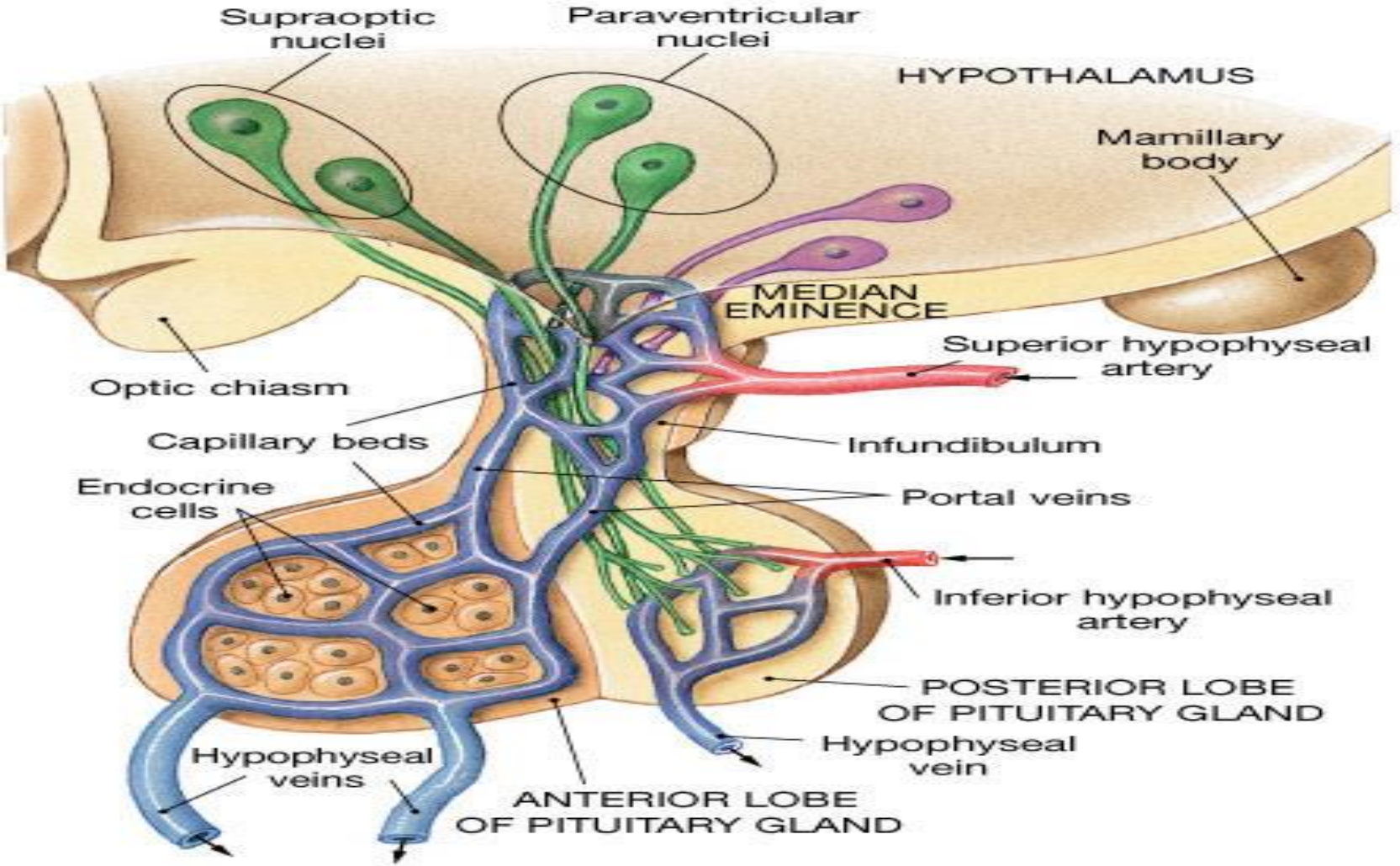
Pituitary Hormones

- Control of STH Output
- Physiological effects of STH
- Effects on Growth
- Metabolic Effects of Growth Hormone
- Effects of Abnormal Production
- Prolactin (Lactogenic hormone)

Hypothalamo-hypophysial portal System



SOMATOTROPIN (STH)

- Somatotropin or growth hormone (GH) is a complex protein having 191 amino acids and S–S bridges.
- The STH is species specific and most domestic animals respond best to homologous STH and least to heterologous STH.
- STH is structurally related to prolactin of the same species.

Stimuli that increases the GH secretion

- Deficiency of energy – hypoglycaemia, exercise, fasting, insulin
- Increase in circulating levels of certain amino acids – protein meal, arginine vasopressin
- Glucagon
- Stress (trauma, surgery) pyrogen
- Sleep
- Ghrelin, a 28 amino acid peptide hormone secreted from hypothalamus (also from stomach, kidney, placenta) stimulates GH release

Stimuli that decreases the GH secretion

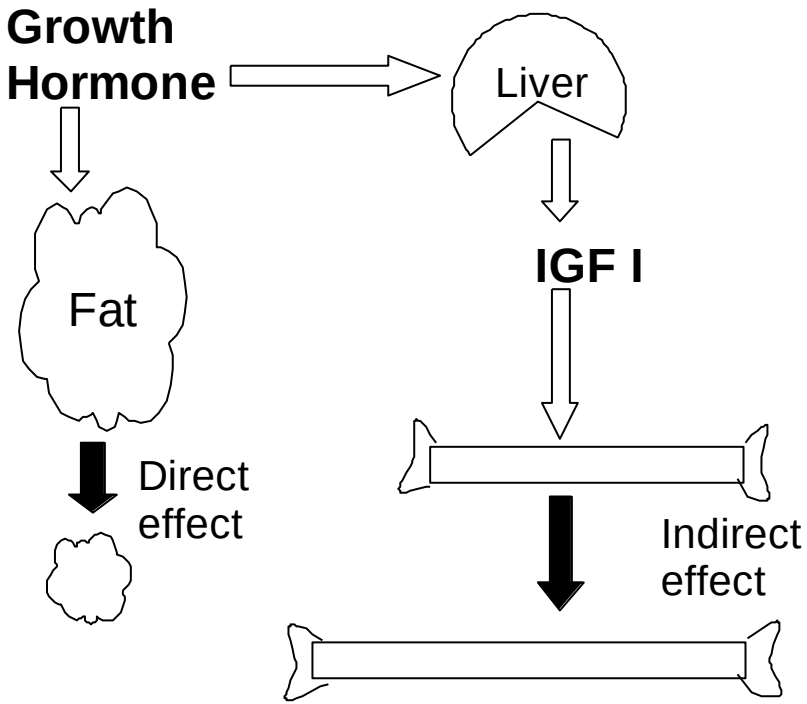
- Increase in glucose, cortisol, free fatty acids, GH
- obesity results in reduced GH release
- GIH

Physiological effects of STH

- STH produces its effects on the target cells by activating intracellular **tyrosine kinase receptors**. Growth hormone has two distinct types of effects:
- **Direct effects** are the result of GH binding its receptor on target cells.
  - Fat cells (adipocytes), for example, have growth hormone receptors, and **GH stimulates them to break down triglyceride and suppresses their ability to take up and accumulate circulating lipids.**
- **Indirect effects** are mediated primarily by an **insulin-like growth factor-1 (IGF-1),** a hormone that is secreted from the liver and other tissues in response to growth hormone.

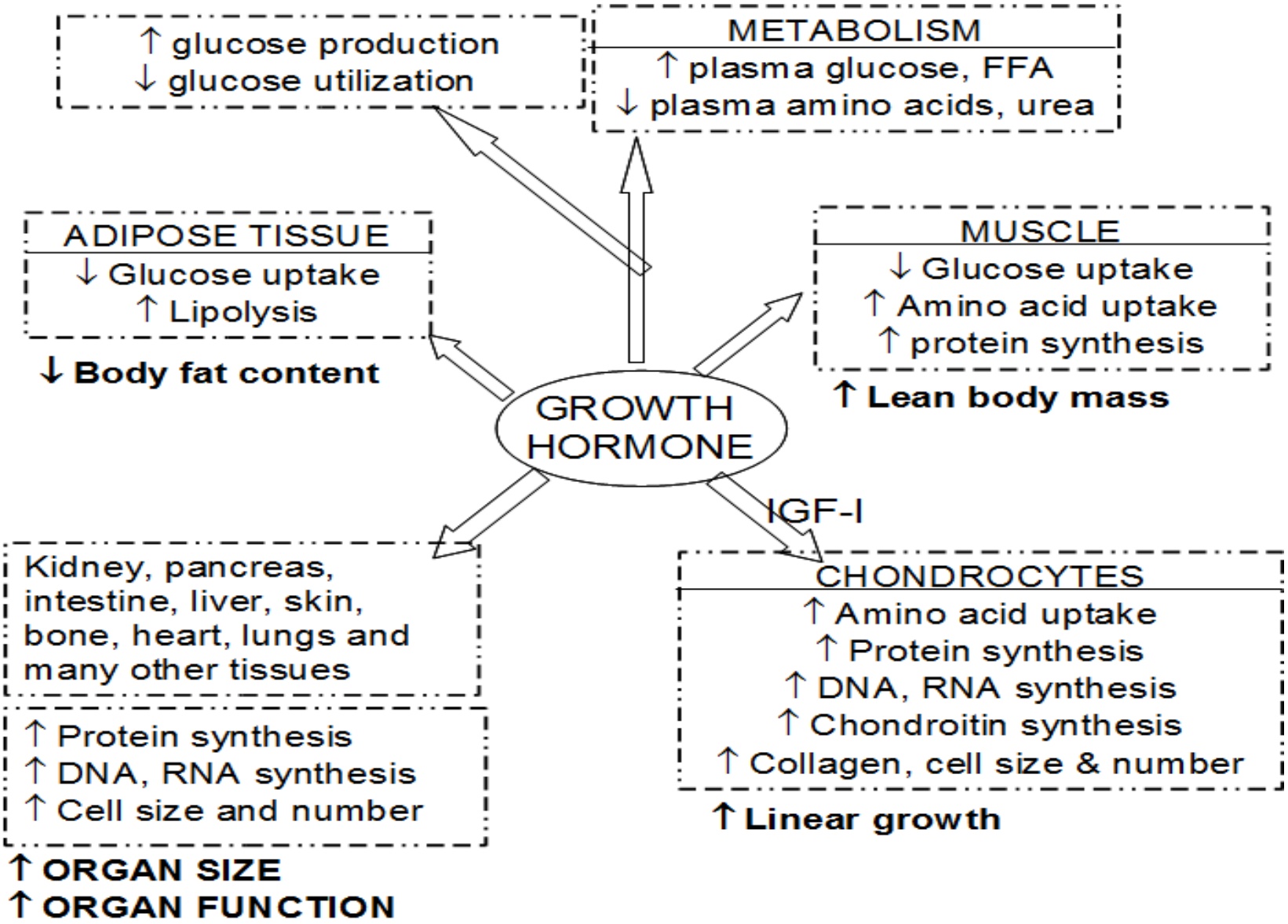
Effects on Growth

- **Two somatomedins, C and A** have resemble structurally to insulin so they are also known as **insulin like growth factors I and II (IGF I & II),** respectively.
- IGF I is transported in blood bound with specific binding proteins called IGF-binding proteins (IGFBP); this binding of IGF prolongs the half-life of IGF I.
- The receptor for IGF is similar to insulin receptors.
- **IGF I promotes skeletal and cartilage growth and IGF II is functional during foetal period.**


Growth
Hormone
Liver
Fat
IGF I
Direct
effect
Indirect
effect

- Excessive amount of STH at times causes greater amounts of fat mobilization resulting in excess acetyl Co-A which is converted to acetoacetate, β-OH butyric acid and acetone leading to ketonemia which is called as **ketogenic effect of GH**.
- It reduces lipid synthesis and leads to leaner animal. GH decreases body fat content and promotes lean body mass.

- GH causes decreased utilization of glucose for energy (possibly duo to utilization of fat for energy) and enhanced glycogen deposition. It diminishes uptake of glucose by the cells for energy by the muscle and adipose cells, thus increases blood glucose concentration which is known as **Diabetogenic effect of GH.**


↑ glucose production
↓ glucose utilization
METABOLISM
↑ plasma glucose, FFA
↓ plasma amino acids, urea
ADIPOSE TISSUE
↓ Glucose uptake
↑ Lipolysis
↓ Body fat content
MUSCLE
↓ Glucose uptake
↑ Amino acid uptake
↑ protein synthesis
↑ Lean body mass
GROWTH HORMONE
IGF-I
Kidney, pancreas, intestine, liver, skin, bone, heart, lungs and many other tissues
↑ Protein synthesis
↑ DNA, RNA synthesis
↑ Cell size and number
↑ ORGAN SIZE
↑ ORGAN FUNCTION
CHONDROCYTES
↑ Amino acid uptake
↑ Protein synthesis
↑ DNA, RNA synthesis
↑ Chondroitin synthesis
↑ Collagen, cell size & number
↑ Linear growth

Effects of Abnormal Production

- **Panhypopituitarism** is decreased secretion of all the anterior pituitary hormones. Underproduction of pituitary hormones in the immature animal results in underdevelopment of the animal referred to as **pituitary dwarfism**. Such an animal shows reduced activity in the other target organs of the pituitary (hypothyroidism, hypogonadism, hypoadrenocortical function).

- If the overproduction occurs before the closure of epiphyseal lines in the long bones, it results in lengthening of the long bones and increased deposition of soft tissue, resulting in **gigantism**. This condition occasionally occurs in domestic animals (dogs, cats).

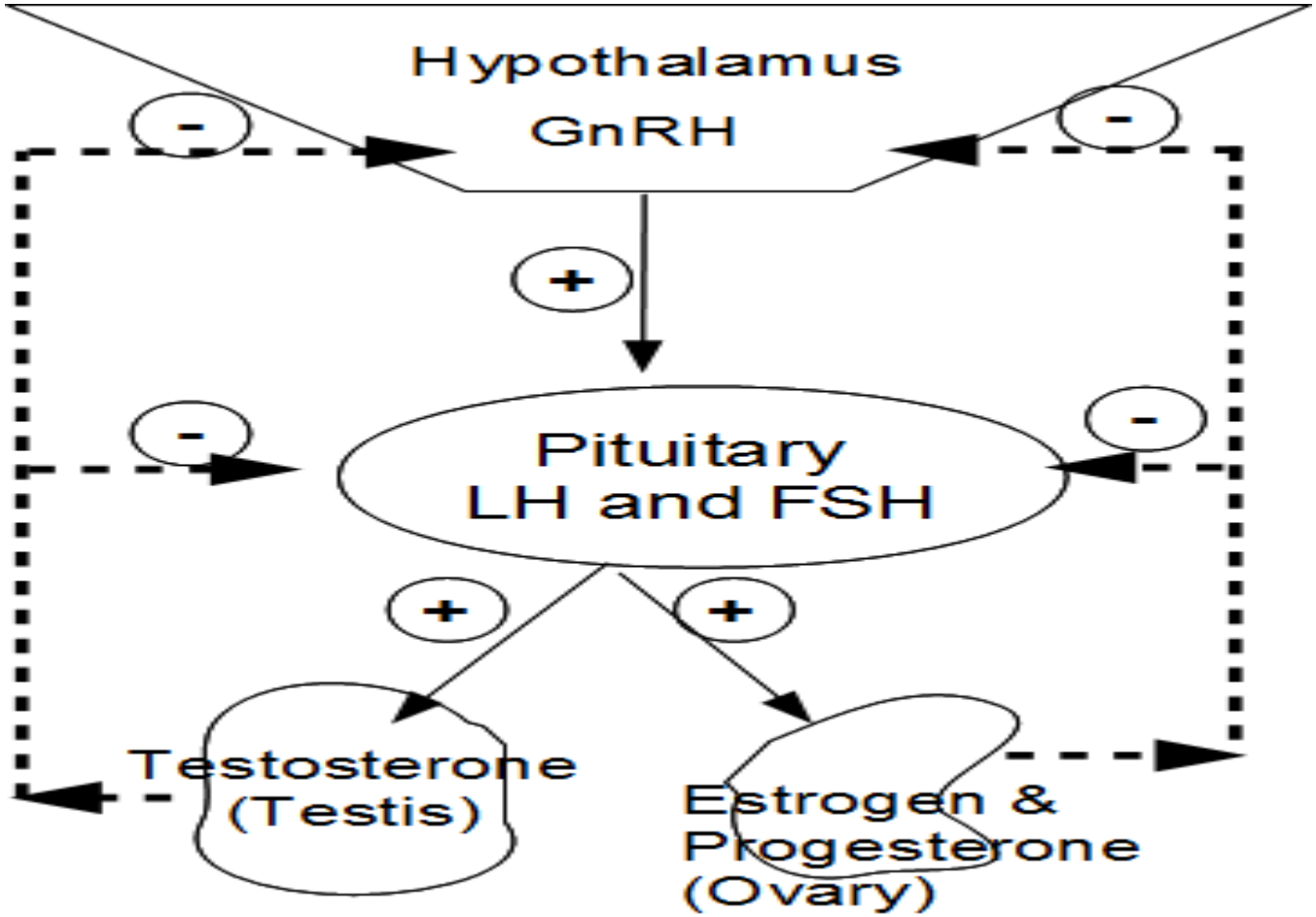
- If excess production of STH occurs after the closure of epiphyseal lines, the long bones of the body are thickened and there is excessive soft tissue and this condition is termed as **acromegaly.**
- Eg. This is produced in acidophilic tumours.

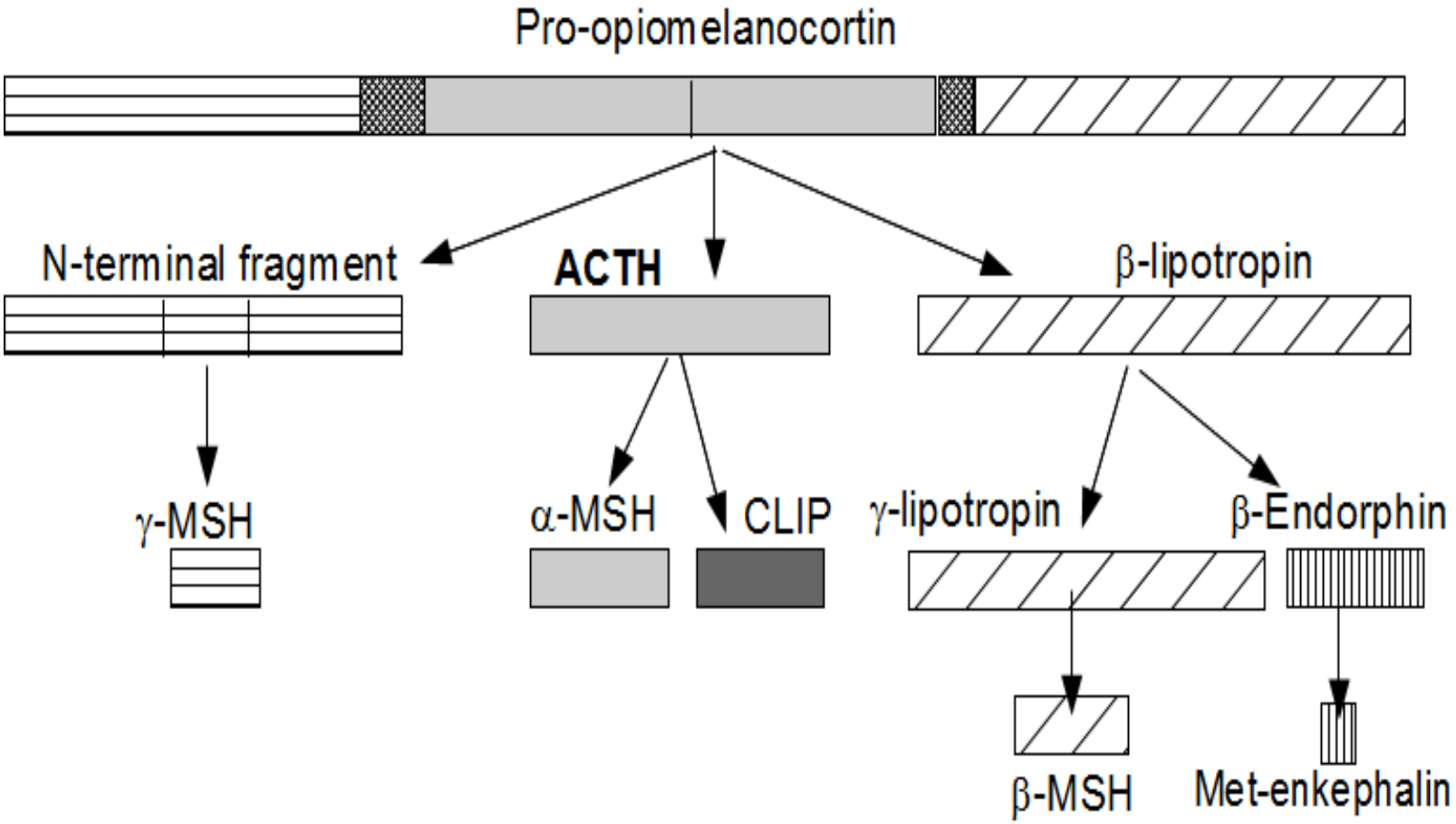
Prolactin (Lactogenic hormone)

- PRL, a lactogenic hormone, is a single-chain peptide consisting of **199 amino acids** and three disulfide bridges.
- The most important function of PRL occurs with the **combination of pregnancy, oestrogen and nursing of newborn.**
- It has an essential role in lactation, and PRL secretion increases steadily during pregnancy.
- PRL secretion rises at night similar to GH.
- Suckling inhibits **dopamine (PIF)** secretion, thus stimulates PRL release.
- PRL is the principle hormone responsible for lactogenesis (milk production).
- PRL together with oestrogen, cortisol and GH cause **proliferation of duct system of the mammary gland.** During pregnancy prolactin and progesterone cause development of secretory alveoli in the mammary gland thus causes initiation and maintenance of lactation in domestic animals.

- PRL level increases just prior to parturition and after parturition, milk synthesis and secretion require PRL along with cortisol and insulin. **PRL induces enzymes necessary for lactose synthesis. It provokes synthesis of milk constituents including lactalbumin, casein, and lipids. Prolactin increases in the peripheral blood of the cow during milking.**
- In pigeon it causes the crop gland to hypertrophy and stimulates the secretion of crop milk (this is used in bioassay of prolactin).
- In ewes, prolactin stimulates corpus luteum which is referred to as the **luteotropic effect**; hence it is also referred as **luteotropin.**
- It is necessary for maintenance of CL in rat, dog.
- An excess of PRL blocks the synthesis and release of LH-RH which inhibits gonadotropin (FSH/LH) secretions from the pituitary and prevents ovulation and spermatogenesis.
- High PRL concentration also inhibits the synthesis of gonadal steroids both in male and female.
- In animals PRL provides productive maternal behaviour toward the newborn.
- **Broodiness in birds** is controlled by PRL.
- Prolactin may have a growth mediating role similar to GH and reduces lipid synthesis
- Helps in partitioning of nutrients.

- FSH
- LH
- Pro-opiomelanocortin


Hypothalamus
GnRH
-
-
+
-
Pituitary
LH and FSH
-
+
+
Testosterone
(Testis)
Estrogen &
Progesterone
(Ovary)

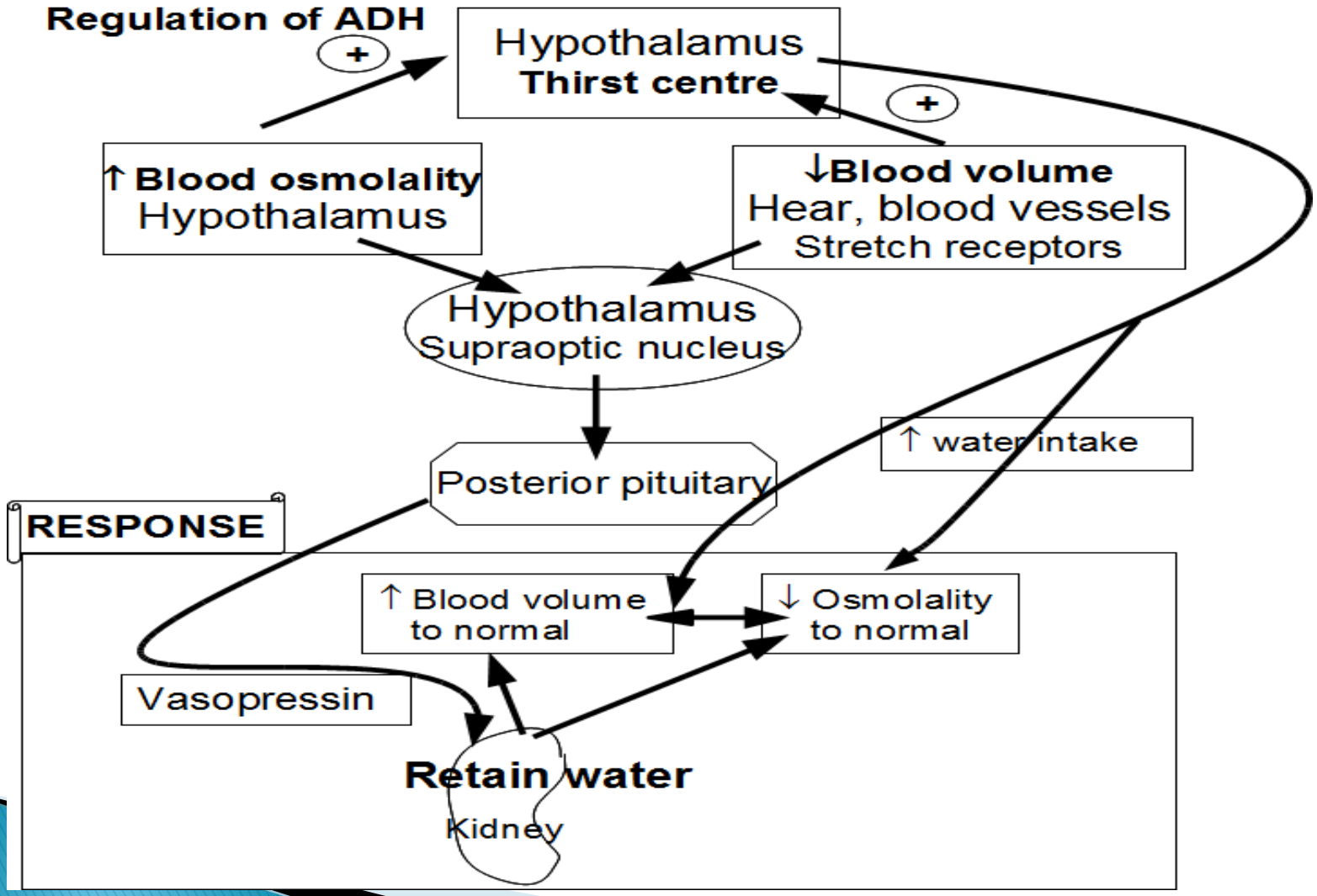

Pro-opiomelanocortin
N-terminal fragment
ACTH
β-lipotropin
γ-MSH
α-MSH
CLIP
γ-lipotropin
β-Endorphin
β-MSH
Met-enkephalin

NEUROHYPOPHYSIS (Posterior Pituitary)

- Neurohypophyseal hormones are synthesized by the cell bodies of the neuroendocrine cells of the hypothalamic nuclei (**supraoptic, paraventricular**), packaged in vesicles and move along the axons of the hypothalamo-hypophyseal nerve tracts to the neuro-hypophysis, stored in the neurohypophysis until the proper signal arises to cause their release into the circulation.
- Two peptide hormones consisting of nine amino acids are released from the neurohypophysis
  - **Antidiuertic hormone (ADH) or vasopressin is produced from the supraoptic nucleus**
  - **Oxytocin is produced from the paraventricular nucleus.**
- These two hormones after their synthesis are complexed with a polypeptide known as **neurophysin** and transported as Hering bodies within the axons to the neurohypophysis. Neurophysin I and II aid in transport of oxytocin and ADH respectively.

Antidiuretic Hormone Or Vasopressin

- The vasopressin is a peptide containing 9 amino acids
- It shows species specificity in its composition.
- In cattle, man and most mammals the main form of vasopressin is **arginine-vasopressin** (arginine at position 8 is essential for antidiuretic effect),
- **In swine it is lysine-vasopressin**
- **In birds it is arginine- vasotocin.**
- **ADH has a half-life of 18 minutes.**


Regulation of ADH
+
Hypothalamus
Thirst centre
+
↑ Blood osmolality
Hypothalamus
↓Blood volume
Hear, blood vessels
Stretch receptors
Hypothalamus
Supraoptic nucleus
↑ water intake
Posterior pituitary
RESPONSE
↑ Blood volume
to normal
↓ Osmolality
to normal
Vasopressin
Retain water
Kidney

- ADH acts on the distal tubule and collecting ducts of nephrons and increases a group of water channel proteins called **aquaporins** which increases the reabsorption of water.
- A deficiency of ADH hormone leads to increased urine volume (diuresis) resulting in a condition known as **diabetes insipidus** in the dog, cat and horse.

OXYTOCIN

- It is a peptide hormone containing **9 amino acids.**
- Seven amino acids are common between oxytocin and ADH.
- Oxytocin has a **half life of 2 min.**
- Oxytocin has specific effects on the smooth muscle of the uterus and the myoepithelial cells of the mammary gland.
- It also functions in the release of prostaglandins from the endometrium.