

REPRODUCTION I

I Introduction

- A Contribution of reproductive system to survival and homeostasis = none
- B Function of reproductive systems: enable the union of genetic material contributed by male and female
 - 1 Male
 - a Production of sperm (spermatogenesis)
 - b Delivery of sperm to the female
 - 2 Female
 - a Production of ova (oogenesis)
 - b Reception of sperm
 - c Transport of sperm and ovum to proper site for fertilization
 - d Maintenance of embryo/fetus (gestation/pregnancy)
 - e Giving birth (parturition)
 - f Nourishing the infant by milk production (lactation)

II Male reproductive system

A Spermatogenesis

- 1 Takes place in seminiferous tubules of testes
- 2 Process involves
 - a meiosis
 - i mitosis
 - ii meiosis
 - b maturation of sperm ("packaging")
 - i head: contains nucleus
 - ii acrosome: a large vesicle that contains digestive enzymes needed for penetrating the ovum
 - iii midpiece: contains numerous mitochondria
 - iv tail: a single long flagellum that provides motility

B Male reproductive tract

- 1 Mature sperm and seminiferous tubule fluid stored in epididymis
- 2 During ejaculation, sperm/seminiferous tubule fluid mixed with secretions from the accessory sex glands
 - a seminal vesicles: supply fructose, additional fluid, prostaglandins, and fibrinogen
 - b prostate: secretes an alkaline fluid, clotting enzymes, and fibrinolysin
 - c bulbourethral glands: mucus

- C Testosterone
 - 1 A steroid hormone produced by Leydig (interstitial cells) of testes
 - 2 Actions of testosterone (at and after puberty)
 - a growth, maturation, and maintenance of reproductive system
 - b development of sex drive
 - c development of secondary sex characteristics (hair growth, voice change, etc.)
 - d essential for spermatogenesis
 - e Anabolic effects: promotes bone and muscle growth
 - 2 Regulation of testosterone production
 - a 2 tropic hormones of anterior pituitary are involved: LH and FSH
 - b LH = luteinizing hormone
 - c FSH = follicle-stimulating hormone
 - d GnRH = gonadotropin-releasing hormone: hypothalamic hormone that stimulates release of LH/FSH
- D Physiology of erection
 - 1 Erection mediated by a spinal reflex
 - 2 Reflex initiated by
 - a tactile stimulation
 - b psychic stimuli
 - 3 Parasympathetic neurons send message to effectors
 - a effectors are arteriolar smooth muscle
 - b vasodilation causes engorgement of vascular spaces
 - c venous outflow is reduced because veins are compressed

- 4 What is the signal?
 - a nitric oxide (NO), is synthesized and released directly from the parasympathetic neurons
 - b Viagra

III Female reproductive system

A Oogenesis

- 1 Takes place in ovary, within specialized structures called follicles
 - a 2 kinds of follicular cells facilitate oogenesis
 - i thecal cells (outer part of follicle) -- also synthesize androgen, the precursor to estrogen (estradiol)
 - ii granulosa cells (inner part of follicle) -- also perform the last step of estrogen synthesis by converting androgen to estradiol
- 2 Process involves
 - a meiosis
 - b maturation/ovulation: components of a mature ovum, released from the follicle at ovulation
 - i the ovum itself: contains the nucleus, mitochondria, and a generous store of glucose, protein and mRNA (= maternal RNA)
 - ii zona pellucida: a gel-like material that surrounds the ovum
 - iii corona radiata: granulosa cells that adhere to the ovum

- B Estradiol and Progesterone
- 1 Two phases of female reproductive function
 - a follicular phase (1st phase)
 - i dominated by estradiol; occurs prior to ovulation
 - ii estradiol synthesized by follicular cells
 - b luteal phase (2nd phase)
 - i dominated by progesterone; occurs after ovulation
 - ii progesterone synthesized by corpus luteum, the remnant of the follicle after ovulation
 - 2 Actions of estradiol
 - a Anabolic effects: promotes bone growth
 - b Effects during the follicular phase
 - i essential for oogenesis
 - ii proliferation of the uterine endometrium
 - 3 Actions of progesterone
 - a Effects during luteal phase
 - i converts uterine endometrium to a thick and highly vascularized layer
 - b Has further effects if fertilization and implantation occur, otherwise corpus luteum degenerates and progesterone levels decrease

REPRODUCTION II

I Regulation of female sex hormones and the menstrual cycle

A follicular phase

- 1 LH and FSH involved
- 2 LH acts on thecal cells to produce androgens including testosterone
- 3 FSH acts on granulosa cells to convert testosterone and other androgens to estradiol
- 4 levels of LH and FSH regulated by
 - a negative feedback by estradiol and inhibin
 - b GnRH from hypothalamus
 - c negative feedback is imperfectly regulated and allows a steady rise in estradiol

B ovulation

- 1 When estradiol levels are high, system switches from negative feedback to positive feedback, resulting in a surge of LH and FSH
- 2 the surge of LH triggers ovulation
 - a triggers production of prostaglandins in the ovary, which cause swelling and rupture of the follicle
 - b causes follicular cells to become luteal cells and synthesize progesterone

C luteal phase

- 1 LH primarily involved: acts on corpus luteum to synthesize both estrogen and progesterone
- 2 progesterone has a very strong negative-feedback influence on LH secretion

- D w/o fertilization, corpus luteum degenerates and follicular phase starts over
 - 1 lack of progesterone causes endometrium to degenerate and the blood and debris is discharged
 - 2 lack of progesterone allows LH/FSH to begin to rise again

II Fertilization

- A Sperm transport to the oviduct
 - 1 Cervix
 - a At ovulation, estradiol causes usually thick mucus to become thin and watery
 - 2 Uterus
 - a Uterine contractions (from prostaglandins in semen? Oxytocin from female?)
 - b At least some of the sperm reach an oviduct
 - 3 Oviduct
 - a Oviduct cilia move ovum toward uterus; sperm have to fight this
 - b Oviduct peristaltic contractions help more sperm the other way

- B Process of fertilization (in oviduct)
 - 1 Acrosome reaction
 - 2 Cortical reaction: The first sperm to get to the ovum fuses with the ovum plasma membrane; this triggers
 - a rapid depolarization of the ovum and entry of Ca^{++}
 - b exocytosis of vesicles that contain material that will constitute a protective barrier to the fertilized egg (a block to polyspermy)

III Implantation

- A Fertilized egg (zygote) divides many times
 - 1 Travels to uterus
 - 2 Uses internal energy stores for one day
 - 3 Uses glycogen from endometrium for next few days

- B Cell proliferation continues; forms a blastocyst
 - 1 Hollow sphere of cells with a dense mass of cells grouped on one side
 - a Outer part (trophoblast) is important for implantation
 - b Inner part (inner cell mass) will become the embryo
 - 2 Trophoblast cells digest the endometrium; blastocyst becomes entirely embedded in uterine wall

IV Placenta formation and function

- A Placenta is derived from the trophoblast and the uterine wall
 - 1 Trophoblast forms a network of cavities that are filled with maternal blood
 - 2 Developing embryo sends out its own capillaries that project into the pool of maternal blood

- B Placenta transfers O₂, nutrients to embryo/fetus; CO₂, waste products are transferred to mother

- C Endocrine function of placenta
- 1 Human chorionic gonadotropin (hCG) produced by placenta for the first 10 weeks following fertilization
 - a Prolongs the life of the corpus luteum
 - b Corpus luteum of pregnancy continues to make estrogen and progesterone
 - c Allows for maintenance of endometrium
 - 2 Progesterone is synthesized throughout pregnancy by the placenta
 - a primary function is to prevent miscarriage (abortion) by suppressing uterine contractions
 - b stimulates development of milk glands
 - 3 Estradiol and estriol (an estrogen distinct from estradiol) are synthesized after 10 weeks by the placenta
 - a stimulate growth of uterine musculature
 - c promote development of milk ducts
 - 4 Human Chorionic Somatomammotropin (hCS)
 - a also known as Placental Lactogen & Chorionic Somatotropin
 - b inhibits effects of insulin on mother
 - c more glucose for fetus?
 - d important in breast development along with estrogen and progesterone

- D Other maternal changes
 - 1 Weight gain due to
 - a fetus
 - b uterus (grows by 20X)
 - c breast enlargement
 - d blood volume (30% higher)
 - 2 Respiratory activity increases by 20%
 - 3 Urinary output increases
 - 4 Food consumption increases

V Parturition - what triggers?

- A Events near the end of pregnancy to prepare for birth
 - 1 Production of relaxin by the placenta & ovaries
 - a causes connective tissue of the cervix to dissolve (cervical "softening")
 - b increases flexibility of the pelvic bones
 - 2 Fetus shifts downward in uterus and becomes oriented upside-down

- B 1st stage of Labor = cervical dilation
 - 1 Uterine musculature begins rhythmic, coordinated contractions
 - a oxytocin (from hypothalamus/posterior pituitary) involved
 - b throughout pregnancy, the number of oxytocin receptors on uterine muscles increases (due to estrogen)
 - c oxytocin is also secreted by placenta
 - 2 A positive feedback cycle is set into progress

- 2 A positive feedback cycle is set into progress
 - a uterine contractions push fetus against cervix
 - b this contact increases oxytocin secretion
 - c oxytocin increases uterine contractions
 - d oxytocin also promotes prostaglandin release and this increases uterine contractions

- C 2nd stage of labor = delivery of the baby
 - 1 When cervical dilation is complete (10 cm, to accommodate baby's head), baby begins to move into vagina
 - 2 Stretch receptors in vagina activate a reflex that triggers abdominal contractions in synchrony with uterine contractions
 - 3 Mother assists by voluntarily contracting these muscles

- D 3rd stage of labor = delivery of placenta (afterbirth)
 - 1 A second wave of uterine contractions separates the placenta from the uterus
 - 2 Continued contractions constrict uterine blood vessels to prevent hemorrhage