General Overview of the Endocrine System

Questions to be thinking about to help organize your learning of the components of the Endocrine System:

**Anatomy**

1) Where are the different hormone producing cells located?

2) What hormone does a particular type of endocrine cell or neuron produce?

**Hormones**

1) What is their general chemical structure?
2) How does their structure affect their function?
3) Where are they produced?
4) What environmental or physiological stimuli regulate their production and secretion?
5) Is their production and secretion under direct neural or hormonal control?
6) What are their targets?
7) What effects do they produce on their targets?
8) How do they produce their effects on their targets (how is the signal transduced? i.e. receptor mechanisms)
Often endocrine cells are clumped together into a well defined gland (e.g. pituitary, thyroid, adrenal, testes, ovaries), but not always (e.g. gut, liver, lung).

Remember, it's cells that produce hormones, not glands.

Although many glands secrete more than one type of hormone, most neurons or endocrine cells only produce one type of hormone (there are a few exceptions).
Some Terminology

Neurohormone: a hormone that is produced by a neuron

All of the hormones we discuss can be classified as belonging to one of 2 general functional categories:

1) Releasing hormone (or factors) — hormone that acts on endocrine cells to regulate the release of other hormones. (Note: the influence may be stimulatory or inhibitory)

2) Effector hormone — non-releasing factors; hormones that produce a regulatory effect on physiological/psychological function.
There's an especially important interaction between the hypothalamus, pituitary and some of the other endocrine glands.
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**Neuroendocrine Arrangements**

3 "orders" of neuroendocrine arrangements: "starting with a particular neurohormone, how many hormones must be secreted in order for an effector hormone to be secreted?"

**first order — neurohormone itself is an effector hormone (released in posterior pituitary).**
Example of a first order arrangement:

*Oxytocin*

The neurohormone oxytocin is released in the posterior pituitary, where it enters the general circulation and travels to distant targets to produce the physiological effects of milk-ejection (milk let-down) in the mammary gland or contraction in the uterus during parturition (child-birth).

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**Neuroendocrine Arrangements**

3 "orders" of neuroendocrine arrangements: "starting with a particular neurohormone, how many hormones must be secreted in order for an effector hormone to be secreted?"

second order — neurohormone is a releasing factor for an anterior pituitary hormone that is an effector hormone.
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Example of a second order arrangement: 

**GHRH → growth hormone**

The neurohormone growth hormone releasing hormone (GHRH) stimulates cells in the anterior pituitary to secrete growth hormone, which enters the general circulation and travels throughout the body to stimulate growth of various target tissues.
There's an especially important interaction between the hypothalamus, pituitary and some of the other endocrine glands.

**Neuroendocrine Arrangements**

3 "orders" of neuroendocrine arrangements: "starting with a particular neurohormone, how many hormones must be secreted in order for an effector hormone to be secreted?"

**third order** — neurohormone is a releasing factor for an anterior pituitary hormone, which is a releasing factor for an effector hormone.
Example of a third order arrangement:

\( GnRH \rightarrow \text{luteinizing hormone} \rightarrow \text{testosterone} \)

The neurohormone gonadotropin releasing hormone (GnRH) stimulates cells in the anterior pituitary to secrete the tropic hormone, luteinizing hormone (LH), which enters the general circulation and travels to the testes where it stimulates production and secretion of testosterone into the general circulation, which travels throughout the body to affect muscle growth, secondary sex characteristics, sexual behavior, etc.

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Basic Anatomy of Hypothalamus:

neurohormones are produced by neurons located in the hypothalamus
Basic Anatomy of Hypothalamus:

Location of hypothalamus — **below thalamus, base of forebrain, surrounds third ventricle**

A number of hypothalamic subnuclei contain the cell bodies of neurons that produce neurohormones.

- Some of these neurohormones are releasing factors
- Some of these neurohormones are effector hormones
Subdivisions of hypothalamus—
*Anterior portion:* anterior hypothalamic nucleus (n.), preoptic area, suprachiasmatic n.

*Middle portion:* paraventricular n., periventricular n., supraoptic n., arcuate n., dorsomedial n., ventromedial n.

*Posterior portion:* mammillary bodies, posterior hypothalamic area

Subdivisions of hypothalamus—

Median eminence: part of hypothalamus immediately above pituitary stalk
Features of Neurosecretory Neurons of the Hypothalamus

<table>
<thead>
<tr>
<th>General class of hormone produced</th>
<th>Size of cell body</th>
<th>Location of cell body</th>
<th>Location of axon terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effector hormone</td>
<td>Large “magnocellular neuron”</td>
<td>Lateral paraventricular n. or supraoptic n.</td>
<td>Posterior pituitary</td>
</tr>
<tr>
<td>Releasing hormone</td>
<td>Small “parvocellular neuron”</td>
<td>Various hypothalamic nuclei</td>
<td>Median eminence</td>
</tr>
</tbody>
</table>

Why the difference in neuronal cell body size?

**Hint #1**: it has to do with the general class of hormone produced and the quantity of hormone required to do its task

**Hint #2**: it has to do with whether the hormone is a systemic hormone
Basic Anatomy of Pituitary

pituitary—pitui, Latin = “snot gland”

AKA hypophysis—Greek = “undergrowth”

The pituitary is situated in the sella tursica (Latin = Turkish Saddle), indentation in sphenoid bone.
Subdivisions (lobes) of pituitary:

1] anterior pituitary (AKA adenohypophysis or pars anterior) developmentally originates from roof of mouth

2] posterior pituitary (AKA neurohypophysis or pars nervosa) developmentally originates from brain

3] intermediate pituitary, distinct junction between anterior and posterior pituitary in non-human mammals

The pituitary is attached to the hypothalamus by the infundibulum (L. funnel) or pituitary stalk.

**Portal Blood System**

Specialized blood vessel system that serves to carry neurohormones:

- from **median eminence**
- to **anterior pituitary**
Portal Blood System

Components:

Primary plexus—located in median eminence

Secondary plexus—located in anterior pituitary

Portal vein—connects primary and secondary plexus; in pituitary stalk; one-way blood flow from hypothalamus