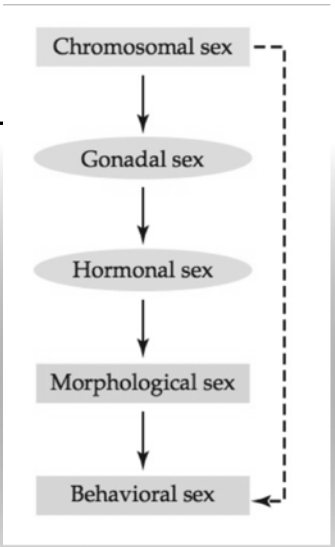
BEHAVIORAL ENDOCRINOLOGY

1. Lecture & Discussion topics
   a. Sex Differences in Behavior: Sex Determination & Differentiation
   b. Discussion of Adkins-Regan et al. (2013)

SEX DETERMINATION SEXUAL DIFFERENTIATION

- Determination: develop as either a male or a female
- Differentiation: developmental process of becoming male or female.
  - To what extent are behavioral sex differences mediated by androgenic and estrogenic steroid hormones?

Chromosomal sex→ gonadal sex → hormonal sex → morphological sex → behavioral sex differences.



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}**

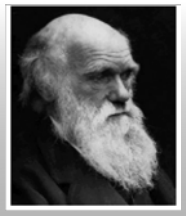
3. Survival value of behavior
4. Evolution of behavior

- **{Ultimate level questions}**

PROXIMATE CAUSES OF BEHAVIORAL SEX DIFFERENCES?

- Nature-versus-nurture.
- Genes-versus-environment.
- Behavior, like any other phenotypic trait, is the result of the interaction of biological and environment factors.
- Cake analogy

MAIN PREMISE OF BEHAVIORAL ECOLOGY



- Behavior is a product of Natural Selection…
- Under what conditions can Natural Selection occur?
  1. Variation
  2. Heritability = Degree to which VARIATION IN A TRAIT IN A POPN IS DUE TO VARAITION IN GENETICS BETWEEN INDIVIDUALS
  3. Differential reproductive success

HOW STUDY THE ORIGIN OF HUMAN BEHAVIORAL SEX DIFFERENCES ?

- Animal Models
- Studies of individuals that have undergone anomalous sexual differentiation.
- Hormone concentrations obtained during amniocentesis correlated with future behavioral patterns.
- Look for universal commonality in the behavior of all children, across cultures.

WHAT IS SEX?

- Lots of definitions (see the chapter 3 definitions)
- In Behavioral Ecology we usually use "gametic sex"
  - fundamental basis underlying the two sexes.
    - ovaries of female animals produce small numbers of large, immobile, resource-rich gametes (ova / eggs)
    - testes of male animals produce many small, mobile gametes (sperm)

ULTIMATE CAUSES OF SEX DIFFERENCES

- We will spend a lot of time on this later on
  - Evolution of Sex = one field of study using asexual species to elucidate why sex evolved
  - Sexual selection theory

PROXIMATE CAUSES ORGANIZATIONAL/ACTIVATIONAL HYPOTHESIS

- Behavioral sex differences result from:

(1) differential exposure to hormones that act early in development to organize the neural circuitry underlying sexually dimorphic behaviors

(2) differential exposure to sex steroid hormones later in life activate the neural circuitry previously organized.

MAMMALIAN SEX DIFFERENTIATION

- XX / XY sex determination

(1) germinal ridge

(2) primordial gonad bipotential

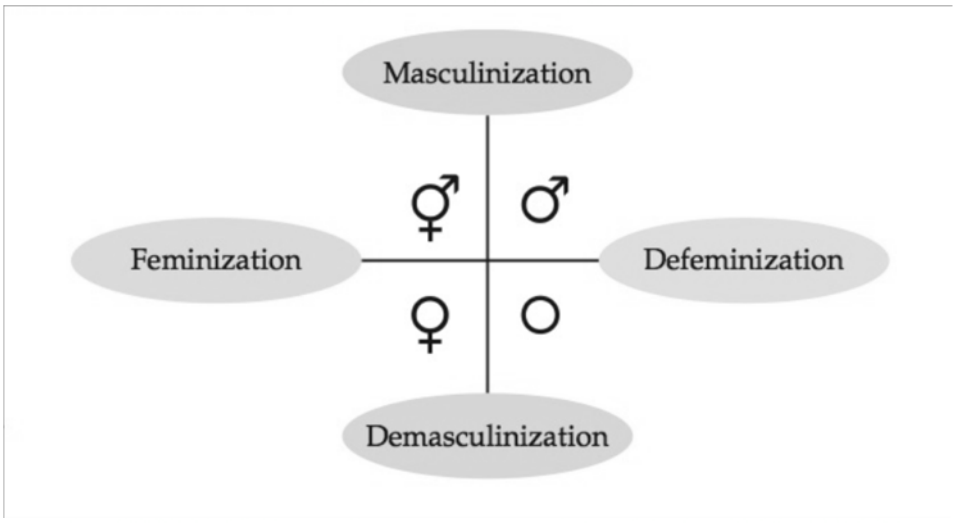
(3) development into testis determined by cellular expression of SRY gene on Y chromosome in the indifferent gonads

MAMMALIAN SEX DIFFERENTIATION

- XX / XY sex determination

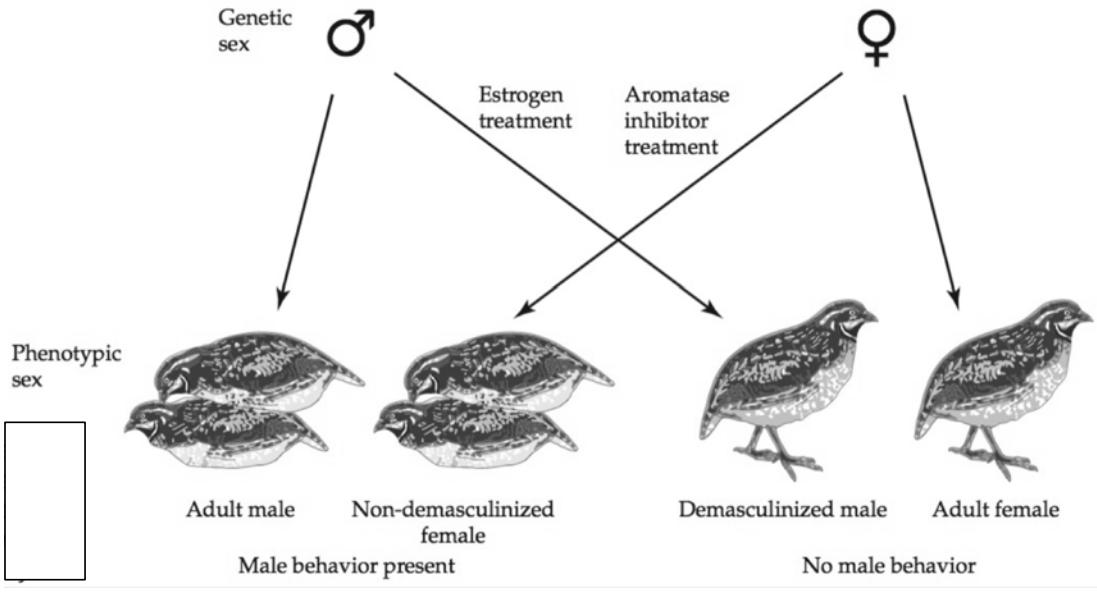
(4) embryonic testes produce androgens, & peptide hormones that steer the development of the body, central nervous system, and subsequent behavior in a male direction.

(5) embryonic ovaries do not secrete high concentrations of hormones and development follows a female pathway. (but low E may be necessary).



AVIAN SEX DIFFERENTIATION

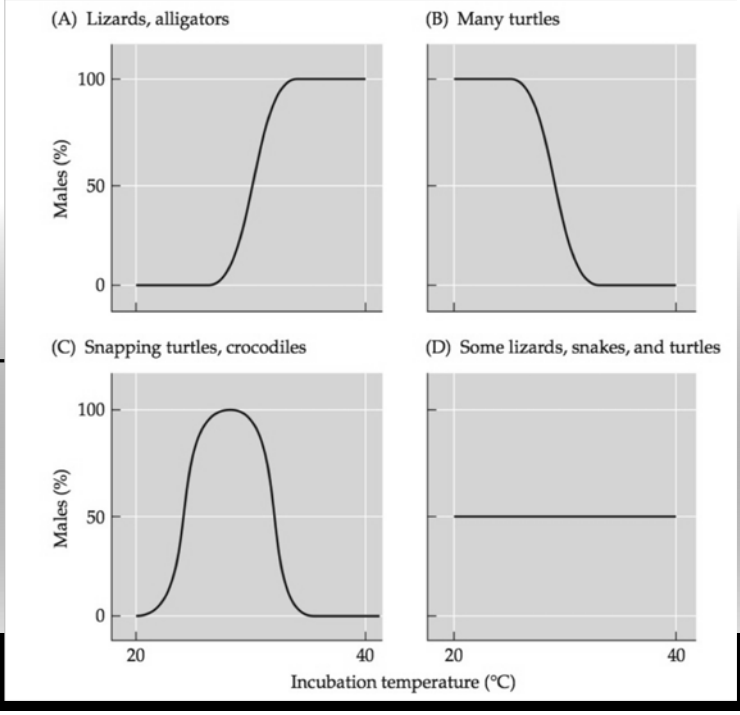
- Females heterogametic (ZW), males homogametic (ZZ).
- Female pattern of development attained by active hormonal secretion.
- Sexually dimorphic neuromuscular system underlying singing behavior requires estrogens to exert masculinizing effect on singing.
  - absence of hormonal stimulation leads to feminine pattern of no birdsong.



AVIAN SEX DIFFERENTIATION

- No known sex-determining gene has been identified in birds.
- W sex chromosome → primordial gonad secrete estrogens → proliferation of the germinal epithelium in left gonad→ovarian cortical development.

TEMPERATURE-DEPENDENT SEX DIFFERENTIATION



SOME EXAMPLES OF ALTERNATIVE MORPHS AND HORMONE MEDIATORS

11-KT GOES FROM LOW TO HIGH AS TRANSISTION FROM FEMALE TO MALE

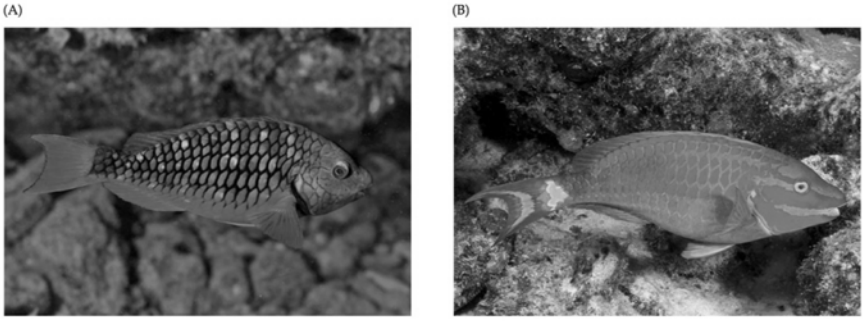
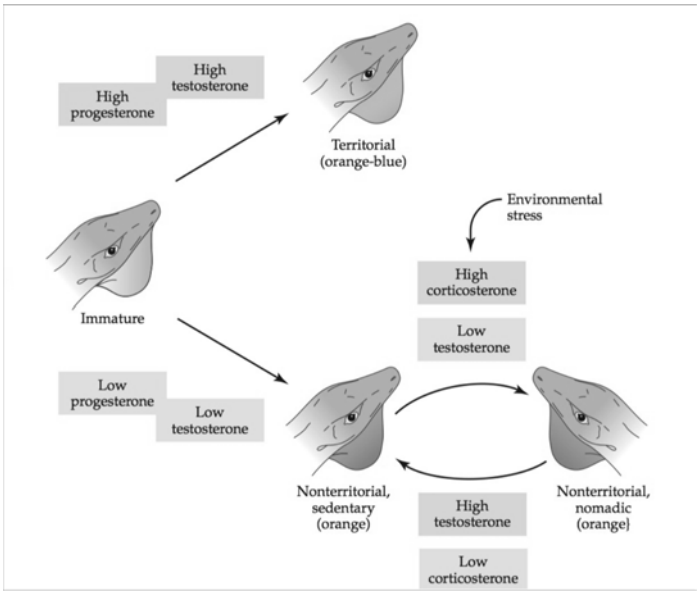


FIGURE 3.26 Sequential hermaphroditism in the striped parrotfish. (A) Young females of this species have bold stripes and defend territories along the edges of reefs. (B) As females mature and grow in size, they change sex and adopt male-typical coloration and behavior, joining other males in defending large territories encompassing several "harems" of young females.



ORGANIZATIONAL/ ACTIVATIONAL

Experimental approaches

Exposure to androgens prior to day 20 of life permanently organizes the brain to permit later expression of masculine behavior.

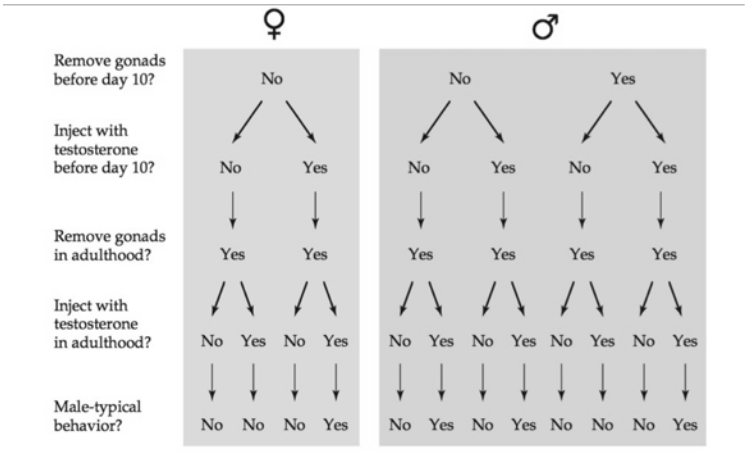
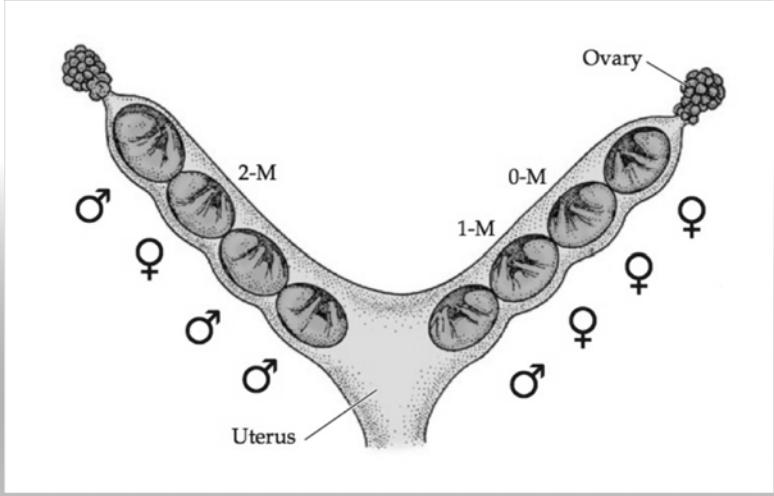


FIGURE 3.32 **Experimental protocol** for determining organizational versus activational effects of androgens on sexually dimorphic mating behavior in rodents.

EPIGENETIC REGULATION

- Alteration in gene transcription resulting from modification in structure of chromatin.
  - E.g., DNA methylation: methyl groups added to DNA to reduce gene expression.
  - E.g., histone deacetylation also reduces gene expression
- Likely plays a role in mammalian sex differences in behaviors
  - suppression of particular genes during sensitive period of development required for brain masculinization.
- Epigenetic events may be guided by hormones

EFFECTS OF THE INTRAUTERINE ENVIRONMENT



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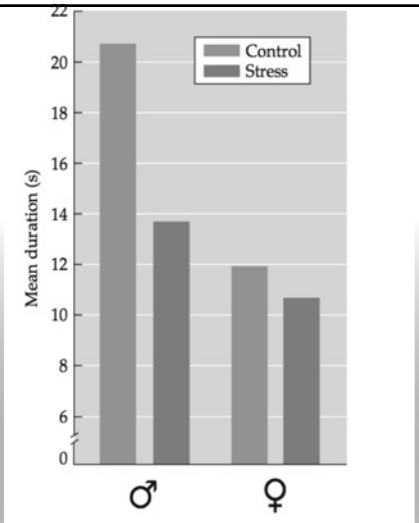

FIGURE 3.36 Rough-and-tumble play is demasculinized in males by stress in utero. When pregnant rats were stressed by exposure to bright lights during the last trimester of gestation, the average duration of rough-and-tumble play (at 31 days of age) in their male offspring was similar to that in females. After Ward and