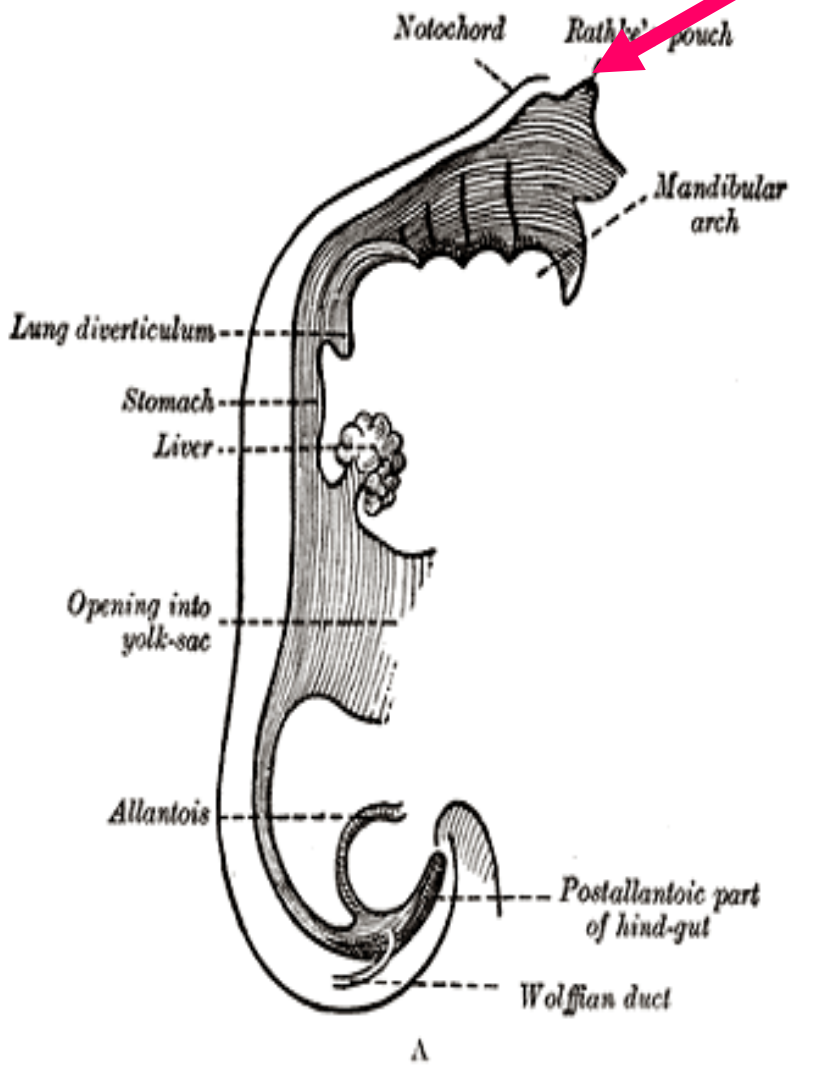
3. Posterior lobe



Anterior pituitary

- Derive from Rathke's pouch
- Consists of cords of cells with fenestrated sinusoidal capillaries
- 2 main cell types in staining
 - Chromophils – acidophils and basophils
 - Chromophobes

Rathke's pouch



Objectives

- List the hormones secreted from the anterior pituitary and describe their functions
- Describe the synthesis and secretion, transport, feedback regulation and disorders caused by deficiency and excess of the following hormones
 - Growth hormone
 - Prolactin

Hormones of the anterior pituitary



Hormones produced by the anterior pituitary

1. Growth hormone
2. Prolactin
3. Adrenocorticotrophic hormone (ACTH)
4. Thyroid stimulating hormone (TSH)
5. Follicle stimulating hormone (FSH)
6. Leutinizing hormone (LH)

Secretion of anterior pituitary hormones

- Acidophilic cells
 - Somatotrope – growth hormone
 - Lactotrope – prolactin
- Basophilic cells
 - Corticotrope – ACTH
 - Thyrotrope – TSH
 - Gonadotrope – FSH, LH

**Neurosecretory
neurons**

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Hypothalamus

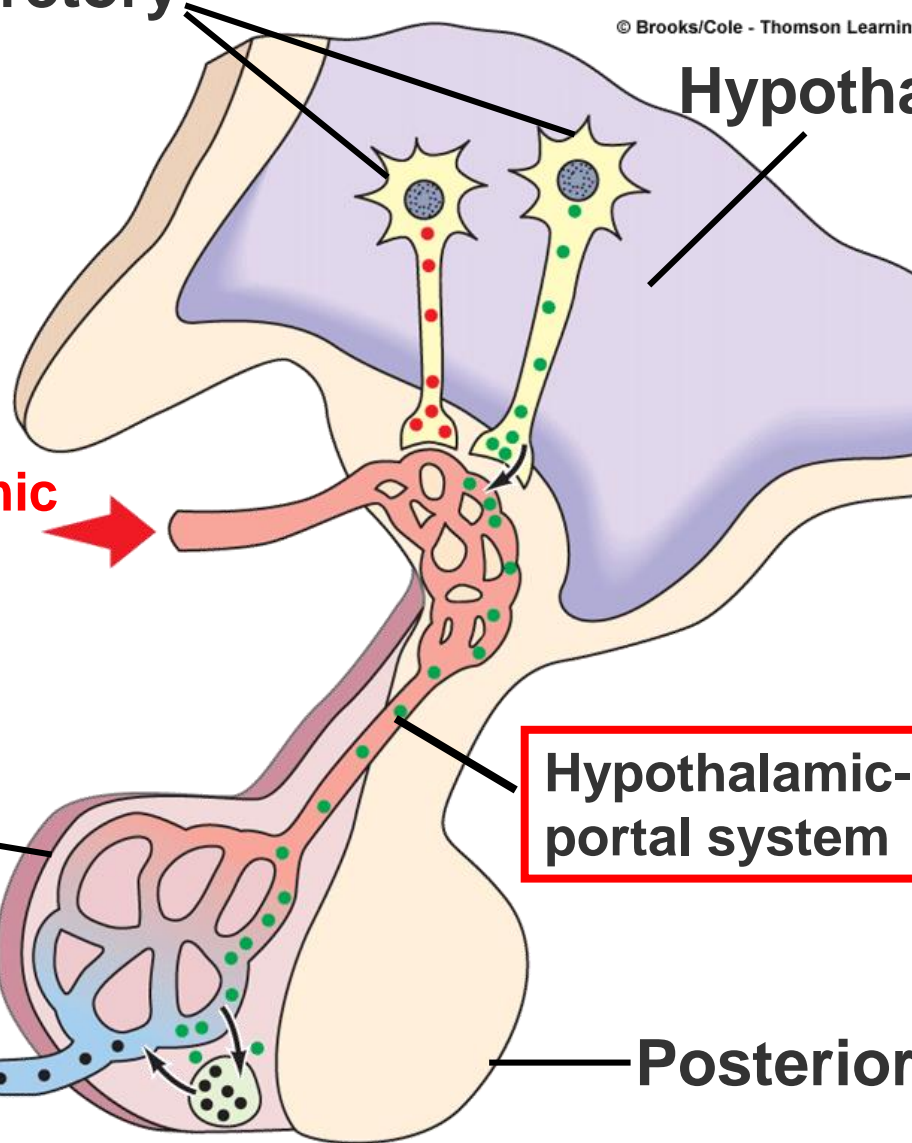
**Systemic
arterial
inflow**

Anterior pituitary

**Hypothalamic-hypophyseal
portal system**

**System
venous
outflow**

Posterior pituitary



Regulation of the pituitary gland

Hypothalamus



Hormones

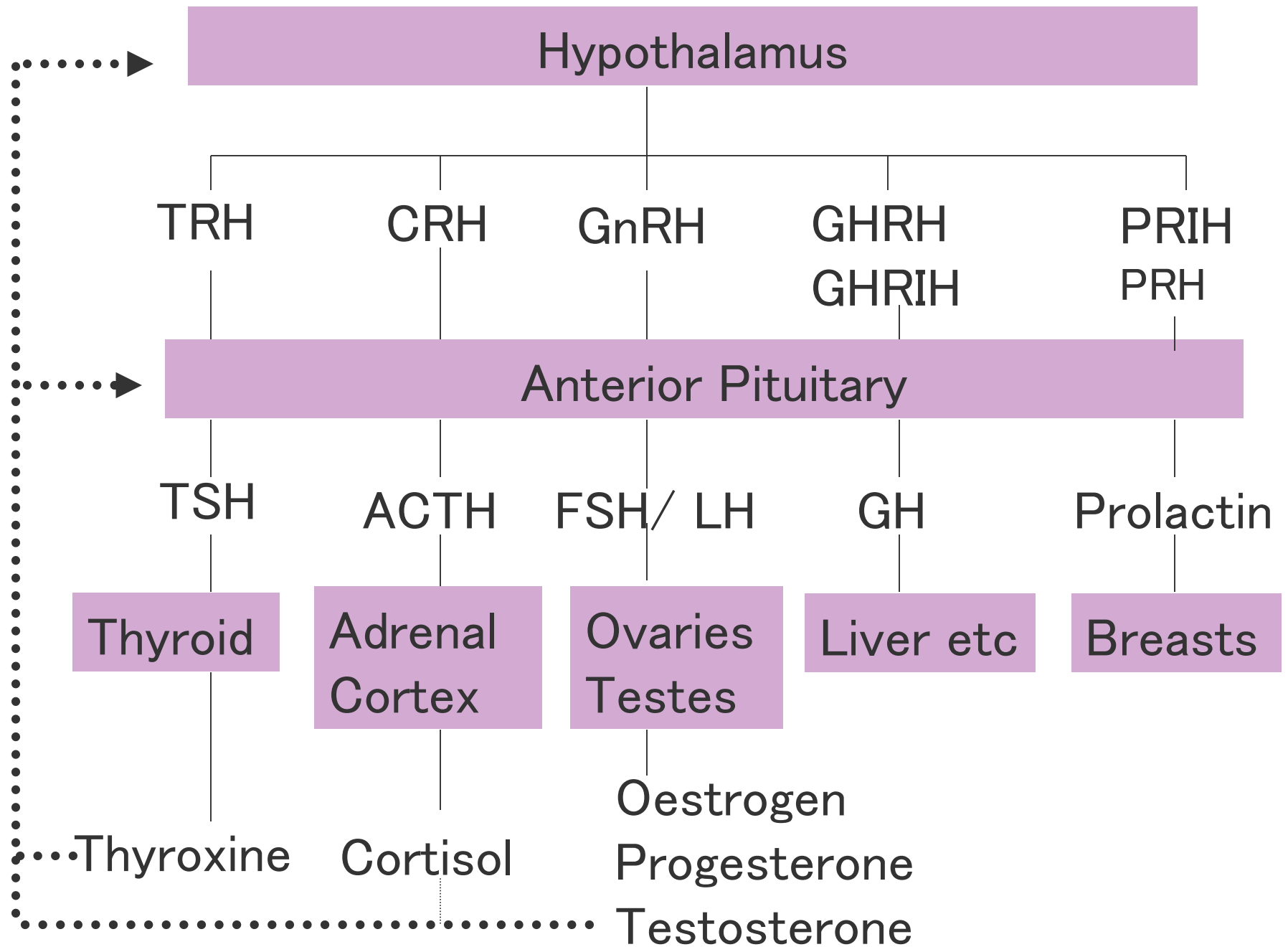


Via portal
blood

Anterior pituitary



Synthesis & release of
pituitary hormones



Growth Hormone

- Secreted by somatotropes in anterior pituitary
- An anabolic hormone
- Main functions
 - growth
 - metabolism (glucose, protein and lipids)
- Secreted in spikes (irregular throughout the day)
- Short half life

Home work - How can you measure GH level?

Actions of GH

- Effects of GH is mediated directly and indirectly by **somatomedins**
 - E.g. **Insulin like growth factor I (IGF-I)**
- Somatomedin is produced by liver (& other tissues)
- Polypeptide – Structure closely related to insulin

Growth hormone

```
graph TD; GH[Growth hormone] --> SR[Sodium retention]; GH --> DIS[Decrease insulin sensitivity]; GH --> L[Lipolysis]; GH --> PS1[Protein synthesis]; GH --> IGF1[IGF-1]; IGF1 --> EG[Epiphyseal growth]; IGF1 --> ILA[Insulin like activity]; IGF1 --> ALA[Anti-lipolytic activity]; IGF1 --> PS2[Protein synthesis];
```

A hierarchical flowchart showing the effects of Growth hormone. The root node is 'Growth hormone' in a purple box. It branches into five nodes: 'Sodium retention', 'Decrease insulin sensitivity', 'Lipolysis', 'Protein synthesis', and 'IGF-1'. The 'IGF-1' node further branches into four nodes: 'Epiphyseal growth', 'Insulin like activity', 'Anti-lipolytic activity', and 'Protein synthesis'. The boxes for 'Growth hormone' and 'IGF-1' are purple, while the others are pink.

Sodium
retention

Decrease
insulin
sensitivity

Lipolysis

Protein
synthesis

IGF-1

Epiphyseal
growth

Insulin like
activity

Anti-lipolytic
activity

Protein
synthesis

IGF – I

- Increases skeletal and cartilage growth
- Concentrations high during childhood, peaks at puberty and then reduce with age

IGF – II

- Action not depend on growth hormone
- Stimulate growth of the fetus

Actions of GH

- Main function is to maintain the growth in children
 - Accelerate chondrogenesis
 - Widen epiphyseal plates
 - Lay down more bone matrix at the ends of long bones
 - Increases stature in childhood
 - Also increases soft tissue growth

Metabolic effects of Growth hormone

Carbohydrate

- Reduce glucose uptake in tissues “anti insulin effect” ? reduce insulin binding its receptor (diabetogenic)
- Increase glucose output by the liver

Lipid

- Lipolysis causing increased plasma FFA (ketogenic)

Protein

- Increase aminoacid uptake and protein synthesis
- Reduce catabolism of protein → +ve nitrogen balance

Metabolic effects cont..

Electrolytes

- ↓ Na^+ and K^+ excretion
- ↑ Ca^{2+} absorption in GIT
- +ve prosperous balance

Growth hormone

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Sodium
retention

Decrease
insulin
sensitivity

Lipolysis

Protein
synthesis

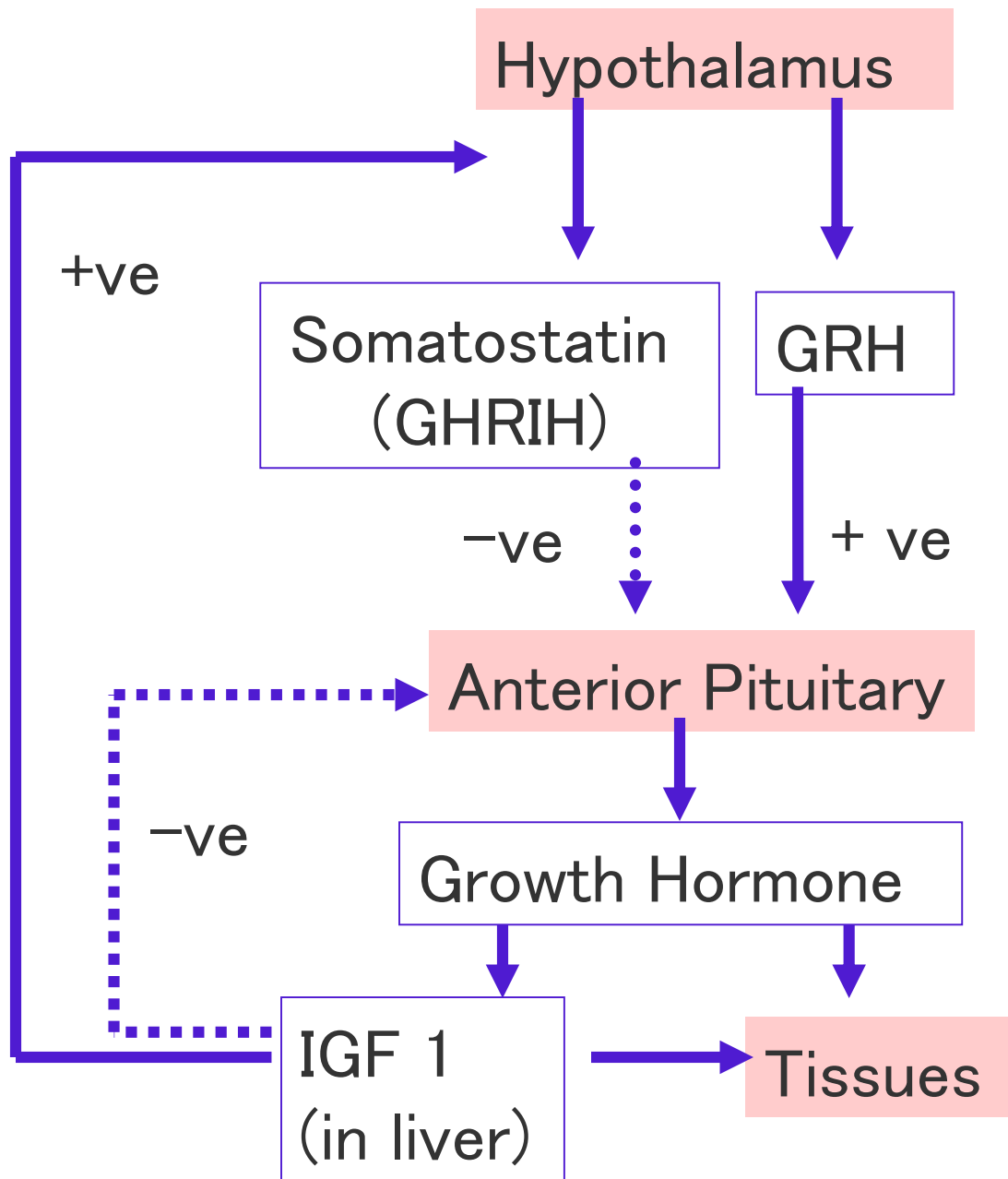
IGF-1

Epiphyseal
growth

Insulin like
activity

Anti-lipolytic
activity

Protein
synthesis



**Regulation of
secretion**

Factors increasing GH secretion

- Reduced substrates for energy (low glucose, FFA during fasting)
- Increase in plasma amino acids (e.g. after high protein meal)
- Stress
- Exercise
- Going to sleep
- Oestrogen and androgens
- Ghrelin

Factors reducing growth hormone secretion

- Increased glucose, FFA (e.g. after meal)
- Old age
- Somatostatin
- somatomedin
- Pregnancy – progesterone
- REM sleep

Increased GH secretion

Childhood – Gigantism

- Before fusion of epiphyses, excess GH causes increased height
- Metabolic effects

Adult life – Acromegaly

- After epiphyses have fused, no increase of height
- Bones of head, face, hands and feet increase in size
- Also visceral & soft tissue growth
- Metabolic effects also occur

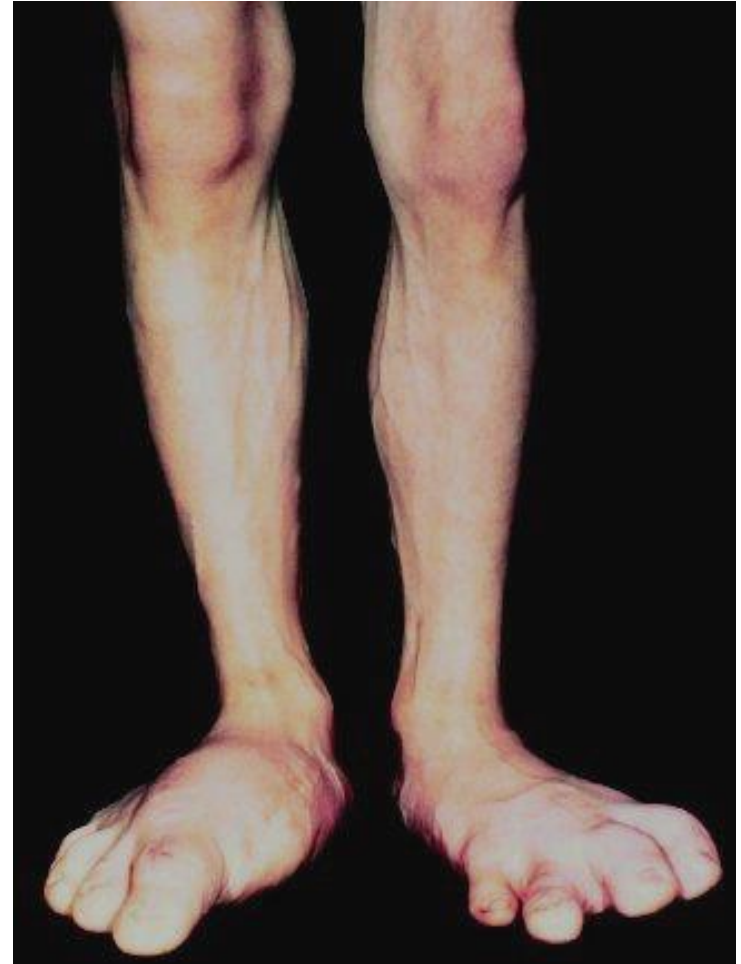
Gigantism



Acromegaly



Acromegaly



Reduced GH secretion

Childhood – dwarfism (proportionate short stature with normal intelligence)

Also caused by

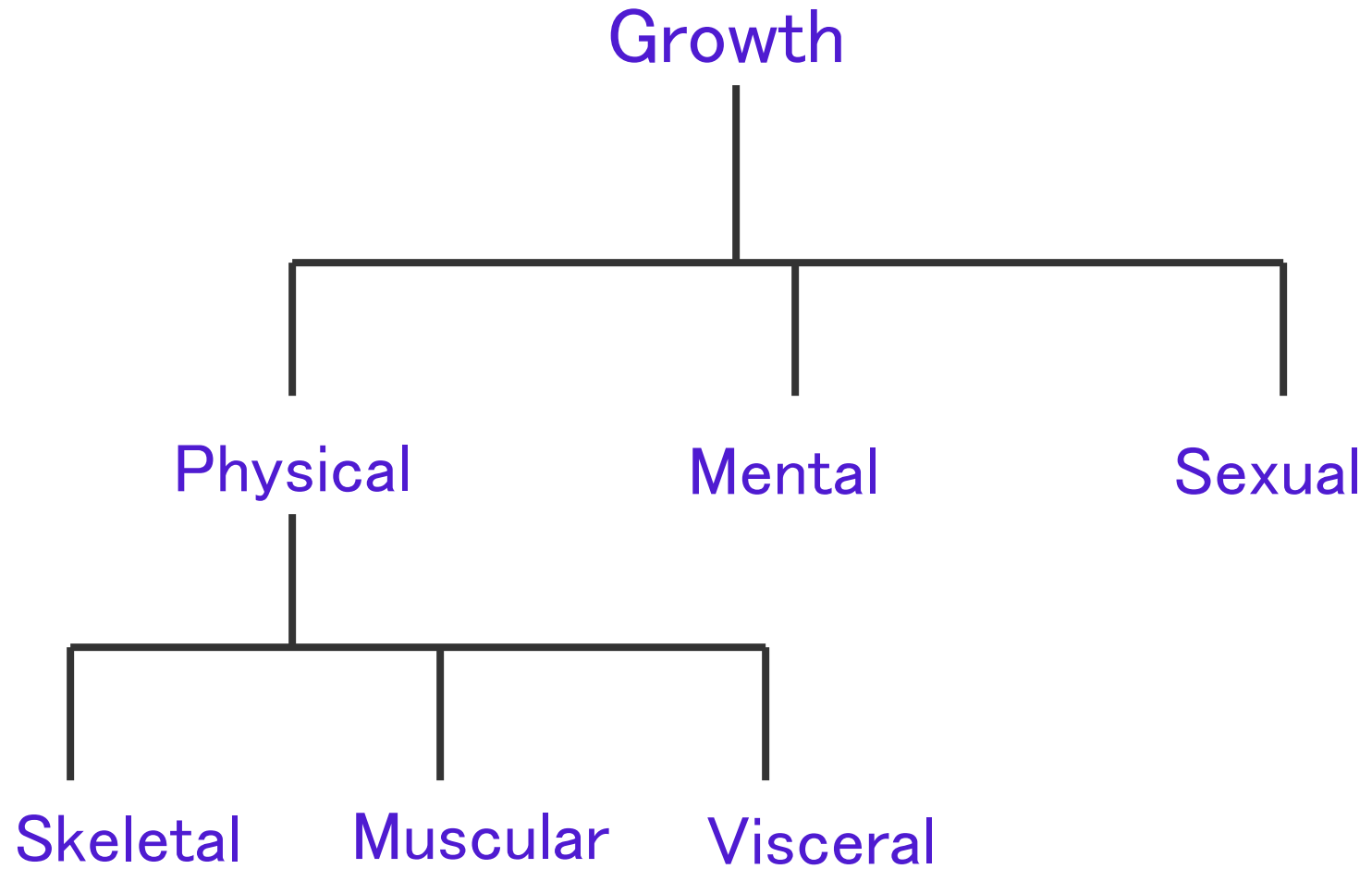
- low GHRH, IGF 1
- receptor insensitivity for GH or IGF-1
- other causes of short stature: genetic factors, thyroid or other endocrine diseases, psychosocial factors

Dwarfism



Growth

- Interaction between hormones, genetic factors, nutrition (and adequate psychosocial stimulation)
- Growth hormone is not the only factor which affect growth
- linear growth (increase in length) happens at the epiphyses in childhood
- when epiphyses fuse, no further linear growth possible



Hormonal requirements for growth

Hormone	Growth effect
Growth hormone	Physical
Thyroid hormones	Physical, mental & sexual
Sex hormones*	Sexual, Physical
Insulin	Physical
Corticosteroids	Physical

* Oestrogen causes the fusion of epiphysis → terminate linear growth after puberty

Prolactin

- Secreted by anterior pituitary lactotropes
- Main function
 - Breast development during pregnancy
 - Milk production after pregnancy
- Prolactin levels are usually low in non pregnant females & males (dopamine effect)
- Dopamin antagonists stimulate prolactin secretion
 - Given to pregnant mothers with poor lactation

Prolactin– continued

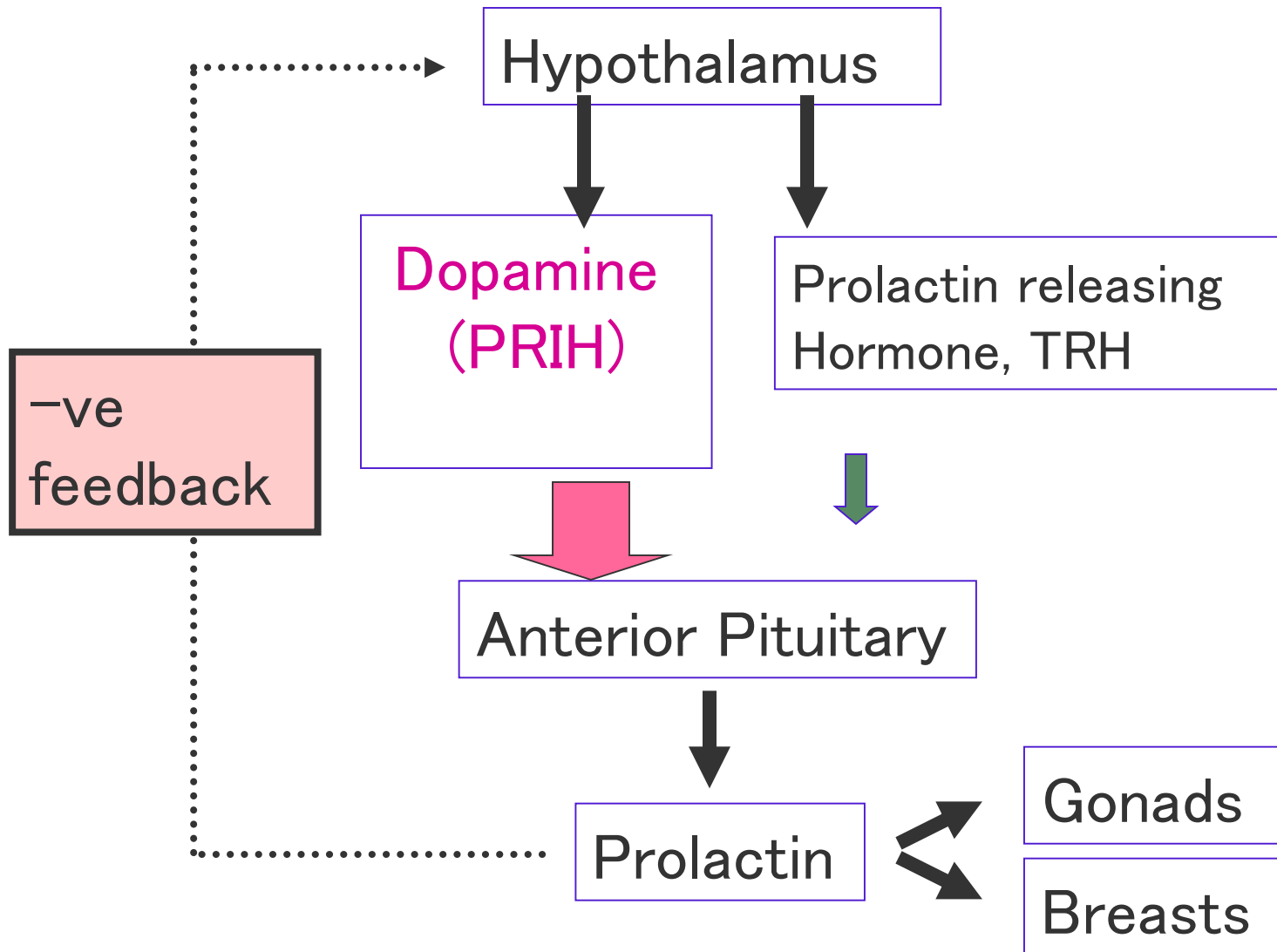
- Levels rise during pregnancy but ‘no’ milk produced in breast
[inhibition by oestrogen and progesterone]
- Prolactin secretion stimulated by suckling

Prolactin inhibit actions of gonadotrophins

High levels causes

- An-ovulatory cycles, amenorrhea and infertility in females
- Hypogonadism and impotence in males
- Galactorrhoea

Regulation of Prolactin Secretion



Adrenocorticotrophic Hormone (ACTH)

- Peptide hormone secreted by **corticotropes** in anterior pituitary
- Secreted as **pro-opiomelanocortin (POMC)**
- POMC produces
 - Adrenocorticotrophic hormone (ACTH)
 - β and γ Lipotropin
 - β Endorphin

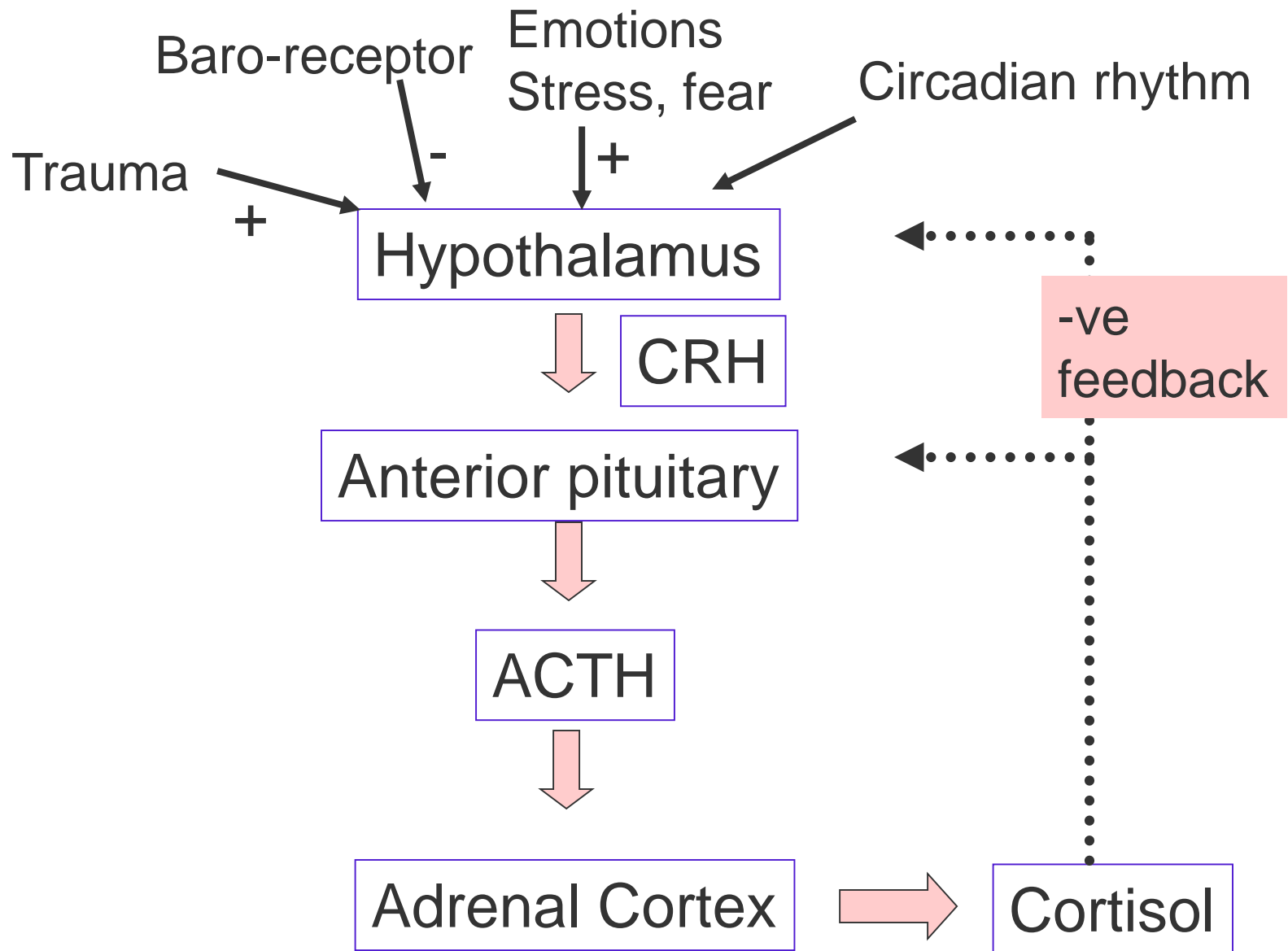
Pulsatile secretion- maximal 0400-1000 hours

- Stimulated by pulsatile CRH from hypothalamus

Functions of ACTH

- Stimulates the **adrenal cortex** (zona fasciculata and zona reticularis) to produce **glucocorticoids** and **sex hormones**
- Stimulate growth of adrenal cortex
- **Skin melanocytes**: causes pigmentation (ACTH has amino acid residues 1–13 of MSH)

Regulation of ACTH secretion



Thyroid stimulating hormone (TSH)

- Glycoprotein (alpha subunit similar to LH, FSH and hCG)
- Secreted by anterior pituitary **thyrotropes**
- TRH stimulates TSH release

Diseases of the pituitary gland

- Commonest causes are benign tumours called adenomas
- These cause
 - **Hyperpituitarism**– excess secretion of a hormone
 - **Hypopituitarism**– insufficient hormone secreted
 - **Compression** of surrounding structures
 - * caused by macroadenomas

Hypopituitarism

- Occurs
 - Tumours of anterior pituitary
 - Compression
 - Pituitary infarction (e.g. following post-partum haemorrhage – Sheehan syndrome)
- Reduces some or all anterior pituitary hormone production
- Posterior pituitary hormones unaffected

Pituitary insufficiency

- ↓ ACTH
 - adrenal gland hypotrophy
 - ↓ glucocorticoids and sex hormones
 - stress induced increase in aldosterone secretion in absent
 - skin colour become pale
- ↓ GH
 - short stature
 - loss of body protein
 - ↑ body fat

- ↓ TSH – hypothyroidism
- ↓ FSH/LH
 - gonads atrophy
 - sexual cycle stops
 - 2^{ry} sexual characteristics disappear
- ↓ cortisol and GH – Fasting hypoglycemia
- ↓ cortisol, thyroid H and GH – transient polyurea

Hyperpituitarism

- Excessive secretion of anterior pituitary hormones
- May be associated with deficiency of other hormones
- Commonest are prolactinomas
- Also ACTH excess (Cushings syndrome), excess growth hormone (Acromegaly)