Reproductive behavior 1

• Why sex? Asexual reproduction in some animals (parthenogenesis)
  – All eggs genetically identical to mother

• Sexual reproduction produces more genetic variation
Why are the gametes different?
Sexual Selection

• Sexual selection is a type of natural selection -- it is selection pressure exerted on individuals by other members of their species in the context of reproduction.

• Two main kinds of sexual selection:
  – **Intrasexual competition** for access to mates
  – **Mate preference**, the preference of potential mates for certain qualities in a partner
Sexual Selection

• Operational sex ratio (OSR) and parental investment.
  - OSR is the ratio of sexually receptive males to sexually receptive females.
    - usually male-biased (M>F), leading to male-male competition
• Parental investment is any investment in offspring that reduces the ability to produce more offspring.
  - usually greater parental investment by females
• If male-biased OSR & low parental investment by males…?
  - male and female behavior
Sexual selection

- morphology (appearance)
- behavior (displays)

http://www.youtube.com/watch?v=m0M8pZnNlnI
Male sexual behavior

- Appetitive – sex drive, libido, courtship
- Consummatory – copulatory behavior
- “Males expend much more time and energy seeking copulation than actually copulating…”
Male rodent consummatory behavior

- Sexual attraction is largely olfactory
- Mounting
- Intromission
- Ejaculation
- Ultrasonic vocalizations and self-grooming
Typical measurements

- Mount latency
- Intermount interval
- Intromissions
- Ejaculations
- Postejaculatory interval
- Environmental context & testing paradigm
Activational Effects of Androgens

- Organizational effects – early development
- Activational effects – after reproductive maturity, transient modifications of behavior
- Behavior can also influence hormone levels
- Androgens do not “cause” male sexual behavior, but rather androgens change the probability that male sexual behavior will be elicited within a particular context.
Endocrine mechanisms: rodents

- Castration typically reduces sexual behaviors in adult male rodents

- Order of loss: mounting, then intromissions, then ejaculations
Effects of androgens in male rats

- **Pre-castration**
- **Post-castration**
- **Period of testosterone administration**

![Graph showing the effects of androgens in male rats.](image-url)
Dose-response experiment

- Blood plasma testosterone level (ng/ml)
- Silastic capsule length (mm)
- Male rats ejaculating (%)

Key points:
- 15%
- 72%
- 94%

Graph shows a dose-response relationship between silastic capsule length and blood plasma testosterone level, with corresponding effects on male rats' ejaculation.
Aromatase

- Aromatization in specific brain regions is crucial
  - in castrated male rats: T, androstenedione, and E₂ restore appetitive and consummatory behaviors
- T + aromatase inhibitor
  - Systemic administration of T
  - Systemic or central administration of aromatase inhibitor
- Aromatase knockout mice or ERα knockout mice
- How else to test?

- In rodents, 5α-DHT is more important in periphery
Aromatase & male sexual behavior

- Japanese quail
- Male will peer through window at female...
- Removal of testes eliminates sexual interest in female
- T treatment restores interest in female
(B)

![Graph showing time at window (seconds) vs. test series.]

- **Testosterone implanted**
- **Testosterone implant + aromatase inhibitor (at test 9)**
- **Controls (no testosterone implant)**
Sex steroid receptors in the brain

How to determine where sex steroids act to modify male sexual behavior?
T facilitates the release of dopamine in the mPOA and other areas
Endocrine mechanisms: men

- subjects: hypogonadal men
- treatments: s.c. injection of T (0, 100 and 400 mg)
- placebo-controlled
- repeated measures ("within-subject" design)
- random order of treatments
- double-blind

- Measured plasma T levels
- Subjects kept daily logs of erections, erotic thoughts, sexual activity.
Effects of T on hypogonadal men

![Graph showing plasma testosterone levels after injection for Placebo, 100 mg, and 400 mg doses.](image)
• DHT can also reinstate sexual behaviors in hypogonadal men
  • DHT has little effect on sexual behavior in castrated rodents

• E2 is not effective in hypogonadal men
  • in contrast to castrated rodents
Female sexual behavior

![Graph showing hormone concentrations during the estrous cycle.](image-url)
Components of female sexual behavior

- During **behavioral estrus**, highest levels of:
  - Attractivity
  - Proceptivity
    - female initiation of copulation
    - motivation
    - e.g., in rats, willingness to cross electrified grid
  - Receptivity
    - responsiveness to male initiation
    - e.g., lordosis
Attractivity
Proceptivity

• In rats, hopping and darting, ear wiggling

• Bonsall et al. (1978) had female rhesus monkeys lever press 250 times in order to gain access to a male
  • operant conditioning
  • time taken to complete bar pressing was shorter just before ovulation.
Receptivity

- LQ = Lordosis Quotient
- Ovariection typically eliminates sexual behavior in rats
  - in some primates, OVX females remain receptive
ERs in female brain

- Autoradiography
  - $E_2$ concentrating cells in hypothalamic, limbic, and mesencephalic structures

- ER$_{\alpha}$ & ER$_{\beta}$ distributions not distinguished by this study

- ERs in vlVMH are critical for female sexual behavior
Endocrine regulation of receptivity

- \( E_2 + \text{PROG} \) sequentially is more effective in inducing lordosis than \( E_2 \) alone
- In OVX female rats, sexual behavior can be restored by \( E_2 \) followed by PROG treatment
  - mimics the estrous cycle
  - in rats, PROG treatment is 2 days after \( E_2 \)
  - testing is 4 hours after PROG
- Hypothesis: \( E_2 \) modulates brain responsiveness to progesterone...
Estradiol and PR

OVX rats
Estrogen affects neurons at these two sites.

- Ventromedial hypothalamus
- Periaqueductal gray
- Medullary reticular formation

Stimuli

- Lordosis
- Spinal cord (L1-L6)
- Reticulospinal tract
Lordosis circuit

- **Telencephalon**
- **Mesencephalic flexure**
- **Cerebellum**
- **Cervical flexure**

**Forebrain**
Inhibits lordosis.

**Hypothalamus**
Responds to steroid hormones; produces proteins and peptides.

**Midbrain**
Receives hypothalamic peptides; changes slow to fast signaling.

**Lower brain stem**
Integrates posture across segments.

**Spinal cord**
Each segment receives stimulation; receives descending information; produces motor response.
Blood Levels of Four Hormones During the Human Menstrual Cycle

- LH
- FSH
- Estradiol
- Progesterone
Birth Control Pills

• Birth control pills prevent pregnancy by interfering with the usual feedback cycle between the ovaries and pituitary.

• The combination-pill contains an estrogen and a progestin.
  – Prevents the surge of FSH and LH that would release an ovum.
Human attractivity

• Men prefer scent of ovulating women
Human proceptivity

- Women taking birth-control pills
- Women using intrusive methods
- Women using nonintrusive methods
- Estimated time of ovulation

Graphs showing the mean number of activities per day for days before menstruation for different groups.
Human receptivity

- Studies suggest that women are more sexually receptive during the periovulatory period