

IN SUMMARY
MALE SYSTEM

MALE SYSTEM ANATOMY

TESTIS

- Testis descends from a retroperitoneal position through the inguinal canal to take to scrotum during the eighth fetal month.
- Lower temperature required for spermatogenesis
- Countercurrent vascular heat exchange system
- Seminiferous tubules comprise 95% of testicular volume,
- 500 tubules per testis.
- Surrounded by the tough tunica albuginea.
- Seminiferous tubules -> rete testis -> epididymis -> vas deferens ->prostate ->ejaculatory duct ->urethra
- Seminal vesicle secretions join sperm in prostate
- Gonad undifferentiated at 8 weeks
- Influence of Y chromosome
- Wolffian duct -> male
- MIS -> regression of Mullerian ducts (uterus and fallopian tube in female)
- Testosterone to DHT by 5 alpha reductase causes masculinization of external genitalia

SERTOLI CELLS

- Sertoli cells and germ cells make up the seminiferous tubules
- Tight junctions between Sertoli cells (blood-testis barrier)
- Sertoli cells separate germinal epithelium into basal and adluminal compartments.
- Single Sertoli cell envelopes up to 20 germ cells
- Sertoli cells: support and nutrition of germ cells, release of mature germ cells, secrete androgen binding protein, transferring, inhibin, cell-cell communication (gap junctions)

GERM CELLS

- Spermatogonia – line basement layer of seminiferous tubules – small, round, mitotically active
- Develop into type B spermatogonia -> primary spermatocytes during first meiotic division (tetraploid)
- Pre-leptotene, leptotene, zygotene, pachytene, diplotene
- Secondary spermatocytes result from first reduction division (diploid)
- Second meiotic division lasts a day and result in spermatids (haploid)
- Cells in any cluster are synchronized

SPERMATOZOA

- Morphologically mature – highly polarized – 60 μ M
- Condensed nucleus (acrosome) and membrane
- Tail – has neck, mid piece (sheath of mitochondria), principle piece, end piece
- 9+2 axoneme extends from neck to end piece
- Entire tail covered by plasma membrane

LEYDIG CELLS

- Between seminiferous tubules
- Production of testosterone – local and distant purposes
- In testes, testosterone bound to androgen binding protein secreted by Sertoli cells
- In plasma, testosterone is bound to circulating testosterone binding globulin

SEMEN

- Suspension of sperm in seminal plasma
- Seminal plasma: seminal vesicles, prostate and also bulbourethral gland (Cowper's), urethral glands (Littre), rete testis, epididymis, vas deferens, ampullae
- Seminiferous tubules drain to mediastinum testes and then into rete testis where 90% of fluid is produced
- 8-12 efferent ducts from rete testis to epididymis

EPIDIDYMUS

- 20 meter long duct, pseudostratified columnar epithelium, cilia
- Sperm conduit, fluid resorption, sperm reservoir (cauda), sperm maturation (fertilizing ability and motility)

VAS DEFERENS

- Continuation of epididymis
- Straight duct, pseudostratified columnar epithelium, cilia, 25-45 cm long
- Transport of sperm through scrotum, inguinal canal, behind base of bladder (ampullae)
- Thick muscular wall for rapid transport of sperm during ejaculation

PROSTATE

- 20 grams

EJACULATE

- 2-5 cc with 150-200 million sperm

HORMONAL CONTROL OF SPERMIOGENESIS

- Testosterone (for germinal epithelium), FSH (stimulates Sertoli cells to make protein kinases and protein synthesis)
- LH stimulates Leydig cells to make testosterone
- GnRH made in hypothalamus – pulses every 70-90 minutes – half life 2-5 minutes
- Testosterone inhibits LH release from pituitary and GnRH release from hypothalamus
- Estradiol derived from aromatase conversion of testosterone
- Estradiol more potent inhibitor of LH and FSH
- FSH secretion down regulated by inhibin (made by Sertoli cells)

SPERM PHYSIOLOGY

- Traverse female genital tract, bind to ova, penetrate zona pellucida, fuses with plasma membrane of ovum
- Fresh ejaculate is gel (made in seminal vesicles), liquefies in 5-20 minutes (by prostate protease)
- Fructose (seminal vesicles) is energy substrate for sperm
- Capacitation -> acrosome reaction, release of lysosomal enzymes, alter plasma membrane of sperm head, affects sperms stickiness to egg, cause hypermotility, change in tail beat frequency

MALE INFERTILITY EVALUATION

- History
- Prior history of infertility, timing of puberty, genital abnormalities, medications, prior surgery, chronic illness
- Physical exam
- Evidence of endocrine abnormalities->gynecomastia, hair pattern, phallus, urethral meatus, size and consistency of testes (4.5 cm diameter), vas deference, varicocele

SEMEN ANALYSIS

- Volume 2-5 cc
- Sperm density >20 million/cc (avg. 50-60)
- Motility >60%
- Morphology Absence of WBC's, RBC's, bacteria, agglutination
- >60% normal forms

VARICOCELE

- Dilated pampiniform plexus, left side, 10-15% of all men, 50% of infertility patients

- Abnormal thermoregulation
- Testes usually 20 degrees C cooler than core temperature
- Ligation of gonadal vein, improves sperm quality in 70% of men

EJACULATION – ERECTION

- Emission (deposition of sperm into posterior urethra) and expulsion from urethra
- Under control of sympathetic nervous system
- Emission – contractions of vas, seminal vesicles and prostate
- Ejaculation – closure of bladder neck and contraction of periurethral muscles, bulbocavernosus
- Point and shoot

ERECTION

- Neurologic initiation, reflex or centrally mediated
- Arterial filling of erectile bodies – corpora cavernosa and corpus spongiosum
- Venous occlusion of erectile bodies
- Flaccid state – resting sympathetic tone, small caliber cavernosal arteries and contracted muscle
- Signal for erection – relaxation of arterioles, increased caliber, relaxation of cavernosal sinusoids, venules are compressed by inflow of blood and increased intracorporal pressure causing reduced outflow
- When sympathetic tone returns the arteries constrict and the veins allow outflow

VIAGRA AND SIMILAR DRUGS

- Sildenafil and many others
- NO (nitric oxide) released in corpus cavernosum during sexual stimulation
- NO->guanylate cyclase->cGMP->smooth muscle relaxation->blood flow
- Sildenafil enhances effect of NO by inhibiting type 5 phosphodiesterase (degrades cGMP)
- Has no effect in absence of sexual stimulation
- Most potent effect on PDE5 (4000 times that for PDE3)
- Also affects PDE6 found in retina (color vision problems with high dose)
- Hepatic metabolism (cytochrome P450) – active metabolite
- Caution if using other P450 inhibitors (itraconazole, ketoconazole, erythromycin, ritonavir, cimetidine)
- Rapidly absorbed, maximum plasma concentration within 30-40 minutes
- Decrease in supine BP

FUNDAMENTAL QUESTIONS

1. Where are sperm produced?
2. What is a Sertoli cell? A Leydig cell?
3. In what cell in the testes is testosterone synthesized?
4. On what cell does FSH act? LH?
5. What is the function of the epididymis?
6. What is the function of the seminal vesicles?
7. What causes the undifferentiated gonad to differentiate into the males testes?
8. What is semen made of?
9. Describe the structure of a sperm? What is the acrosome? The midpiece?
How does the tail move?
10. What do Cowper's glands do?
11. When a man has a vasectomy what comes out when he ejaculates? What test would one do on a woman who states she was raped in order to prove ejaculation occurred in her vagina?
12. Describe the contribution of the sympathetic and parasympathetic nervous systems to ejaculation.
13. What is the role of the prostate gland? If a man has had a prostatectomy can he make a woman pregnant?
14. How does Sildenafil (VIAGRA) work?
15. What are some of the significant side effects and contraindications of VIAGRA?
16. What is the range of normal sperm count for a male?
17. What is the volume of an average ejaculate?