BEHAVIORAL ENDOCRINOLOGY

1. Lecture & Discussion topics
   a. Behavioral Ecology Introduction
   b. Hormone systems Introduction
   c. Reading Scientific papers

WHAT IS BEHAVIORAL ECOLOGY?

- Behavioral ecology as a discipline is concerned with evolution and fitness consequences of behavior

An Introduction to Behavioural Ecology, Fourth Edition. Nicholas B. Davies, John R. Krebs and Stuart A. West.

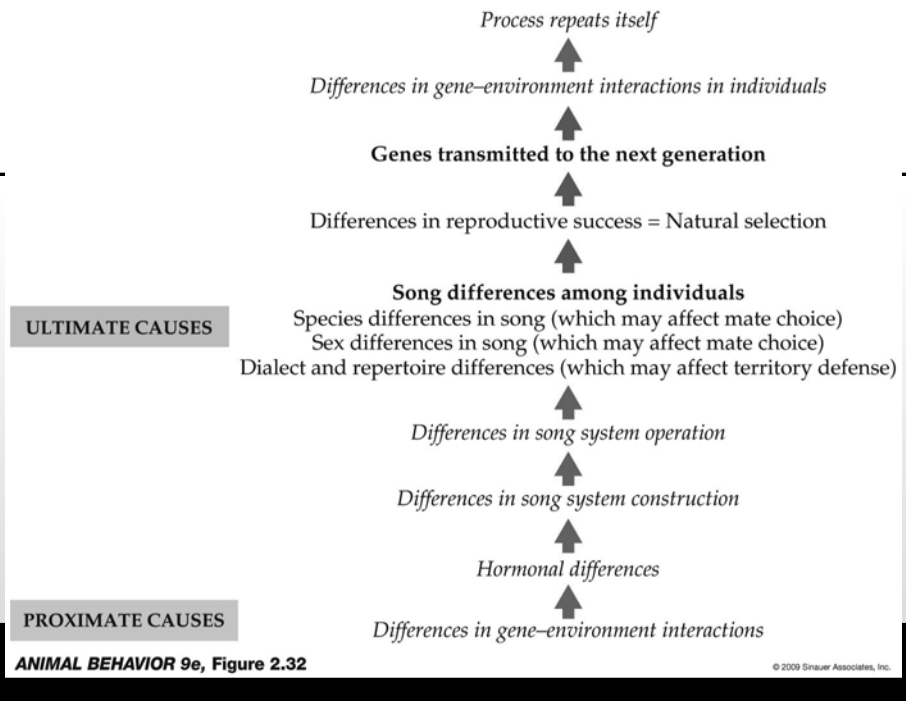
TINBERGEN'S FOUR QUESTIONS

1. How does the behavior develop
2. What causes behavior (mechanism)

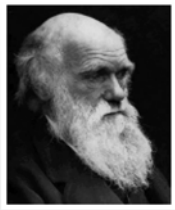
- **{Proximate level questions: our focus will be on hormone—behavior linkage}**

3. Survival value of behavior
4. Evolution of behavior

- **{Ultimate level questions}**



MAIN PREMISE OF BEHAVIORAL ECOLOGY



- Behavior is a product of Natural Selection…
- Under what conditions can Natural Selection occur?
  1. Variation
  2. Heritability
  3. Differential reproductive success

BIOLOGICAL FITNESS

- Lifetime reproductive success of an individual
  - More offspring produced = higher fitness
  - Fewer offspring in one season may increase the survival of the parents and their future reproductive success
  - Tradeoffs….

ARE TRAITS FAVORING INCREASED SURVIVAL ALWAYS ADAPTIVE?

- If traits favor higher survival, but lower reproductive success, these traits will be selected against.
- What is an adaptation?
  - Trait(s) that evolved because they resulted in higher fitness
  - Selection acted in past to produce current adaptations

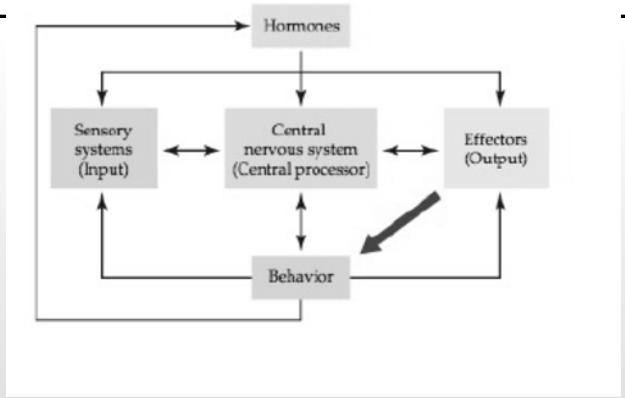
THE ENDOCRINE SYSTEM

BRIEF OVERVIEW

WHAT ARE HORMONES?

- Organic chemical messengers produced and released by specialized glands = endocrine glands.
  - Released into bloodstream
  - then act on target organs (or tissues) at a distance from their origin.
- Coordinate physiology and behavior (dual functions)
  - E.g., hormones that cause gametic (egg or sperm) maturation also promote mating behavior in many species.

HOW DO HORMONES AFFECT BEHAVIOR?



Bi-directional relationship

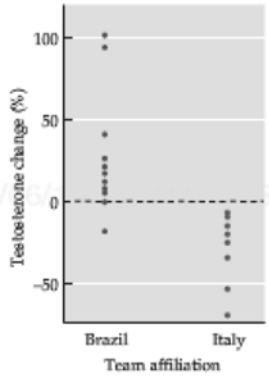


FIGURE 1.10 Percent change of testosterone of sports fans Testosterone concentrations of male Brazilan and Italian fans were measured in saliva samples obtained before and immediately after the final soccer match of the 1994 World Cup, which Brazil won. The graph shows the change in testosterone concentra-

HOW DOES BEHAVIOR AFFECT HORMONES?

DETERMINING HORMONE–BEHAVIOR INTERACTIONS

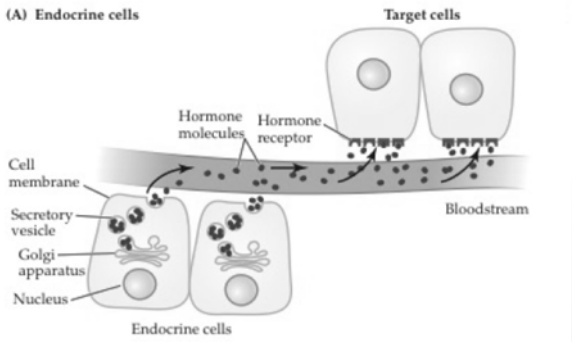
- Hormonally dependent behavior should disappear when source of hormone removed or actions of hormone blocked.
- Restoring missing hormonal source or its hormone should restart absent behavior.
- Hormone concentrations and behavior should covary – behavior should be observed only when hormone concentrations are high and not when low.

PRIMARY QUESTIONS ABOUT THE ENDOCRINE SYSTEM

- Where do hormones come from?
- Where do hormones go?
- What do hormones do?

GENERAL FEATURES

1. Ductless.
2. Rich blood supply.
3. Hormones secreted into bloodstream.
4. Travel to virtually every cell in body and potentially interact with any cell that has appropriate receptors.
5. Hormone receptors are specific binding sites, embedded in cell membrane or elsewhere in cell, that interact with a particular hormone.



FOUR CLASSES

(1) protein and peptide hormones

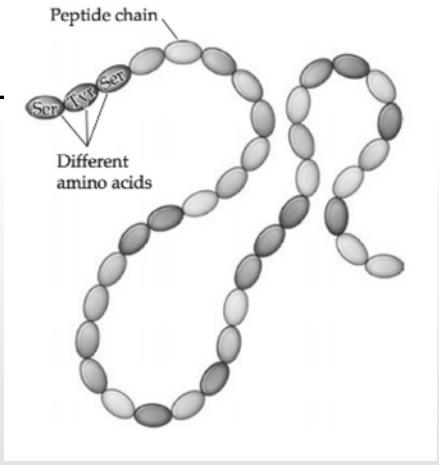
(2) steroid hormones

(3) monoamines

(4) lipid-based hormones.

PROTEIN & PEPTIDES

- Most vertebrate hormones are proteins.
- Made up of individual amino acid building blocks.
  - few amino acids in length = peptide
  - larger ones = protein hormones or polypeptide

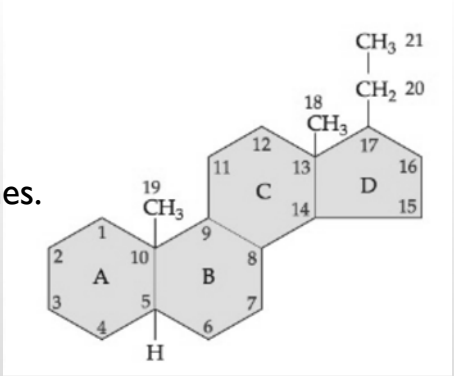


PEPTIDE/PROTEIN HORMONES VARY TAXONOMICALLY

	1	2	3	4	5	6	7	8	9	10
Mammal	pGlu	His	Trp	Ser	Tyr	Gly	Leu	Arg	Pro	Gly-NH_2
Chicken I	pGlu	His	Trp	Ser	Tyr	Gly	Leu	Gln	Pro	Gly-NH_2
Catfish	pGlu	His	Trp	Ser	His	Gly	Leu	Asn	Pro	Gly-NH_2
Chicken II	pGlu	His	Trp	Ser	His	Gly	Trp	Tyr	Pro	Gly-NH_2
Dogfish	pGlu	His	Trp	Ser	His	Gly	Trp	Leu	Pro	Gly-NH_2
Salmon	pGlu	His	Trp	Ser	Tyr	Gly	Trp	Leu	Pro	Gly-NH_2
Lamprey	pGlu	His	Tyr	Ser	Leu	Glu	Trp	Lys	Pro	Gly-NH_2

STEROID HORMONES

- Source: adrenal glands, gonads, and brain
- Structure (in Verts): 3 six-carbon rings + 1 conjugated five-carbon ring.
- Precursor (in Verts): cholesterol.
- Fat-soluble = move easily through cell membranes.
- Leave cells in which they were produced immediately.
- Signal to produce = signal to release



WHAT AFFECTS ACTIONS OF STEROIDS?

(1) hormone concentrations in the blood
- (1) rate of steroid biosynthesis
- (2) rate of steroid inactivation (in liver)
- (3) affinity with which hormone is bound to plasma carrier protein

(2) number of available receptors in target tissue

(3) availability of appropriate co-activators.

GLUCOCORTICOIDS

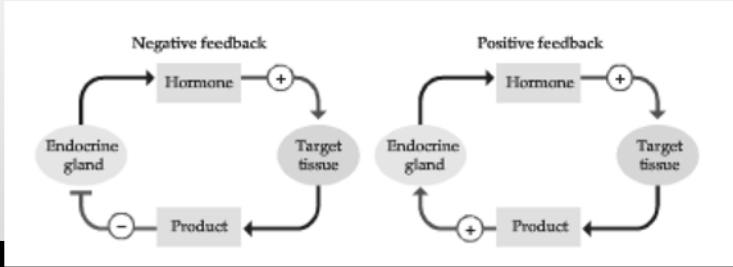
- Carbohydrate metabolism
- Released in response to stress
  - Corticosterone (CORT): amphibians, reptiles, birds, rats and mice
  - Cortisol: primates & fish

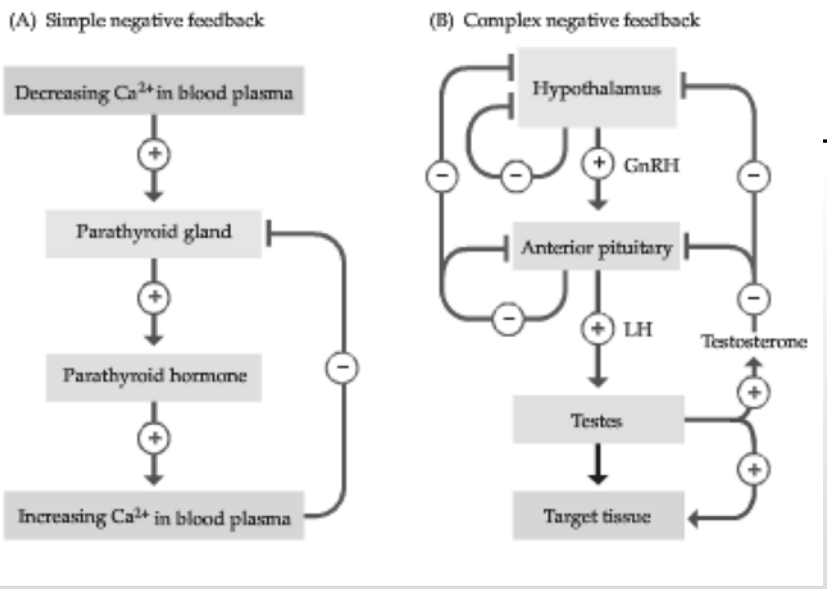
ANDROGEN ACTIONS

- Operate via androgen receptors = AR
- Spermatogenesis
- Maintain accessory sex organs
- Support secondary sexual characteristics
- Behavior (Courtship, copulation, aggression)
- Metabolism
  - E.g., heart, liver and kidney

Negative Feedback loops and the HPA VIDEO

- Two patterns of internal hormonal regulation:
  - physiological by-products generated in response to their actions
  - stimulatory or inhibitory effects of hormones
    - negative or positive feedback directly from the circulating levels of the regulated hormone itself





EVOLUTION OF HORMONES

- Evolution of hormones has been an evolution in the function of hormones.
- Chemical structures of **steroid** hormones are virtually identical among all vertebrate animals
- *Some* **protein** hormones have been conserved over evolutionary time and perform diverse functions.
  - Insulin found virtually unchanged in species ranging from bacteria to humans

THE ANATOMY OF A PUBLISHED PAPER:

- Title (Statement of the Question)
- Abstract (Summary)
- Introduction (Background)
- Materials and Methods
- Results
- Discussion (Interpretation of Results)
- Literature Cited
- Figures/Tables

But some journals do not have this exact sequence or lack headings (e.g. Science, Nature, PLoS)

FIRST READING

- Read the paper for the first time without worrying about details of what you can't understand.
  - Don't take notes at this time, but:
- Look at all the figures and tables
- Write down your thoughts in your own words
- Read the paper again, taking notes now about the questions asked, what the data show, and what the author concludes

HOW TO READ THE DATA: FIGURES

- What are the y- and x- axes measuring?
  - Response/dependent variables and independent variables.
- What does the figure legend say?
- Write down your own one sentence conclusion about what the data suggest.

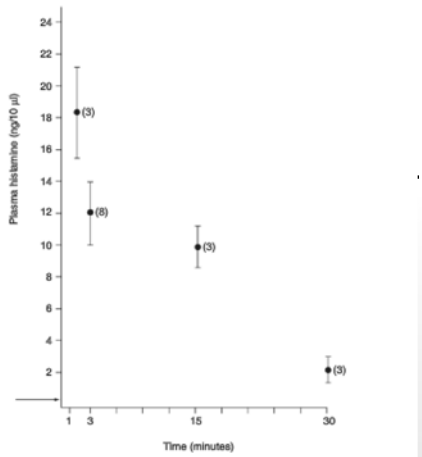


Figure 1. Plasma histamine concentrations in response to neurotensin (NT) given at t = 0. Rats were anesthetized and given NT (5 nmol/kg) or saline (0.3 ml) intravenously. Blood samples were collected at the indicated times. Each point represents the mean (one standard error about the mean) of n values (given in parentheses). The horizontal arrow (lower left) shows the mean histamine concentration before addition of NT. Intravenous injection of saline did not alter this concentration over the 30-minute observation period.

Source: From Cochrane, D.E., 1990. Peptide regulation of mast-cell function. In *Progr. Medicinal Chemistry*, Vol. 27; G.P. Ellis and G.B. West, eds.; Elsevier Science Publ. (Biomedical Division), pp. 145–185.

HOW TO READ THE DATA: TABLES

- What is displayed in the rows and columns?
  - Response/dependent variables and independent variables.
- What does the table legend say?
- Write down your own one sentence conclusion about what the data suggest.

Table 1. The diets of 3 predatory cats from Rio Manu, Peru, inferred from fecal samples collected in nature. An entry of 5% (top left) means that fish, in this case, made up 5% of all the prey items found in the feces from that predator. The data are based on the minimum number of prey that must have been eaten to obtain the number of bones of each type collected. n = number of feces examined from each kind of predator.

	Name of predator			Total eaten
Kind of prey	Jaguar (n = 40)	Puma (n = 12)	Ocelot (n = 177)	from all predators
Fish (%)	5	0	2	7
Reptiles (%)	33	17	12	62
Small rodents and opossums (%)	8	17	66	91
Large rodents (%)	15	58	5	78
Other large mammals (%)	23	0	0	23
Birds (%)	10	0	11	21
Bats (%)	5	8	5	18
Total (%)	99	100	101	

Based on Emmons, L.H. 1987. *Behav. Ecol. Sociobiol. 20: 271–283.*