Carlson (7e)

PowerPoint Lecture Outline

Chapter 10: Reproductive Behavior

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Reproductive Behaviors

- Reproductive behaviors are social behaviors that are critical for survival of the species
  - Courting, mating, parental behavior
- Reproductive behaviors are sexually dimorphic
  - Behaviors vary systematically in males and females
    - Most forms of aggressive behavior are dimorphic
  - Early hormone experience plays a prominent role in the development and control of sexually dimorphic behaviors

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Markers of Sex

- Chromosomal: XX or XY (23rd chromosome pair) is determined at conception
- Gonadal: testes or ovaries
- Hormonal: Estrogen/androgen
- Internal reproductive structures
  - Mullerian system: Fallopian tubes, uterus, inner 2/3 of vagina
  - Wolffian system: epididymis, vas deferens, seminal vesicles
- External reproductive structures
  - Males: penis/scrotum
  - Females: labia, clitoris, outer 1/3 of vagina

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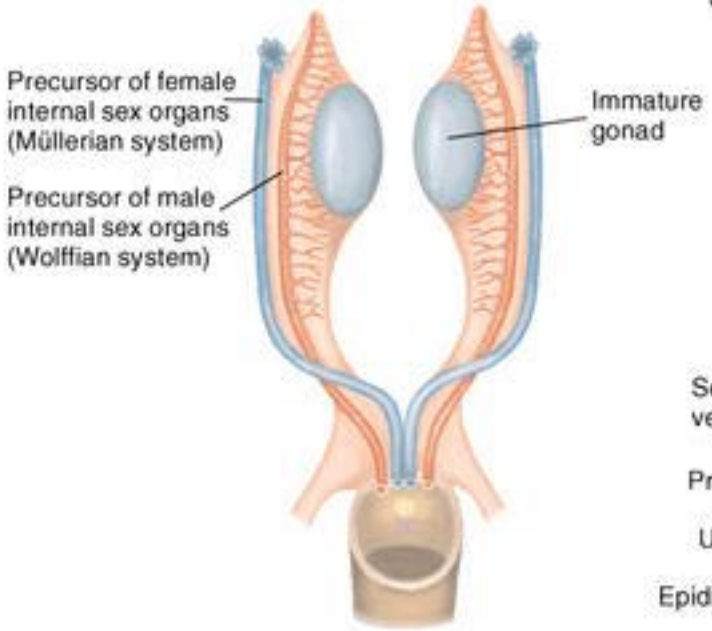
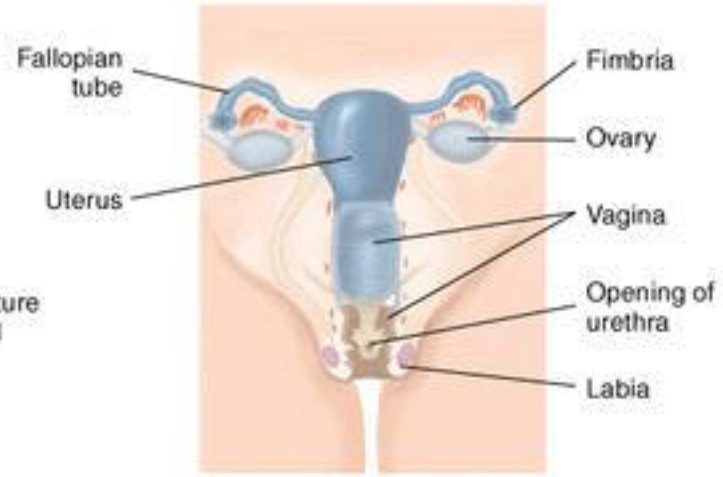
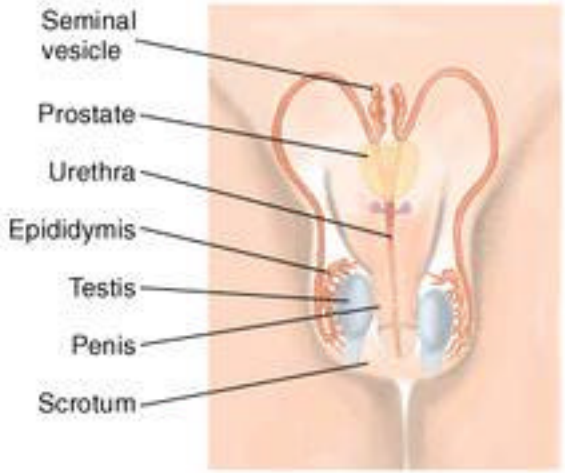
► Development of the Internal Sex Organs



Early in Fetal Development



Adult Female



Adult Male

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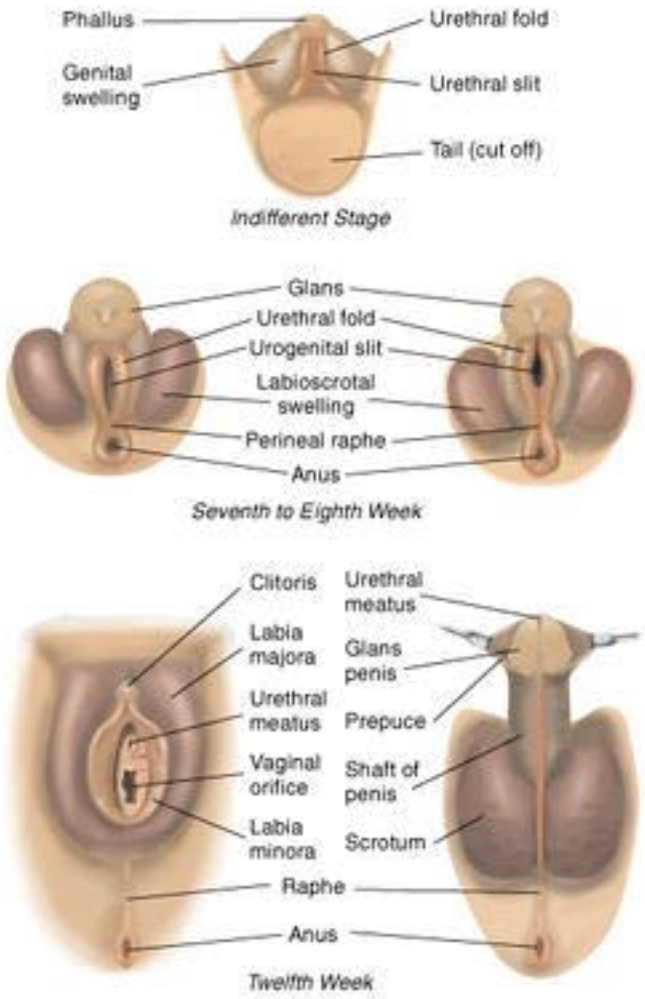
► Development of the External Genitalia



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Sexual Development

- "Nature's Impulse is to create a female"
  - The internal reproductive structures can develop into a male or female pattern
  - Male testes secrete
    - Anti-Mullerian hormone prevents development of the Mullerian system
    - Androgens promote development of the Wolffian system
      - Testosterone
      - Dihydrotestosterone
  - In the absence of androgen secreted by testes, female pattern develops:
    - Mullerian system
    - External genitalia
    - Brain

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Male Sexual Development

- SRY gene on XY chromosome induces development of testis
  - Testes secrete:
    - Anti-Mullerian hormone (defeminizing effect)
    - Androgens: stimulate Wolffiian system development
  - External male reproductive structures require dihyrotestosterone (androgen)

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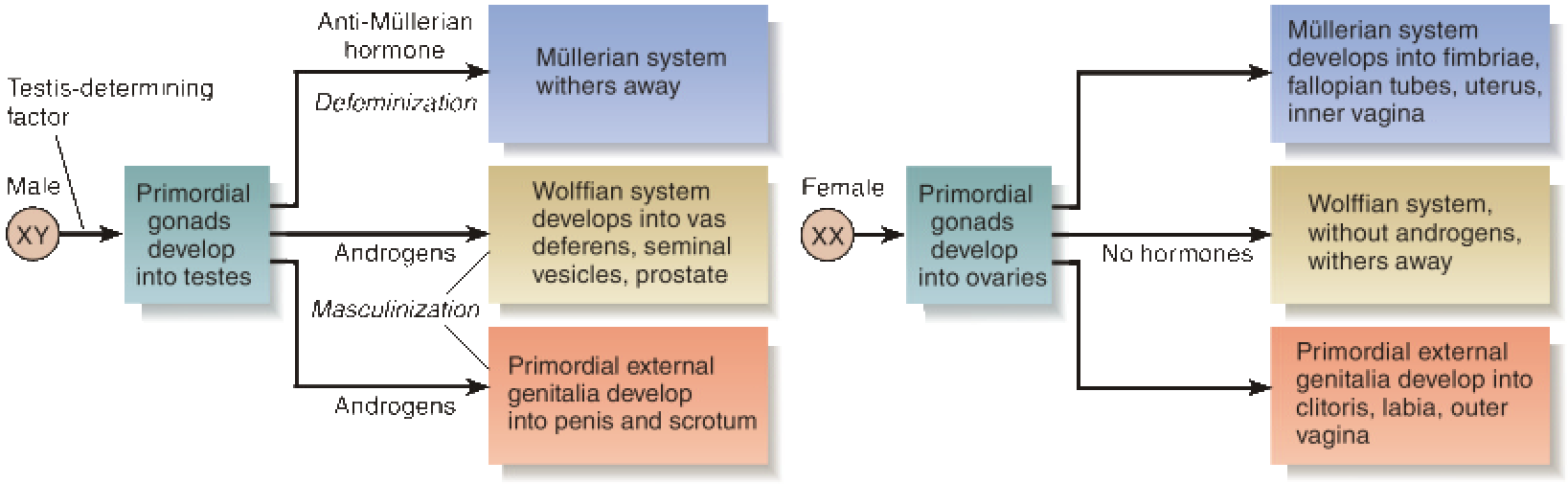
Internal Sex Organ Development



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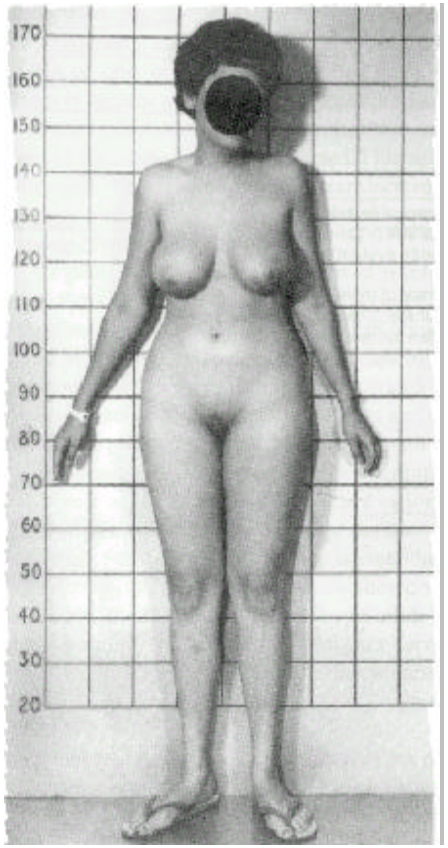

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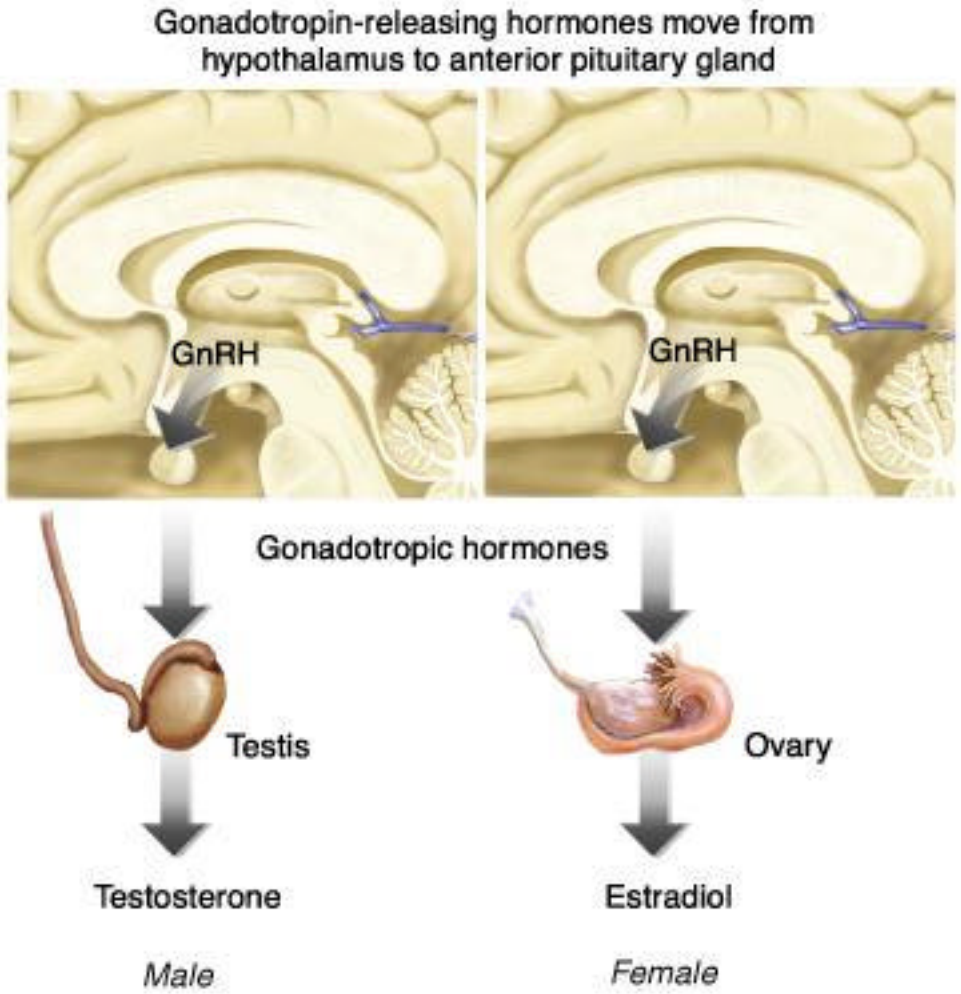
▶ Sexual Maturation



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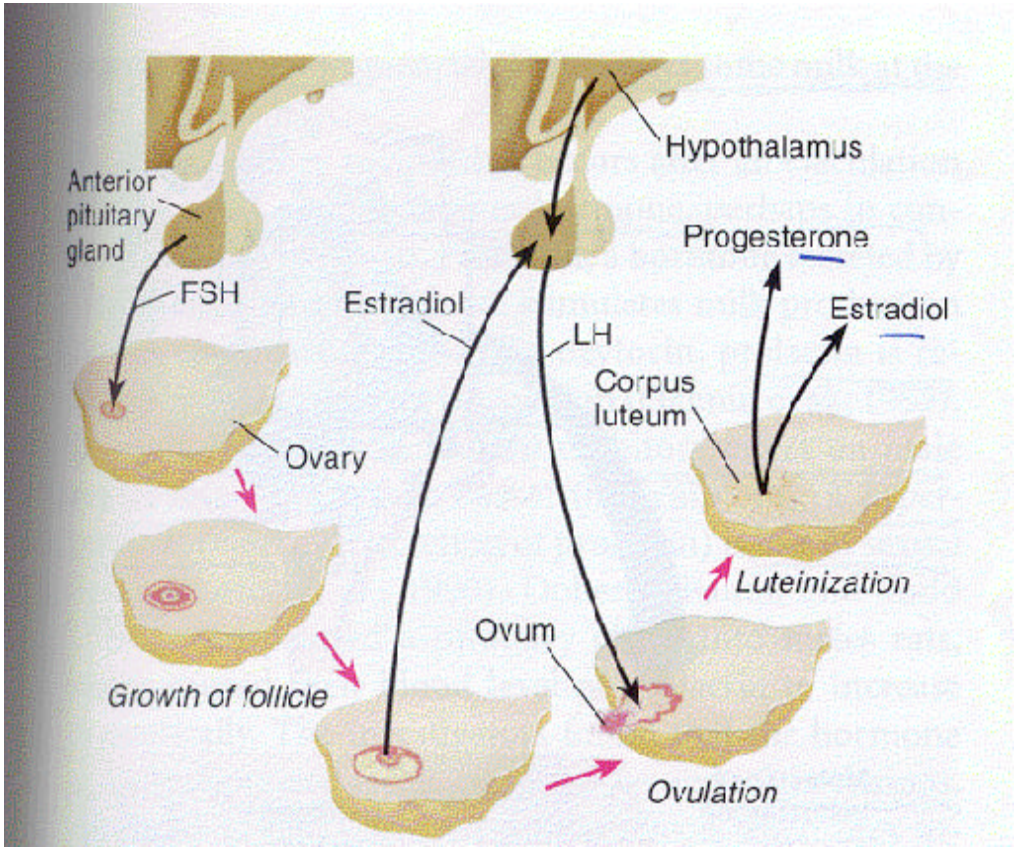

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Sexual Maturation

- Secondary sexual characteristics include
  - Female: enlarged breasts, widened hips;
  - Male: beard, deep voice
- Secondary sex characteristics appear at puberty
  - Puberty is associated with secretion of gonadotropin-releasing hormones (GnRH)
    - GnRH in turn induces secretion from the anterior pituitary of
      - Follicle-stimulating hormone (FSH)
      - Luteinizing hormone (LH)
  - FSH and LH are secreted in females (develop the ovum) and males (stimulate development of sperm, secrete testosterone)
    - Estradiol secreted by the gonads induces breast development
    - Androgens stimulate facial hair, lowered voice, muscle development

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Female Reproductive Cycles

- Reproductive cycles in females involve a fixed sequence of hormonal events
  - Primates: menstrual cycle of uterine lining growth (and loss), mating is not tied to ovulation
  - Rats: estrous cycle is a four day cycle, no menses, mating is tied to ovulation
  - Cycle starts with secretion of gonadotropins from the ant. pituitary
    - FSH stimulates ovarian follicles
    - Follicles secrete estadiol, which stimulates uterine lining growth and triggers a pulse of LH from the anterior pituitary
    - The LH surge induces ovulation, the ruptured follicle (corpus luteum) produces estradiol and progesterone (which maintain the uterine lining)
    - If pregnancy does not result, the corpus luteum shuts down, resulting in menses

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Adult Sexual Behaviors (Rodent)

- Male
  - Intromission
  - Pelvic thrusting
  - Ejaculation
  - Post-ejaculatory refractory period
- Female
  - Lordosis response
  - Receptivity: willingness to copulate
  - Proceptivity: behaviors that seek out and arouse male sexual interest
  - Attractiveness: physiological and behavioral changes that affect the male (odor)

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Hormones: Male Sexual Behavior

- Male sexual behavior depends on testosterone
- Activational effects of hormones in the male:
  - Male sexual behavior requires testosterone
    - Testosterone is converted to estradiol which restores sexual behavior in a castrated male
    - Drugs that block the conversion of testosterone to estadiol reduces male sexual behavior
  - Oxytocin may contribute to smooth muscle contract during orgasm
  - Prolactin is released during ejaculation and may mediate male sexual refractory period
  - The endogenous opiate dynorphin may also contribute to male sexual satiety

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Hormones: Female Sexual Behavior

- Sexual behavior in the mammalian female depends on gonadal hormones secreted during estrus
  - Estrogen is secreted, followed by progesterone
  - Ovariectomized rats are not sexually receptive
    - Restoration of receptivity requires a small amount of estradiol followed by large levels of progesterone
    - Female mice that lack estrogen receptors are not receptive
  - Oxytocin: contributes to smooth muscle contractions during orgasm

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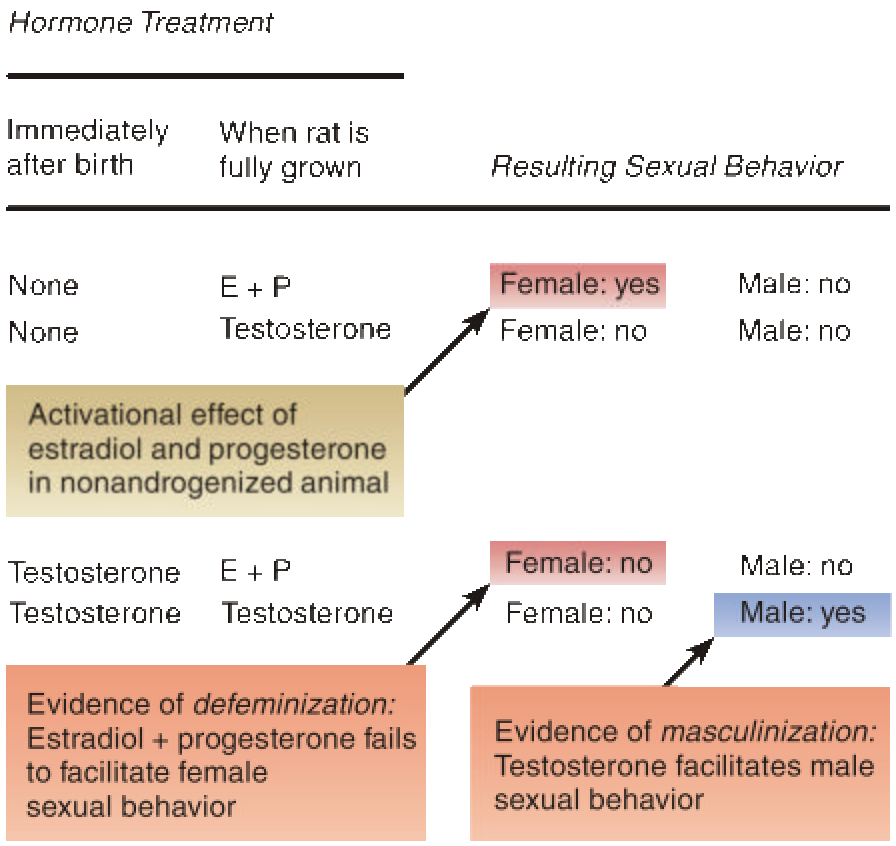
Organizational Effects of Testosterone

- Early androgen exposure promotes:
  - Behavioral defeminization as an adult
  - Behavioral masculinization
  - Involve estrogen receptors



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Pheromone Actions in Animals

- Pheromones are chemicals that transmit a message from one animal to another
  - Pheromones can alter reproduction
    - Lee-Boot effect: the estrous cycle stops when groups of female mice are housed together
    - Whitten effect: the estrous cycle restarts in synchrony when a group of female mice are exposed to the urine of a male mouse
    - Bruce effect: involves the failure of pregnancy when a recently impregnated mouse is exposed to a normal male mouse (other than the one with which she mated)
  - The vomeronasal organ detects nonvolatile chemicals in urine
    - The vomeronasal organ projects to the accessory olfactory bulb which in turn projects to the amygdala which has connections with the hypothalamus
    - Lesions of the accessory olfactory bulb disrupt the Lee-Boot, Whitten and Bruce effects

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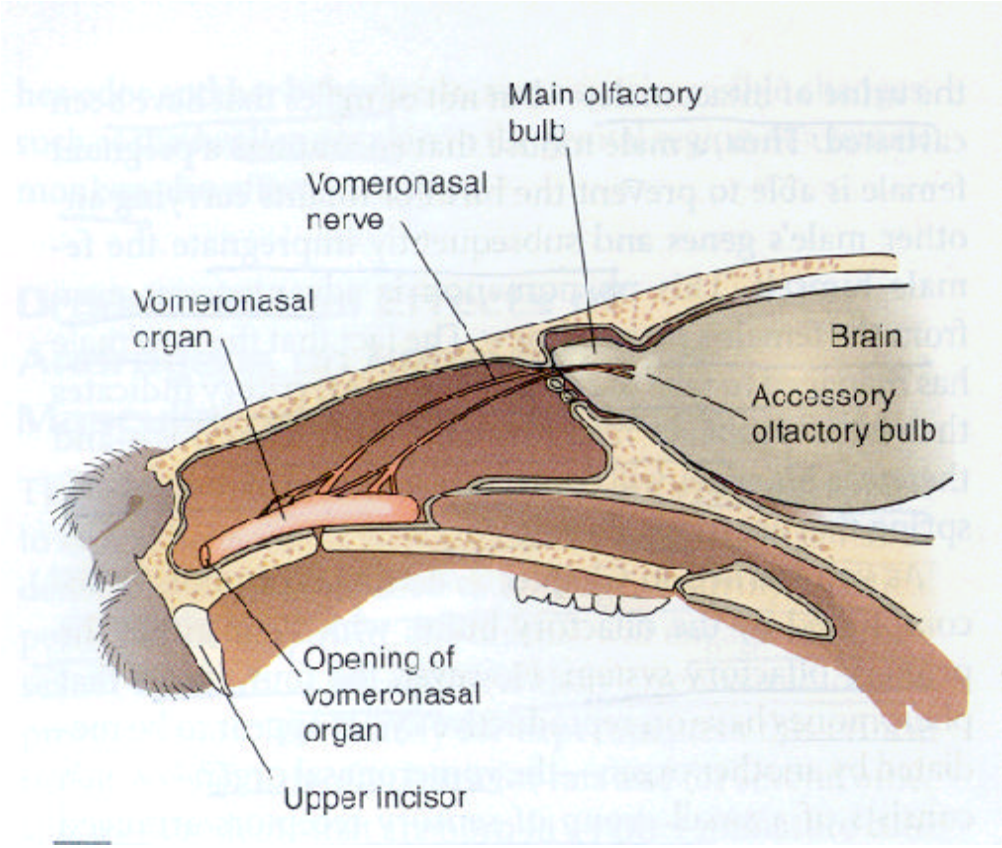

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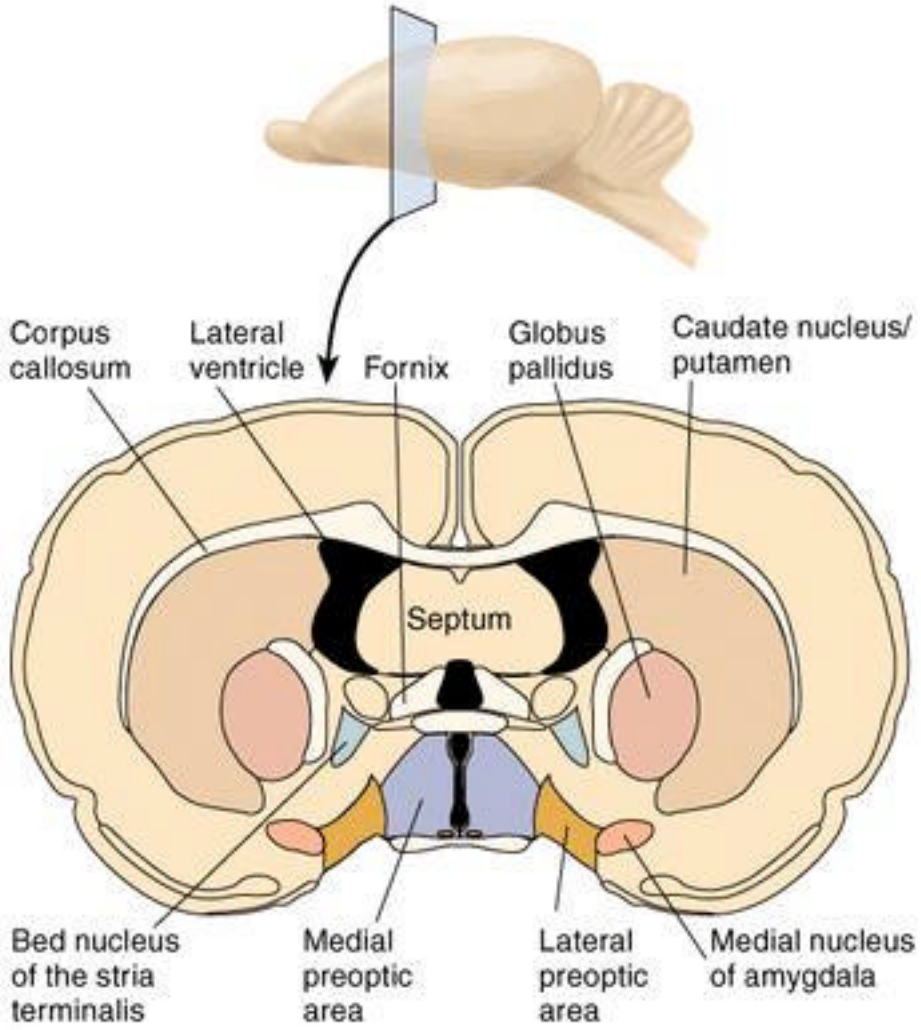
► Cross Section Through the Rat Brain



Source: Adapted from Swanson, L.W. *Brain Maps: Structure of the Rat Brain.* New York: Elsevier, 1992.

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Pheromone Actions in Humans

- Humans possess a vomeronasal organ
- Exposure to chemical present in sweat can alter human behavior
  - McClintock studied the menstrual cycles of women who attended an all-female college
    - Women who spent time together showed synchronization of their menstrual cycles
    - Women who spent time with men showed shorter cycles
    - Exposure to underarm sweat elicited synchronization
  - Pheromones present in human sweat can alter social behavior
    - Androstenol placed on a necklace had no effect on the social interactions of men, but women exposed to androstenol showed more interactions with men

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Sexual Orientation

- Sexual orientation relates to the gender of a person's preferred sexual partner
  - Only humans are exclusively homosexual (prefer a partner of the same sex)
  - Homosexuality does not appear to be a product of childhood experiences (domineering mother, submissive father)
    - Self-reports of homosexual feelings predate homosexual activity
  - Prenatal hormone exposure may play a role in sexual orientation
    - Congenital adrenal hyperplasia (CAH) results in exposure of female fetus to high levels of androgens
    - 37-48% of CAH women reported themselves to be bisexual or homosexual
  - Twin studies indicate a higher concordance for homosexuality among monozygotic twins than for dizygotic twins

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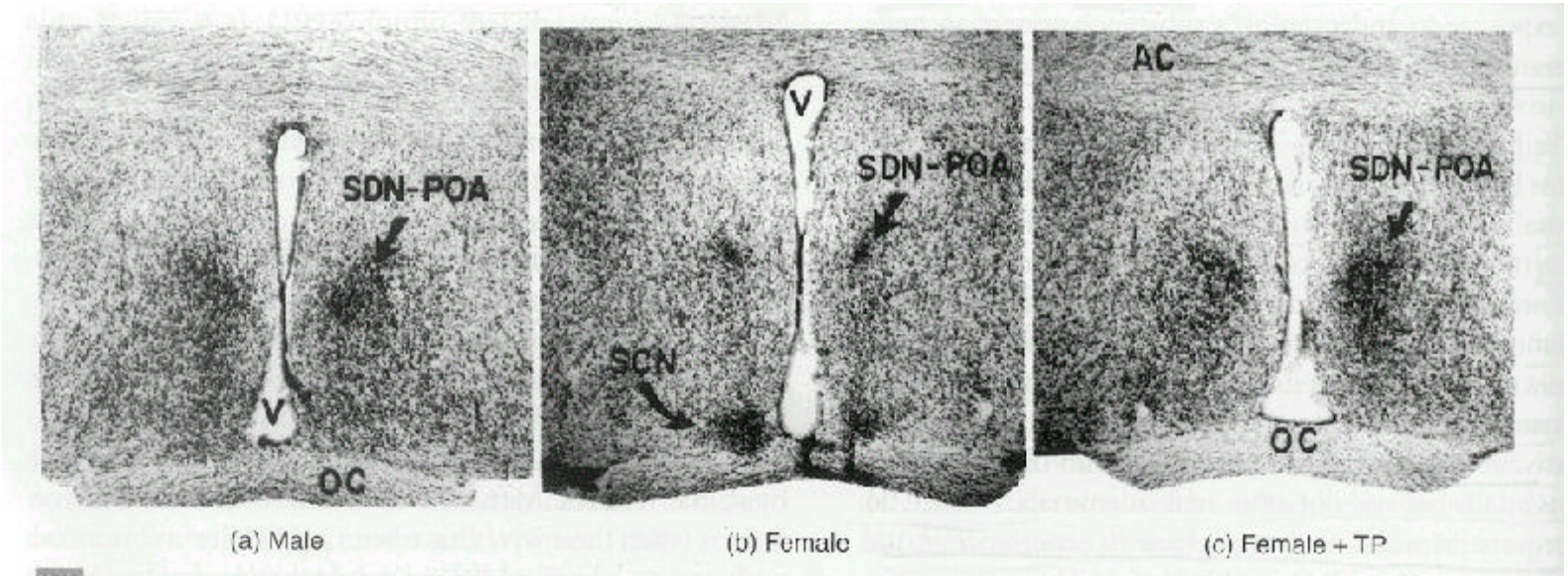

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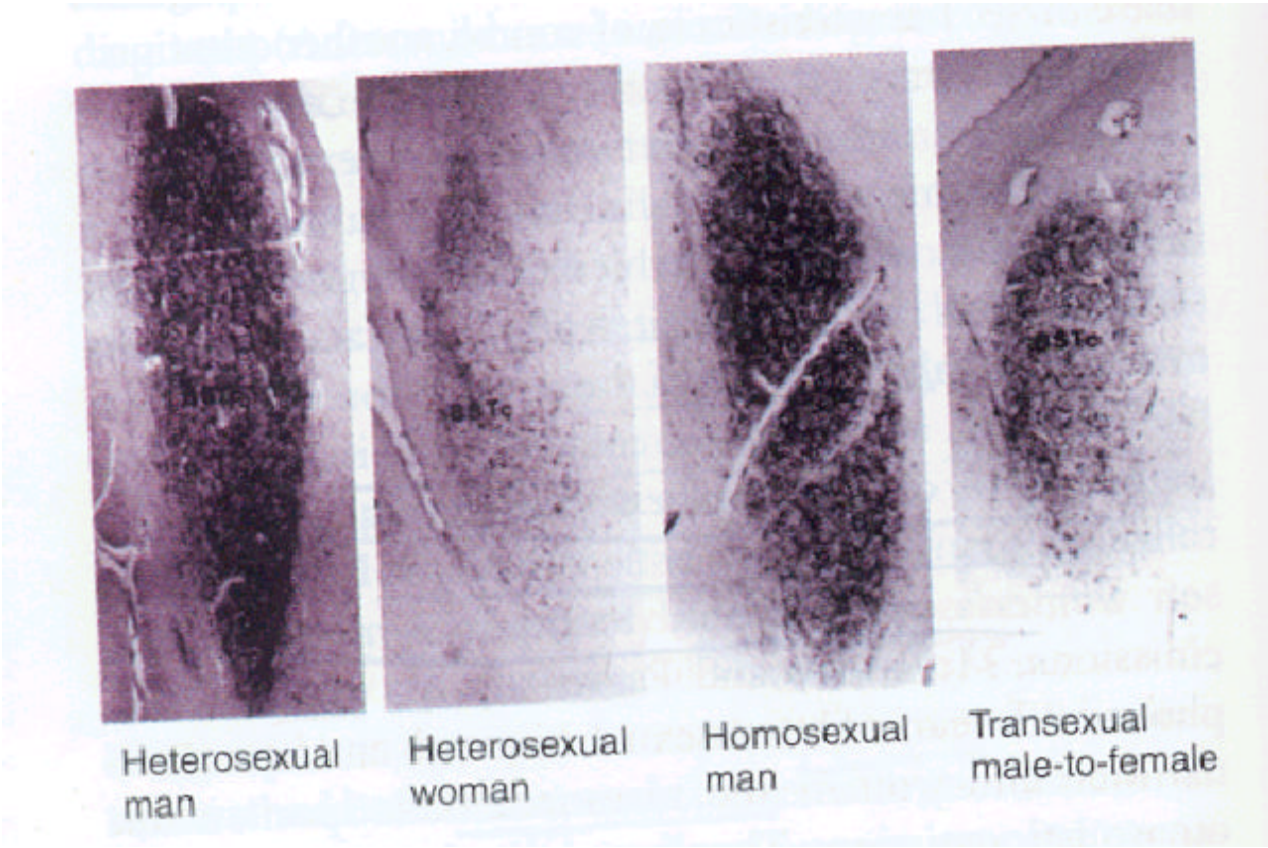

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Male Spinal Sexual Reflexes

- The spinal cord contains circuitry that is sufficient for certain sexual reflexes in the male
  - Erection and ejaculation can occur in animals and humans in which the spinal cord has been transected
  - The transection eliminates the experience of orgasm
  - Circuitry for these reflexes is located beneath the level of the transection
  - Spinal cord neurons that participate in sexual reflexes are sexually dimorphic
    - Spinal nucleus of the bulbocavernosus (SNB) is larger in males than in females
    - Development of the SNB requires androgen exposure

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Medial Preoptic Area

- The medial preoptic area (MPA) is involved in the control of male sexual behavior:
  - MPA contains testosterone receptors
    - Infusions of testosterone into the MPA restore copulation in castrated rats
  - MPA neurons are active during copulation
    - As indexed by firing rate and by c-*fos* studies
  - Electrical stimulation of the MPA induces copulation
  - Lesions of the MPA disrupt copulation
  - The MPA receives input from the vomeronasal organ
  - The MPA has outputs to the motor neurons of the spinal cord that control pelvic organs involved in copulation

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motor neurons in the spinal cord

of Fos protein.

Female Sexual Behavior

- The ventromedial hypothalamus (VMH) has a critical role in modulating female sexual behavior in rats
  - VMH lesions block lordosis in female rats which is not restored by estrogen/progesterone
  - Electrical stimulation of VMH facilitates lordosis
  - Copulation is associated with *fos* production in the VMH (and amygdala)
  - Removal of the ovaries reduces female sexual behavior, this behavior is restored when estrogen and progesterone are placed directly into the VMH
    - Estrogen increases the number of hypothalamic progesterone receptors
  - The VMH projects to the PAG, which projects to the medulla and spinal cord

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- Estradiol treatment or stimulation of VMH increases neural activity.
- Neurons contain estrogen and progesterone receptors.

receptors.

overiectomized rats.

Parental Behavior

- Parental behavior serves to protect and nourish offspring
- Maternal behavior in rodents
  - Pregnant female rats and mice build nests to house their offspring
  - Maternal behaviors that occur at the time of parturition (birth):
    - Delivering the offspring
    - Removing the placental and fetal membranes
    - Stimulating defecation/urination by licking the anogenital region
    - Retrieval of pups into the nest
  - Olfaction plays a role in maternal behavior
  - Lesions of the MPA disrupt maternal behavior

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