Animal Science 434
Reproductive Physiology

Lecture 6 and 7: Endocrinology

What is the function of the endocrine system?

Integration of Body Functions

• nervous and endocrine systems are similar
• nervous system
  » seconds
• endocrine system
  » minutes and hours

Neuro-endocrine Response

Manipulation of the Endocrine System

• Hormones can be used to regulate body functions
  » growth (anabolic steroids)
  » lactation (GH or STH)
  » birth control (Estradiol, Progesterone)
  » estrous cycle (PGF$\alpha$
  » superovulation and embryo transplant (FSH, eCG)
  » parturition (oxytocin)

Endocrine Gland

• A ductless gland
• Secretes substances (hormones) into blood or lymph that affect cells elsewhere in the body
• The secretion does not involve loss of tissue
Exocrine Gland

- A gland with ducts that are used for secretion

Hormone

- Substance produced by endocrine gland
- Acts on cells, tissues or organs at a place other than where produced
- Acts as a catalyst.

Endocrine Glands

Classification and Properties of Hormone

A. Site of Production

B. Type of action

1. Primary hormone of reproduction
2. Metabolic hormone

C. Chemical Structure

1. General structure
   - Proteins and polypeptides
   - Steroids
   - Fatty acids
   - Modified amino acid
2. Size

Location of the Hypothalamus and Pituitary Gland
Hypothalamus

Function of Hypothalamus
- appetite
- thirst
- body temperature
- vasomotor activity
- emotion
- use of body nutrient reserves
- activity of intestine
- sleep
- sexual behavior
- Production and release of releasing hormones

Releasing Hormones of the Hypothalamus

A. Structure
   - short chain polypeptides (3 - 44 amino acids)

B. General Function
   - to cause the release of trophic hormones from the anterior pituitary gland

Releasing Hormones of the Hypothalamus

C. Hormones
   - Gonadotropin releasing hormone (GnRH)
     - LH, FSH release
   - Thyrotrophin releasing hormone (TRH)
     - TSH and prolactin release
   - Corticotrophin releasing hormone (CRH)
     - ACTH release
   - Growth hormone releasing hormone (GH-RH)
   - Somatostatin (growth hormone inhibiting hormone)
Hypothalamus and Anterior Pituitary Gland

Anterior Pituitary Hormones
A. Structure
1. glycoproteins or proteins

B. Hormones
1. gonadotropins
   » Follicle stimulating hormone (FSH)
   » Luteinizing hormone (LH)
   » Prolactin

2. Other trophic hormones
   - Adrenal Corticotropin (ACTH)
   - thyroid stimulating hormone (TSH)
   - growth hormone (GH or STH)

Structure of LH, FSH and TSH
- Made of 2 amino acid chains
  - α chains are the same
  - β chains differ and give specificity
Posterior Pituitary Hormones

A. Structure
• polypeptides (9 amino acids)

B. Hormone
• Oxytocin - contraction of smooth muscle

Placental Hormones

• Equine Chorionic Gonadotropin (eCG)
  » Formation of accessory CL and maintains pregnancy

• Human Chorionic Gonadotropin (HCG)
  » Maintains primate CL and pregnancy

• Placental Lactogen (PL)
  » Development of the mammary gland in the mother

• Steroids - Estrogen and Progesterone

Gonadal Polypeptide Hormones

• Relaxin
  » Secreted by CL during pregnancy,
  » Parturition

• Inhibin
  » Inhibits FSH release

Gonadal Steroids

A. General
  » Origin - ovary, testis, adrenal

Steroid Synthesis

Cholesterol 27-C → Pregnenolone 21-C → Estradiol 18-C → Testosterone 19-C → Progesterone 21-C

Steroid Synthesis

Cholesterol 27-C → Pregnenolone 21-C → Estradiol 18-C → Testosterone 19-C → Progesterone 21-C
**Gonadal Steroids Cont.**

A. General Cont.
   - Solubility
     - Bound to a binding protein for transport

B. Type of Steroids
   - Androgens - Testosterone
   - Estrogen - Estradiol
   - Progestin - Progesterone

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**Steroid Synthesis**

- Cholesterol → pregnenolone → Mitochondria → Smooth ER → Testosterone → Progesterone → Estradiol

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**Other Hormones**

A. Prostaglandins
   1. PGF_{2\alpha}
   2. PGE_{2\alpha}

**Phospholipids**

- PLA_{2} → Arachidonic Acid → Cyclo-oxygenase
  - PGD_{2}, PGE_{2}, PGF_{2}

- Inhibited by aspirin

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**Other Hormones**

B. Melatonin
   1. Secreted from the pineal gland.
   2. Is a modified amino acid
   3. Functions to integrate effects of light on reproductive processes.
Other Hormones

C. Human Menopausal Gonadotropin (hMG)
1. Anterior pituitary gland
   » Secreted in menopause, FSH-like activity
   » Isolated from urine
     a. Pergonal - superovulation

Classification and Properties of Hormone

A. Site of Production

B. Type of action
1. Primary hormone of reproduction
   (FSH, LH, estradiol, progesterone)
2. Metabolic hormone
   (thyroxin, insulin, STH)

Classification and Properties of Hormone

• Chemical Structure
  » Polypeptides - hypothalamic
  » Protein - pituitary, gonad
  » Steroids - gonad, adrenal
  » Fatty acid - many sources, prostaglandins
  » Modified amino acid - pineal

Chemical Structure of Hormones

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Polypeptide</th>
<th>Modified Amino Acid</th>
<th>Protein</th>
<th>Sex Steroid</th>
<th>Fatty Acid</th>
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</thead>
<tbody>
<tr>
<td>GnRh</td>
<td></td>
<td>melatonin</td>
<td>LH</td>
<td>Estradiol</td>
<td>PGFα</td>
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<tr>
<td>TRH</td>
<td></td>
<td></td>
<td>FSH</td>
<td>Progesterone</td>
<td></td>
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<tr>
<td>CRH</td>
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<td></td>
<td>Prolactin</td>
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<td></td>
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<tr>
<td>GHRH</td>
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<td></td>
<td>ACTH</td>
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<tr>
<td>Somatostatin</td>
<td></td>
<td></td>
<td>TSH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxytocin</td>
<td></td>
<td></td>
<td>GH or STH</td>
<td></td>
<td>Relaxin</td>
</tr>
<tr>
<td>Inhibin</td>
<td></td>
<td></td>
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<td></td>
<td>Inhibin</td>
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Chemical Structure of Hormones Cont.

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Molecular Weight</th>
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<tbody>
<tr>
<td>FSH</td>
<td>30,000 to 37,000</td>
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<tr>
<td>LH</td>
<td>26,000 to 32,000</td>
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<tr>
<td>Prolactin</td>
<td>23,000 to 25,000</td>
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<td>HCG</td>
<td>37,700</td>
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<tr>
<td>eCG</td>
<td>28,000</td>
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<td>Inhibin</td>
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<td>ACTH</td>
<td>4,500</td>
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<td>Oxytocin</td>
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<td>GnRH</td>
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<td>Estradiol</td>
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<tr>
<td>Testosterone</td>
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<tr>
<td>Progesterone</td>
<td>300</td>
</tr>
<tr>
<td>PGF</td>
<td>300</td>
</tr>
</tbody>
</table>

These hormones can not be given orally!
Chemical Structure of Hormones Cont.

Steroids

CHOLESTEROL

PREGNENOLONE

OVARY OR TESTES

PROGESTERONE

CORTISOL

ADRENAL

OVARY OR TESTES

PROGESTERONE

17a OH-PROGESTERONE

ANDROSTEINDIONE

ESTRONE

TESTOSTERONE

ESTRADIOL

These hormones can be given orally!

Mechanism of Hormone Action