MEDICINE 438's

ENDOCRINE PHYSIOLOGY

LECTURE V: Posterior Pituitary Gland

EDITING FILE

IMPORTANT | MALE SLIDES | EXTRA | FEMALE SLIDES | LECTURER'S NOTES

1 POSTERIOR PITUITARY GLAND

Lecture Five

OBJECTIVES

- Describe the posterior pituitary relationship with the hypothalamus(hypothalamic control).
- List the target organs and functional effects and Control of secretion of oxytocin.
- Name the stimuli for oxytocin release in relation to its reproductive and lactation functions.
- List the target cells for vasopressin and explain why vasopressin is also known as antidiuretic hormone.
- Describe the stimuli and mechanisms that control vasopressin secretion.
- Identify disease states caused by a) over-secretion, and b) under-secretion of vasopressin and list the principle symptoms of each.

Posterior Pituitary Gland

Does not synthesize hormones

- Synthesize in the supraoptic and paraventricular nuclei of the hypothalamus [1]

Consists of axon terminals of hypothalamic neurons

Secretions of the posterior pituitary are controlled by **Nervous** signals from hypothalamus

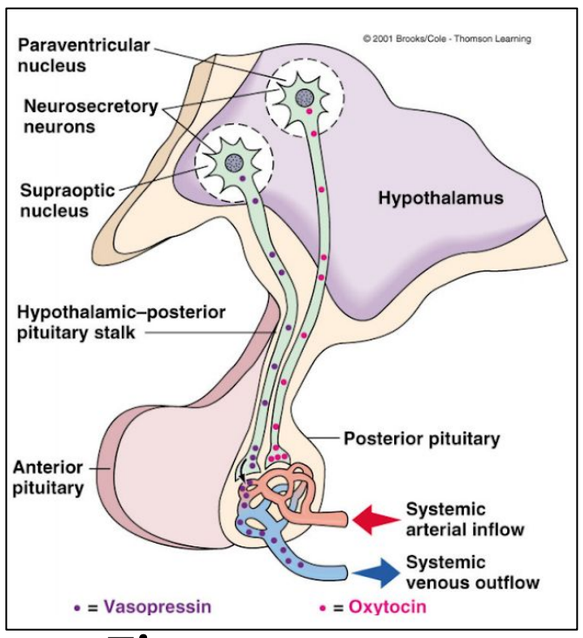
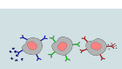


Figure 5-1

Pituicytes Function

- They are glial cells of the posterior pituitary,
- They're NOT a simple glial cells. They have spots, when hormone demand or not needed the pituicytes engulf or completely surround neurosecretory axons.

It forms physical and chemical barrier between nerve terminal and blood vessels



Amplify auto receptor negative feedback [2]

- By satisfaction (Autoregulation)

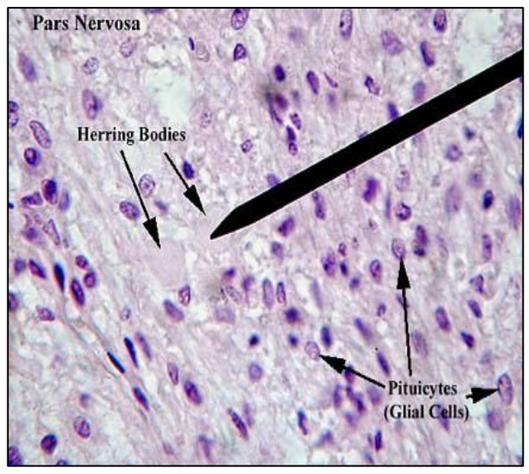


Figure 5-2

Figure 5-3

Synthesis of ADH

Synthesized as pre-prohormone and processed into a nonapeptide (nine amino acids).

Synthesized in the cell bodies of hypothalamic neurons (supraoptic nucleus)[1]

Stored in the neurohypophysis (posterior pituitary)

Receptors of ADH (Vasopressin)

V1A

- Mediate vasoconstriction
- Found in the liver (glycogenolysis)

V1B

- Unique to anterior pituitary
- Mediate increased ACTH secretion.

There can be hyperpigmentation (dark skin) b/c of the stimulatory effect of ACTH precursor molecule on melanocytes.

V2

- Located in the principle cells in distal convoluted tubule and collecting ducts in the kidneys

FOOTNOTES

1. ADH is mainly secreted from the Supraoptic Nucleus, while 1/6th of the total secretion comes from the Paraventricular Nucleus.
2. Pituicytes envelope the axons when conditions are unfavorable, and is reduced when when secretion is increased either by osmotic stim, or in lactation.

Mechanism of Action of ADH

01 ADH binds to V2 receptors on the peritubular (serosal) surface of cells (principle cells[1]) of the distal convoluted tubules and medullary collecting ducts [2].

02 This binding Cause some changes in adenylate cycles leads to activate it to release cAMP

03 Via adenylate cyclase/cAMP induces production and insertion of **aquaporin2** into the luminal membrane and enhances permeability of cell to water.

04 Increased membrane permeability to water permits back diffusion of solute- free water, resulting in increased urine osmolality (concentrates urine).

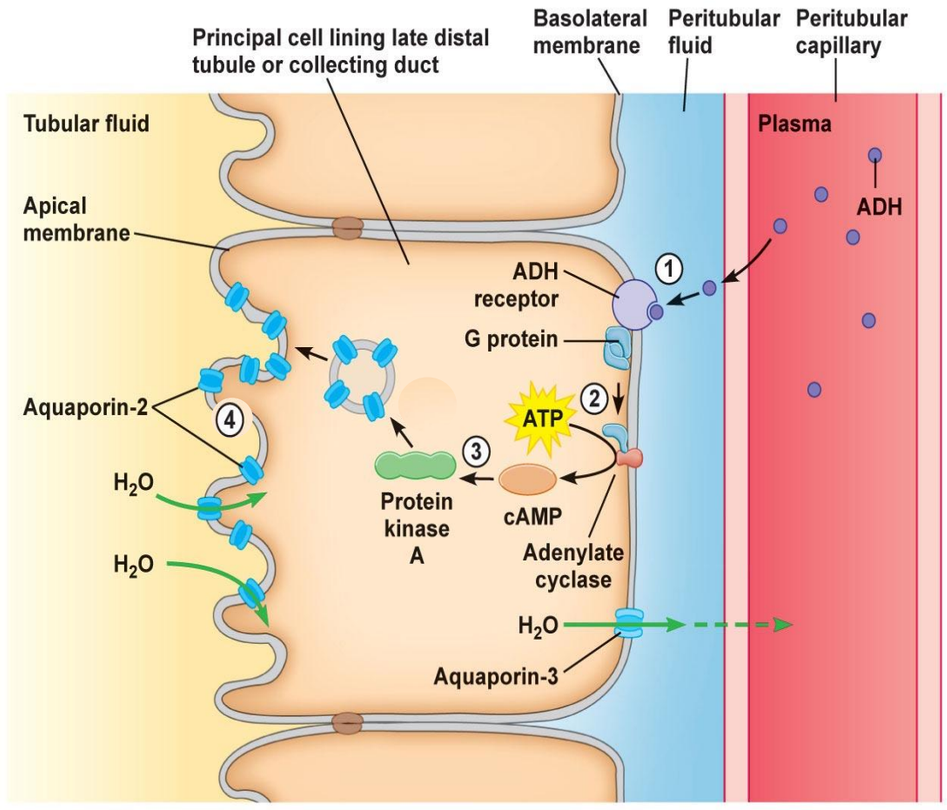


Figure 5-4

★ The single most important function of adh is to conserve body water by reducing urine output.

Secretion of ADH

→ Osmotic stimuli

If plasma osmolality is directly increased by administration of solutes, such as sodium, cause ADH release.

Conversely, substances that enter cells rapidly, such as urea, do not change osmotic equilibrium and thus do not stimulate ADH release.

ADH secretion is very sensitive to changes in osmolality.

Changes of 1-2% result in increased ADH secretion.

→ Non-osmotic stimuli

Hypovolemia is perceived by “pressure receptors” carotid and aortic baroreceptors, and stretch receptors in left atrium[3] and pulmonary veins.

Normally, pressure receptors tonically inhibit ADH release.

Decrease in blood pressure induces ADH secretion by reducing input from pressure receptors.

The reduced neural input to baroreceptors relieves the source of tonic inhibition on hypothalamic cells that secrete ADH.

Sensitivity to baroreceptors is less than osmoreceptors– senses 15 to 25% change in volume.

FOOTNOTES

1. **Principle cells** are the main Na reabsorbing cells, and the site of action for aldosterone(secretion of K). While **intercalated cells** play a major role in acid-base regulation, and are of two types: type A: eliminates H while reabsorbing Bicarbonate in acidosis, type B: secrete bicarbonate into lumen while reabsorbing hydrogen ions In alkalosis.
2. CD are impermeable to water in the absence of ADH.
3. Produced ANP is an antagonist to angiotensin pathway(decrease bp) by inhibiting ADH, Ald and renin.

Control of ADH Release

Osmotic Pressure	Blood Volume
Osmoreceptors mediated Osmoreceptors in hypothalamus	Baroreceptors mediated (vagus nerve) Baroreceptors in carotid artery, aortic arch and left atrium
increase osmotic pressure → increase ADH secretion	high blood pressure → decrease ADH secretion
Low osmotic pressure → decrease ADH secretion	Decrease in blood pressure → increases ADH secretion
Direct relationship	Inverse relationship

Control of ADH Release

Characteristics of Receptors	Osmoreceptors	Baroreceptors
Location	Anterolateral hypothalamus	Carotid sinus, aortic arch, pulmonary veins & atria
Value measured	Plasma osmolality	Circulating volume
ADH release stimulated by	Activation of receptor	Suppression of receptor
Change required for action	1% above 280 mOsm/kg	15-25% decrease
Regulating amount of ADH	Small (antidiuretics)	Large (vasoconstriction)
Override other	No	Yes As it reabsorbs water and vasoconstricts in higher conc.

Other Stimuli That Affect Release of ADH Secretion

- **Decrease Its Secretion**
  - alcohol
- **Increase Its Secretion**
  - Nausea
  - Pain
    - Fear
    - Trauma
  - Stress
    - Emotional stress
    - Surgical stress

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Lecture Five

Function/Regulation of ADH (vasopressin)

Hypothalamus receives feedback from:

- Osmoreceptors
- Aortic arch
- Carotid baroreceptors,
- Atrial stretch receptors.

Any increase in osmolality or decrease in blood volume will stimulate ADH secretion from posterior pituitary.

In regulation of ADH

- Dehydration cause the releases of ADH
- Overhydration inhibits the releases of ADH

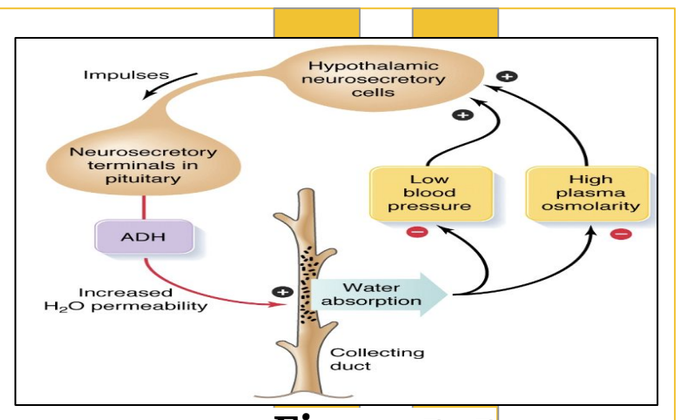

Figure 5-5

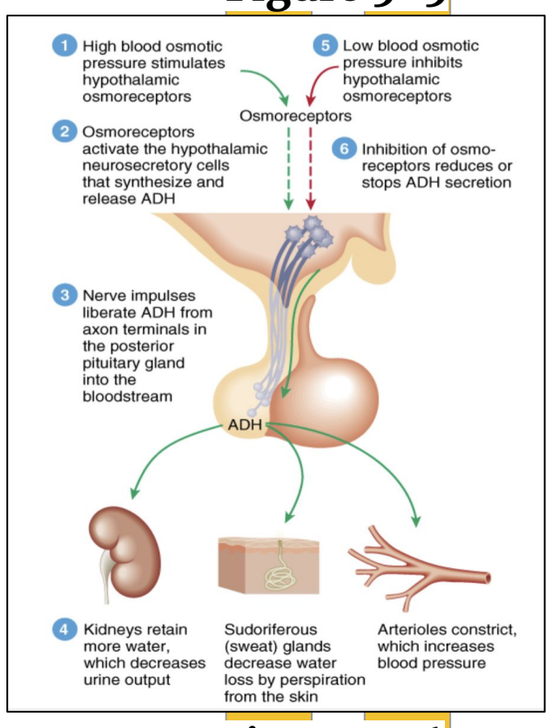

Figure 5-6

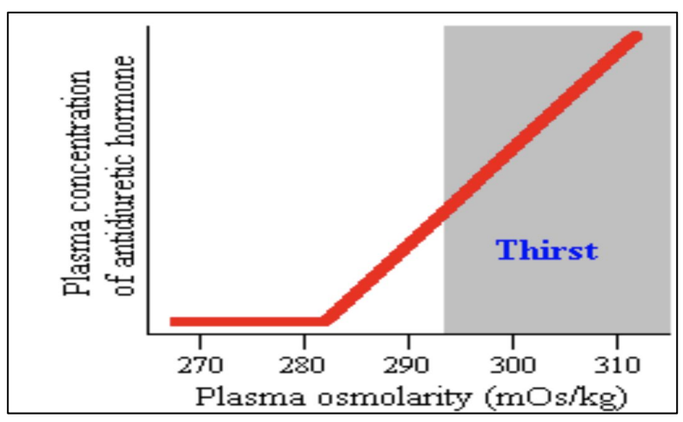

Figure 5-7 Plasma Osmolarity stimulates both ADH release and thirst via osmoreceptors

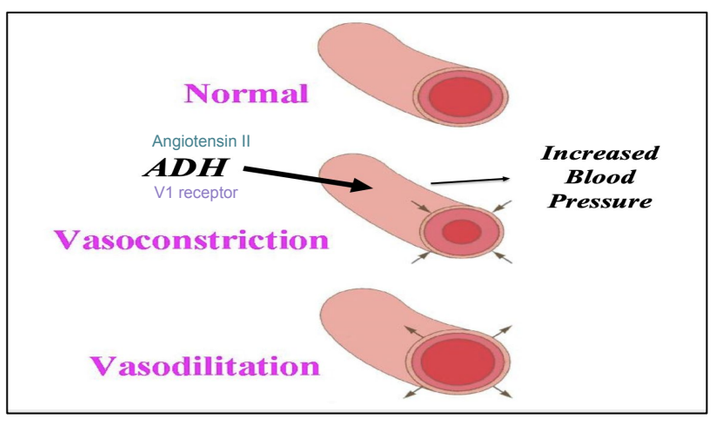

Figure 5-8 ADH effect on blood vessels

ADH Disorders

1

Central (Neurogenic) Diabetes Insipidus

- Failure of hypothalamus or neuro -hypophysis to synthesized or secrete ADH

2

Nephrogenic Diabetes Insipidus

- Failure of kidney to respond to ADH

3

Syndrome of inappropriate antidiuretic hormone (SIADH)

Diabetes Insipidus (DI)

DI is a disorder resulting from deficiency of antidiuretic hormone (ADH) or its action and is characterized by the passage of copious amounts of dilute urine.

- Central DI is due to failure of producing adequate ADH.
- Nephrogenic DI results when the renal tubules of the kidneys fail to respond to circulating ADH.
- The resulting renal concentration defect leads to the loss of large volumes of dilute urine. This causes cellular and extracellular dehydration and hypernatremia.
- It must be differentiated from other polyuric states such as primary polydipsia & osmotic diuresis.

Treatment of DI

High dose of Desmopressin (DDAVP): synthetic analog superior to native AVP due to:

- Longer duration of action (8-10h vs 2-3h)
- More potent
- Antidiuretic activity is 3000x its pressor activity.

Treatment of Nephrogenic DI

Correction of underlying cause.

Provision of adequate fluids & calorie.

Low sodium intake & diuretics.

Synthesis of Oxytocin

Synthesized in the cell bodies of hypothalamic neurons (paraventricular nucleus)[1]

Stored in posterior pituitary

Figure 5-9, during delivery, an I.M. Injection of Oxytocin is given to push the placenta out after child birth, so no complications occur.

Functions of Oxytocin

01 Oxytocin is a strong stimulant for uterine contraction

02 Regulated by positive feedback mechanism

03 Which leads to increased intensity of uterine smooth muscle (myometrium) contraction ending in birth (parturition)

Breastfeeding:

04 Contracts the myoepithelial cells of the alveoli, which triggers milk ejection (letdown reflex) (classic neuroendocrine reflex)[2]

05 Increase contraction of smooth muscle of vas deferens, helping in ejaculation process [3]

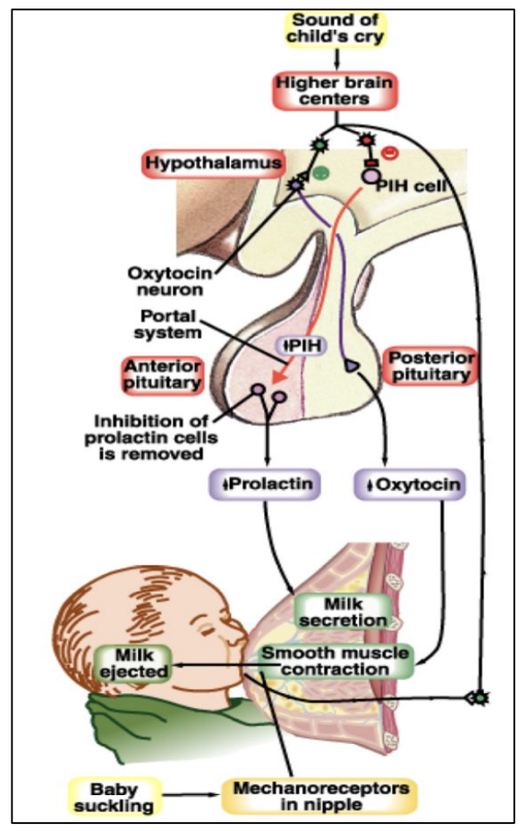

Figure 5-10, the cry of any child could be a trigger.

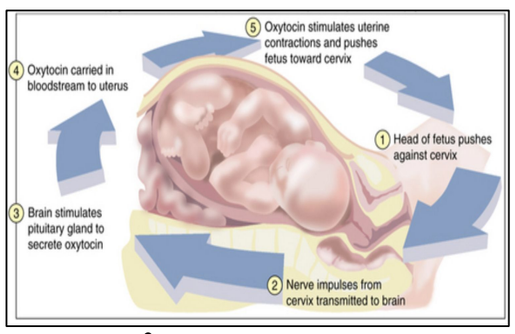

Figure 5-11

FOOTNOTES

1. Oxytocin is mainly secreted from the Paraventricular Nucleus , as only 1/6th of the total secretion comes from the Supraoptic Nucleus.
2. A neuroendocrine reflex is a reflex in which a nervous signal causes the release of hormones into blood.
3. Oxytocin acts on non-pregnant uterus to facilitate sperm transport to uterine tube where fertilization normally occurs. As well as increase contraction of vas deferens, propelling sperm toward the urethra.

Control of Oxytocin Release

Other Stimuli That Control Release of Oxytocin

- **Inhibition**
  - alcohol
- **Increased in**
  - **emotion**
    - Hugging
    - Touching
    - Orgasm
    - Stress
  - **Ejaculation in males**
    - Contraction of vas deferens

Oxytocin and Autism

Autistics have significantly lower plasma oxytocin compared to non-autistics.
Elevated oxytocin was associated with higher scores on social & developmental measures for non-autistic children.

Summary of Posterior Pituitary Hormones Actions

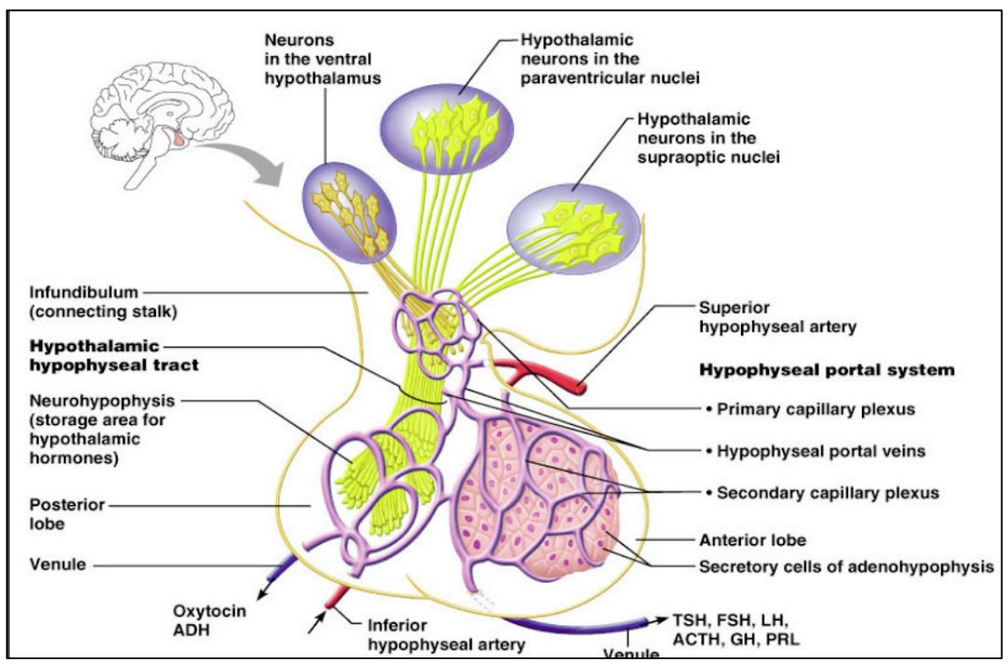

Figure 5-12

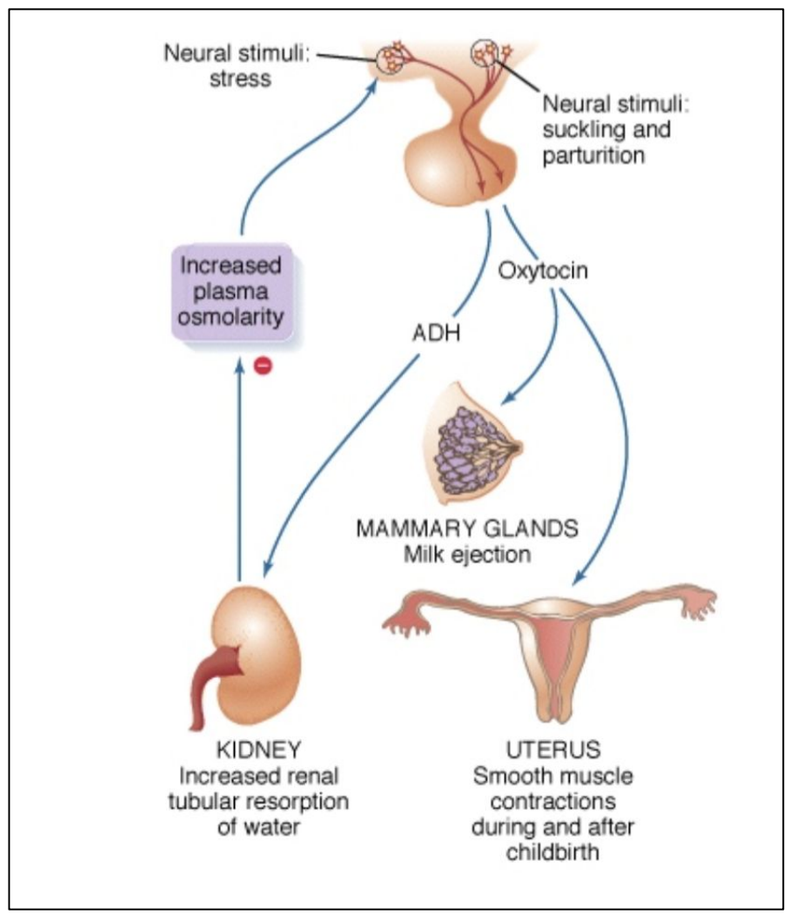

Figure 5-13

QUIZ

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1. Which of the following is the function of oxytocin?
A) Increase metabolic rate
B) Increase cortisol levels
C) Inhibit synthesis of prostaglandin
D) Stimulate uterine contraction

2. Osmoreceptors are located in:
A) Carotid sinus
B) Anterolateral hypothalamus
C) Pulmonary veins
D) Aortic arch

3. Failure of kidney to respond to ADH is
A) Diabetes mellitus
B) Central diabetes insipidus
C) Nephrogenic diabetes insipidus
D) SIADH

4. For milk to flow from the nipple of the mother into the mouth of the nursing infant, what must occur?
A) Myoepithelial cells must relax
B) Prolactin levels must fall
C) Oxytocin secretion from the posterior pituitary must take place
D) All the above

5. Actions of oxytocin includes all the following except
A) Contraction of pregnant uterus
B) Synthesis of milk
C) Ejection of milk
D) Contraction of vas deferens

6. Release of which hormone is an example of neuroendocrine secretion?
A) GH
B) Cortisol
C) Oxytocin
D) Prolactin

ANSWER KEY: D, B, C, C, B, C

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- Ganong's Review of Medical Physiology