

## Male reproductive tract: Development, Structure, & Function

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## What makes a male?

### Objectives

1. Define chromosomal, gonadal, and phenotypic sex.
2. Describe the pathway that sperm take from testis to urethra.
3. Describe the functions of Leydig and Sertoli cells.
4. Compare and contrast the mouse and human prostate (how could these differences influence disease risks?)
5. Describe the embryonic development of the prostate

### Chromosomal sex

- XY vs. XX chromosomes

### Gonadal sex

- Ovaries vs. Testes

### Phenotypic sex

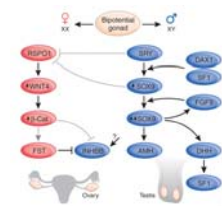
- Male vs. Female genitalia and secondary sex characteristics

### Goals of the male repro tract

- Transfer male's genetic material to Oocyte
  - Survival of the species (?)
  - “Playing field” for natural selection
- Secrete androgens to initiate and maintain male phenotypic sex
  - Stimulate sperm production
  - Develop and maintain male body habitus
  - Male behaviors
    - Mating
    - Nurturing/protecting mates and offspring

### Chromosomal sex

- Male sex encoded by the Y chromosome
  - (SRY=testis determination gene).
  - SRY required for conversion of the gonad into testis
  - Default is otherwise female

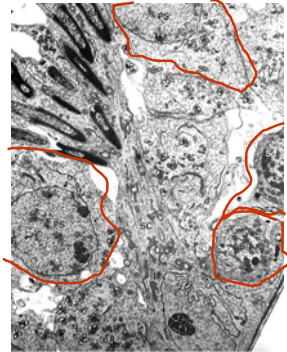


The biology of infertility: research advances and clinical challenges  
Martin M. Matzuk & Dolores J. Lamb  
Nature Medicine 14, 1197 - 1213 (2008) Published online: 6 November 2008



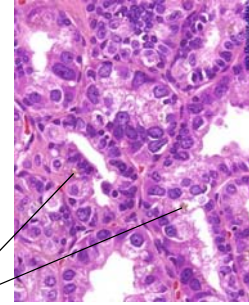


### Sertoli Cell



### Seminal Vesicle

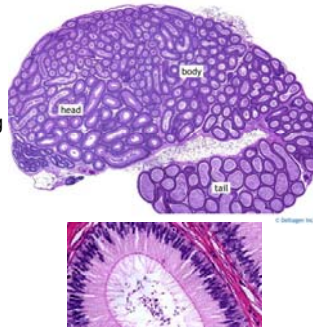
- Androgen-dependent derivative of the Wolffian duct
- Makes nutrient-rich fluid for sperm transport
- Highly disease resistant (that's why you've likely never heard of it)



Lipofuchsin (pigment)

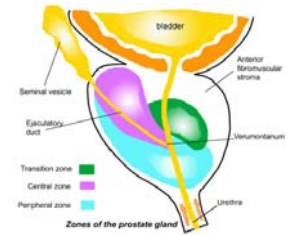
### Epididymis

- Wolffian duct derivative
- Highly androgen-dependent
- Sperm "school" and recycling center
- Highly disease-resistant
  - Epidymitis



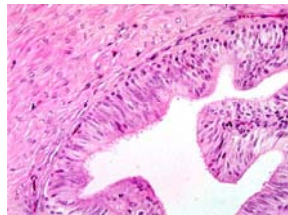
### The Prostate

- Walnut sized gland
- Contributes to seminal fluid
- Starts to grow in 40+ year old men



### Vas (ductus) deferens

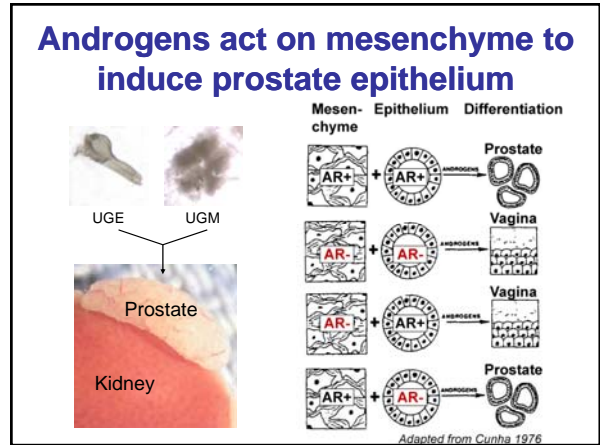
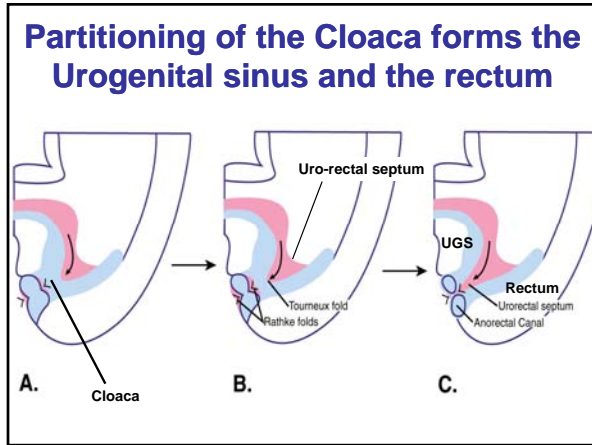
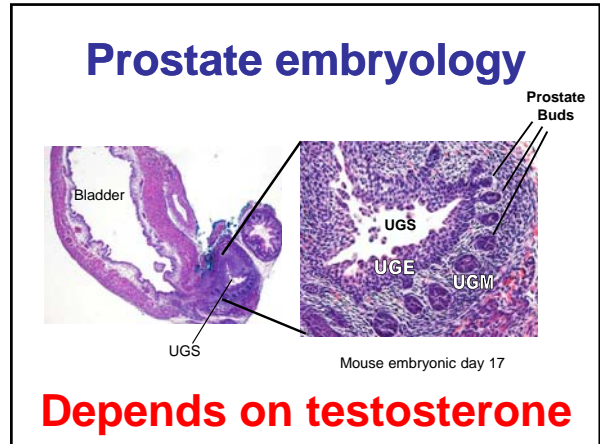
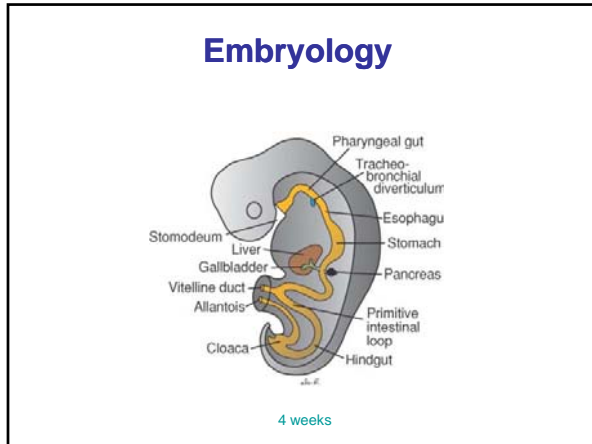
- Fallopian tube for men
- Androgen-dependent
- Ciliated tube specialized for sperm transport
- Target of "vasectomy" and "reversal" surgeries



### Why study the prostate?

- Disease prone
  - Benign hyperplasia
  - Prostatitis
  - Cancer
- Good model systems
  - Developmental biology
  - Steroid hormone action
  - Epithelial-stromal interactions
  - Cancer (?)





### Urogenital Sinus

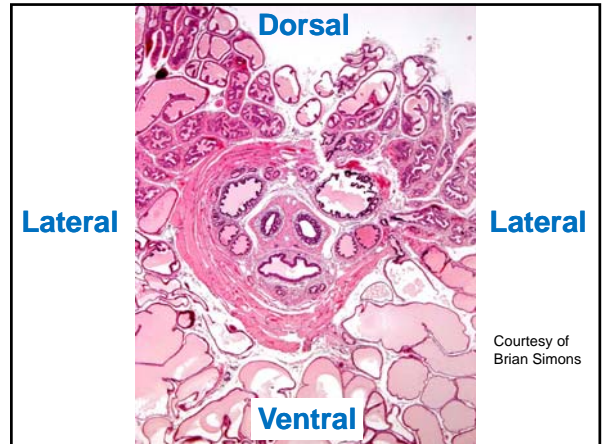
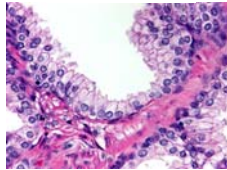
- Cranial portion forms bladder in males and females
- In females, caudal portion forms upper part of vagina and urethra
- In males, caudal portion forms prostate and proximal urethra

### Human prostate: Regional "zones"

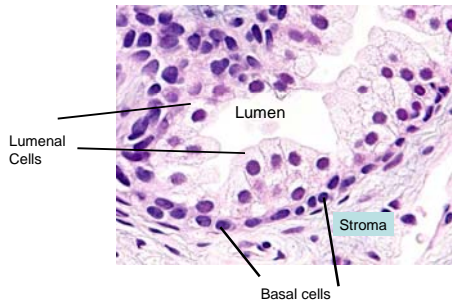
- **Transition zone**
  - Center of gland, surrounds urethra
  - Preferred site for BPH
- **"Central" zone**
  - Surrounds ejac. duct
- **Peripheral zone**
  - Preferred site for carcinoma

## Human Prostate Histology

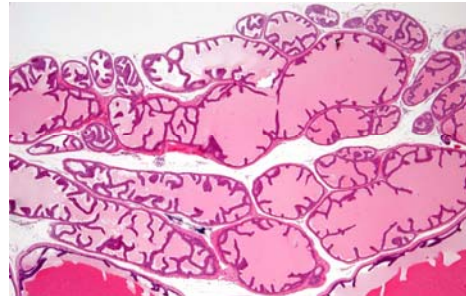
- Abundant stroma
  - Smooth muscle
  - Nerves
  - Blood vessels
- Epithelium
  - Luminal cells
  - Basal cells (putative stem cell compartment)
  - ?Intermediate cells?
  - Neuroendocrine cells (rare)



## Prostate Histology



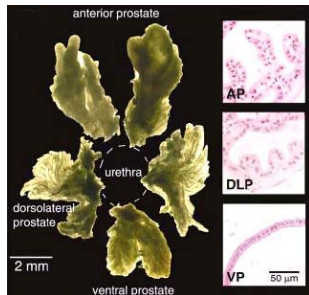
## Anterior prostate



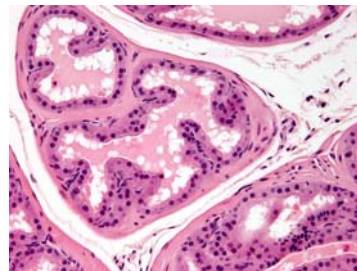
Glands have smooth outer contours and infolded luminal profiles

## Rodent prostate lobes and human homologues

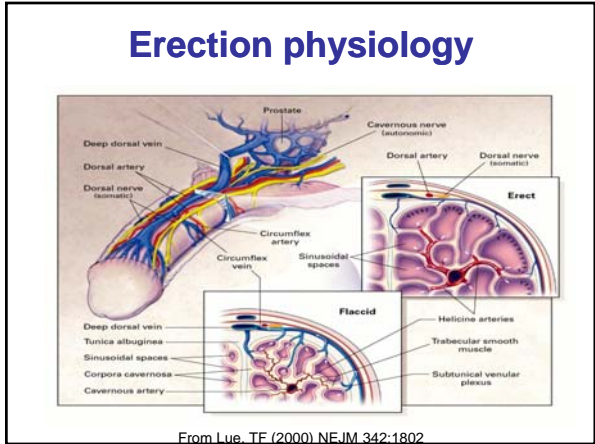
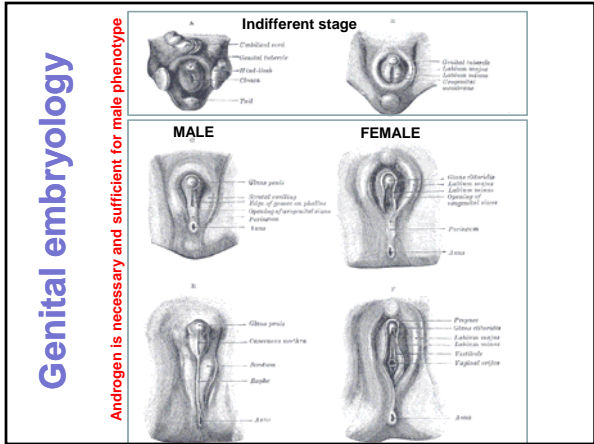
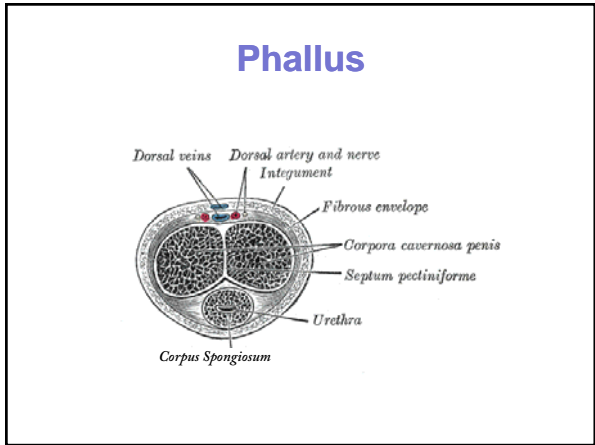
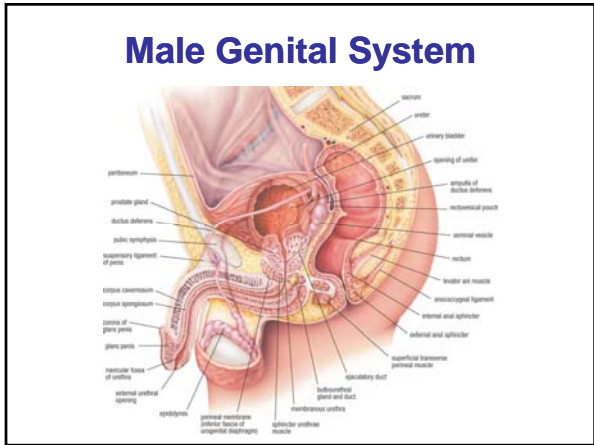
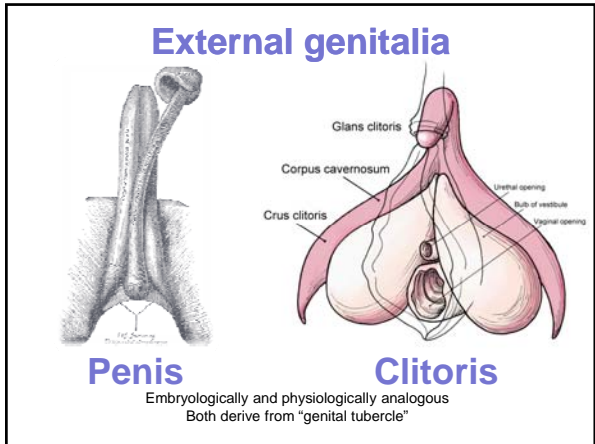
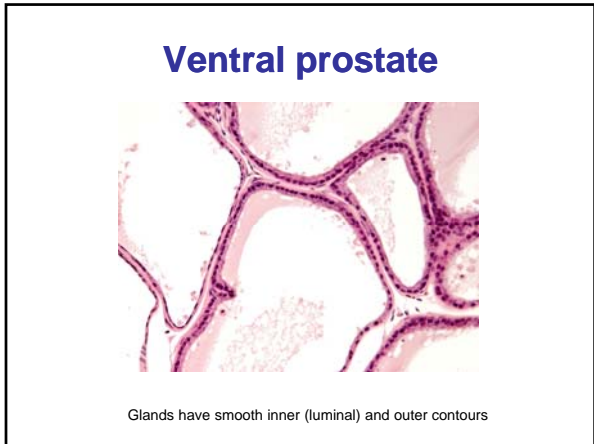
- AP: like human central zone
- DLP: like human peripheral zone
- VP: like human transition zone
  - Most androgen sensitive



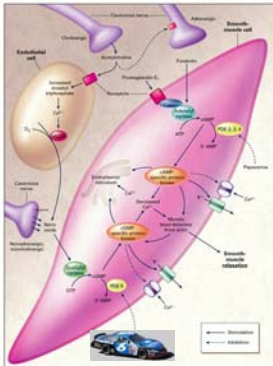
## Dorsolateral prostate



Glands have folded inner (luminal) and outer contours



## Biochemistry of erection



- Peripheral nerves stimulate Nitric oxide (NO) production
- NO relaxes arterial smooth muscle through cGMP
- Sildenafil (Viagra) maintains cGMP levels by inhibiting cGMP-specific PDE5.

From Lue, TF (2000) NEJM 342:1802

## Suggested Reading

- TEXT
  - Martini F (2003) Human Anatomy (4<sup>th</sup> ed.) pp 52-76, 725-737
- For interest/reference
  - Wilhelm D & Koopman P (2006). The makings of maleness: towards an integrated view of male sexual development. *Nature Reviews Genetics* 7: 620-631
  - Lue TF (2000) Erectile Dysfunction. *NEJM* 342:1802
  - Cunha GR et al. (2004) Hormonal, cellular, and molecular regulation of normal and neoplastic prostate development. *J Steroid Biochem Mol Biol* 92:221

## Finish

