Development of the Genital System

Professor Alfred Cuschieri

Department of Anatomy
University of Malta
The mesonephros develops primitive nephrotomes draining into a mesonephric duct.

The gonadal ridge is a thickening on the mesonephros.
The gonads arise from two sources.

The gonadal ridge is a thickening on the mesonephros.

Primordial cells arise in the morula stage. They are distinguishable in the region of the allantois and migrate into the gonadal ridge.
The Indifferent Gonad

Proliferation of coelomic epithelium over genital ridge gives rise to primitive sex cords.

Primitive sex cords
Primordial Germ cells invade the primitive sex cords in the 6th week
Differentiation of the testes
6th week

- Sex cords organized radially to form testicular cords
- Deep part of primitive sex cords form rete testis ...
- ... and communicate with mesonephric tubules, which form efferent ductules
- Tunica albuginea separates coelomic epithelium from testicular cords
- Blood capillaries and myoid cells migrate between testicular cords
Histodifferentiation of testes occurs from 3 sources

- Primordial germ cells → Spermatogonia
- Coelomic epithelium → Sertoli cells
- Mesonephric mesenchyme
  - Connective tissue & tunica albuginea
  - Blood vessels
  - Interstitial (Leydig) cells in 8th week
Differentiation of the ovary occurs in the 7th week.

Second generation of cords from coelomic epithelium form primordial follicles.

Primitive sex cords form rudimentary rete ovarii.

Proliferate rapidly in the 2nd - 4th months.

Enter meiosis in the 4th month.
Genetic control of gender depends on the presence or absence of a Y chromosome.  

3 genes on the Y chromosome are related to testicular development:

- **Sry locus** on Yp
- **ZFY gene** on Yp
- **HY antigen locus** on Yq

**Testes determining factor**

- **Zinc finger transcription factor**
- **Expressed on surface of cells**

Fluorescent segment - unimportant; variable
Genetic Sex and Phenotypic Sex

Y chromosome (SRY gene) → Testes → Male genitalia

Absence of Y chromosome (SRY gene) → Ovary → Female genitalia

Androgens → Male genitalia

Lack of androgens → Female genitalia
Anomalies of Gonadal Development

Anomalies of Sex Chromosomes

- 45,X Turner Syndrome
- 47,XXY Klinefelter syndrome
- 47,XXX 48,XXXXY etc.

True hermaphrodites
(presence of both testes and ovaries)

Anomalies of Receptors
Testicular Feminization Syndrome
(XY females)
Time frame for ovarian development

6 weeks: enter gonad

6 to 16 weeks
4 million oogonia

Mitosis

Oogonia

6 to 16 weeks
2 million oocytes at birth

Primordial Germ Cells

Meiosis I

Meiotic Arrest

Oogonia

16 weeks foetal

Postpubertal cyclic development

puberty

Release from meiotic arrest

Meiosis II

1º oocytes

1º oocyte

2º oocyte

mature ovum
The parmesonephric ducts

* Develop as invaginations from the epithelium lining the urogenital ridges
  * Grow lateral to the mesonephric ducts
  * Cross ventral to the mesonephric ducts

* Fuse caudally in the midline
  * The fused caudal tip projects on the posterior wall of the urogenital sinus
The male genital duct system is derived from the mesonephric tubules and duct
Some vestigial structures remain

- Cranial mesonephric tubules
- Appendix epididymis
- Parmamesonephric duct (cranial end)
- Appendix testis
- Caudal mesonephric tubules
- Paradidymis
The female genital duct system is derived from the paramesonephric duct.

- **Fimbriated end of uterine tube**
- **Uterine tube**
- **Broad ligament with ovary in posterior wall**
- **Uterus - body & cervix from fused parmesonephric ducts**
Vestigial structures derived from the mesonephric duct in the female

Epi-oophoron & Para-oophoron in broad ligament
The uterus is formed from the fused paramesonephric ducts, which contact the urogenital sinus.

At the point of contact a sinu-vaginal bulb arise by cell proliferation from the paramesonephric duct and urogenital sinus.
Development of the vagina

- Proliferation gives rise to the vaginal plate.
- Canalization of the vaginal plate occurs in the 4th month.
- The vaginal fornices form.
- The hymen remains as a thin plate between the vagina and urogenital sinus.
Mesodermal thickenings around the cloacal membrane

- a genital tubercle cranially
- Paired cloacal folds laterally

After separation of urogenital sinus by the urorectal septum

- Genital tubercle
- Urethral folds
- Anal folds
In the male

The genital tubercle (phallus) elongates

A solid cord of urogenital sinus epithelium (urethral plate) grows on its ventral surface

The urethral plate deepens to forms a urethral groove and a urethra
Molecular regulation of genital duct development

Sry

Testes determining factor

Testes

Sertoli cells

Leydig cells

Antimüllerian hormone

Inhibits paramesonephric duct development

Testosterone

Di-hydrotestosterone

Wolffian duct

External genitalia
Congenital anomalies in females

- Ovarian Dysgenesis
- Rudimentary uterus
  - Bifid uterus
  - Septate uterus
- Imperforate hymen

Congenital anomalies in males

- Testicular agenesis (rare)
- Undescended testes
  - Hypospadias
Hypospadias
Defect of closure of the urethral groove
The commonest anomaly of the male genital system
Three levels of abnormality

coronal

penile

Perineo-scrotal
The ureteric bud and metanephric blastema exert inductive effects on one another.

Ureteric bud and branches

Ureter
- Major and minor calices
- Collecting ducts

Metanephric blastema

Nephrons:
- Bowman’s capsule,
- proximal convoluted tubules,
- loops of Henle,
- distal tubules