Spermatogenesis

Dr K Lindsay

Leaning objectives

- To understand basic testicular anatomy
- To understand the cell types and their relationships within the testis
- To understand the development of the human sperm
- To understand the relationship between the various testicular compartments
- To understand the temporal & spatial characteristics needed found in the testis

Chromosomes & gonadal development

Autosomes	Sex Chrom.	Gonad	Syndrome
44	XO	Ovary	Turner's
44	XX	Ovary	Norm.Female
44	XXX	Ovary	Super Female
44	XY	Testis	Norm.Male
44	XXY	Testis	Kleinfelter's
44	XYY	Testis	Super Male
66	XXX	Ovary	Non viable trip.
66	XXY	Testis	Non viable trip.
44	XX ^{SXT}	Testis	Sex reversal

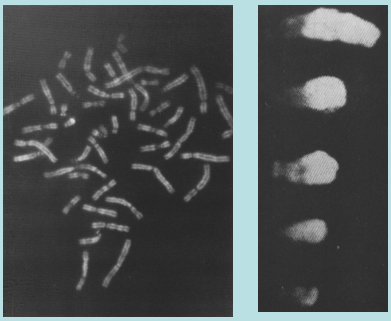
The SRY gene

- **The sex-determining region Y is translocated in XX males.**
- **Critical deletions of the SRY gene are missing in XY females - intersex.**
- **The SRY gene injected into XX mouse zygotes develops into a male.**
- **But ~ 50 genes appear to have different expression between male & female mouse embryos before SRY activation**

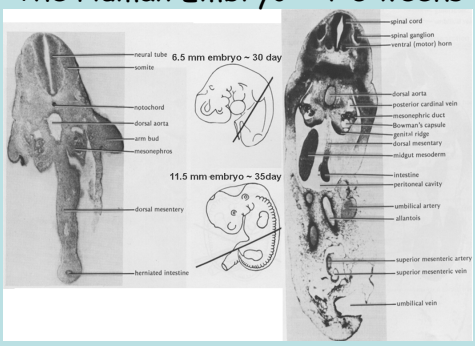
(Vilain etal New Scientist 19.08.02.)

The Y chromosome

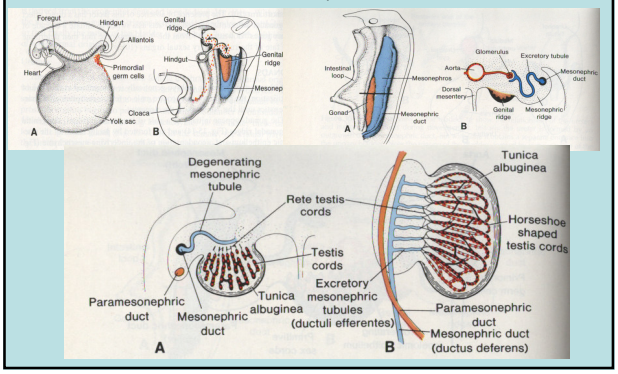
Stained with quinacrine below has ~78 genes with ~ 600 base repairs with 'mirror' image repeats tending to conserve and not crossover



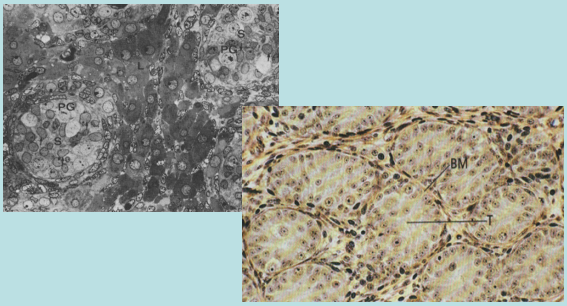
The Human Embryo - 4-5 weeks



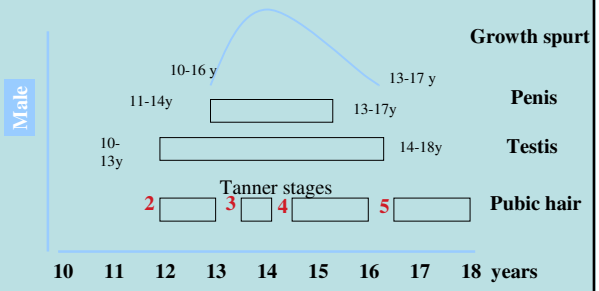
Primordial germ cells and the early testis at 8 & 16 weeks



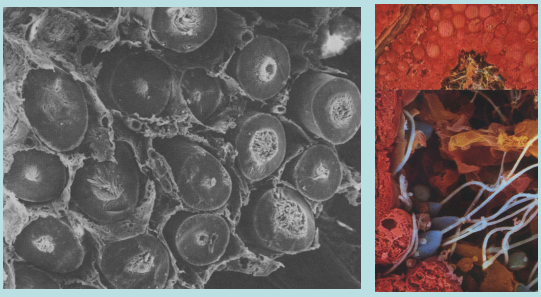
The Immature Testis
16 week fetus & with early seminiferous tubules



Reproductive Development in the human male



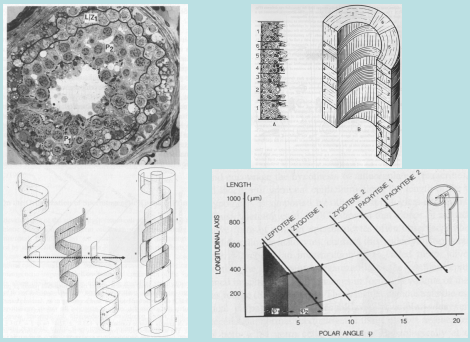
The adult testis is tubular
(Rat - Cut section SEM & human)



Spatial changes along a tube
The spermatogenic wave.

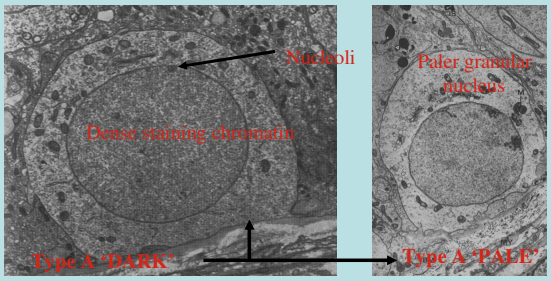
An orderly sequence of successive cell associations is observed along the length of the seminferous tubule of rodents.
The sequence in humans appears to be chaotic, but on closer examination shares the same fundamental feature.

The apparent chaotic appearance is due to the angular / polar cell-cell relationship



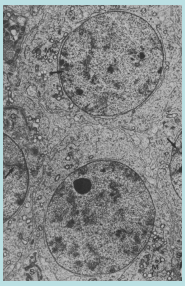
Basal cell type
Spermatogonia -mitotic division

Division renews Type A 'Dark' when producing Type A 'Pale"



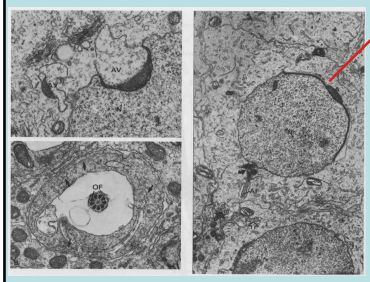
Type B - Larger scalloped chromatin granules and small clumps attached to nuclear envelope with nucleoli in interior of nucleus.

Intermediate cell type, Spermatocytes- meiotic division

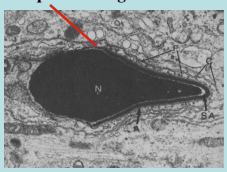


- Primary or "resting" spermatocytes produce two daughter cells.
- Secondary spermatocytes contain a single set of chromosomes and are very short lived.

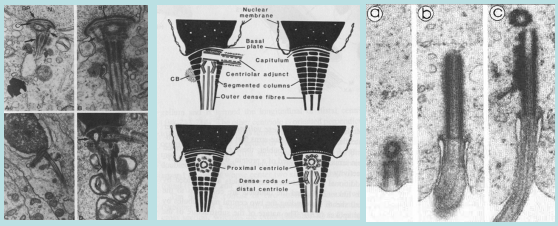
Luminal cell type, Spermatids, cytoplasmic modelling produces an a dense eccentric nucleus covered by a Golgi derived Acrosome -spermiogenesis



The Acrosome eventually 30-60% of the head attenuated at the equatorial segment

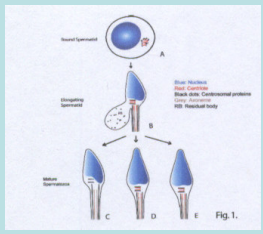


'Round' spermatids elongate and develop a tail from the distal centrosome (a-c)



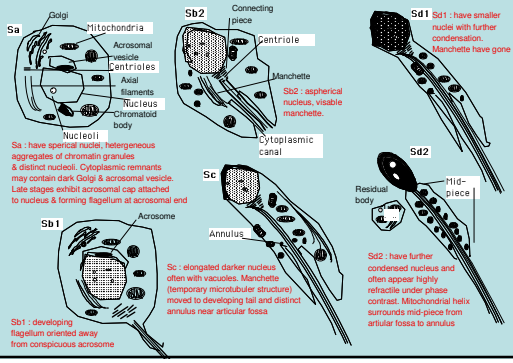
Centrosome degeneration in spermatogenesis

(Manandhar et al 2004 Biolreprod)



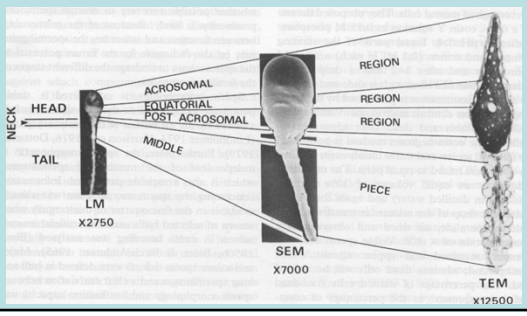
- Intact centrosomes until round spermatid (A)as distal centriole extends as axoneme (B). Degeneration is species dependent & may be complete (C-rodents, snails), retained proximal & partial distal (D-primates), both fully retained (E-Xenopus & Drosophila)

Summary: spermatid formation



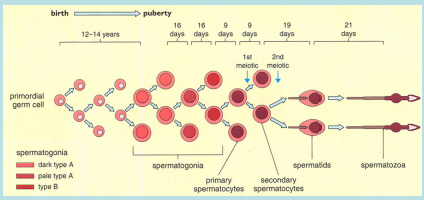
The spermatozoon

A condensed chromatin head of 3 x 5 μm with mitochondrial gyres surrounding mid-piece of 7 -μm and a flagella type tail of 50-55μm.



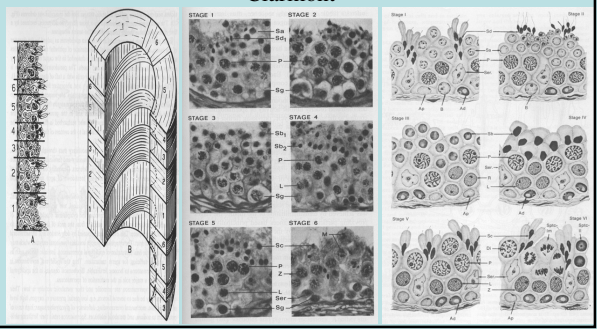
Time/Temporal changes
The spermatogenic cycle

There is a standard mitotic interval or quiescence for stem cells to enter spermatogenesis so that a single area of the seminiferous tubule is a the same stage of development. Generations of daughter cells are linked due to incomplete divisions producing associations over time in a sequence known as the spermatogenic cycle.



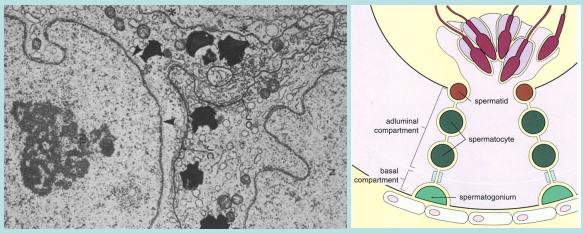
Stages of Spermatogenesis in the Human seminiferous tubes -

Clarmont



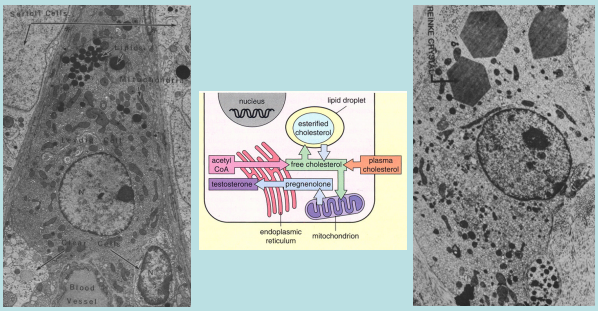
The Sertoli cell

Tall irregular cells with large basal nuclei lining the seminiferous tubules supporting germ cell development across compartments of testis.
Special tight junctions producing a blood-testis barrier which creates local environments and separates mitotic , meiotic from post-meiotic germ cells



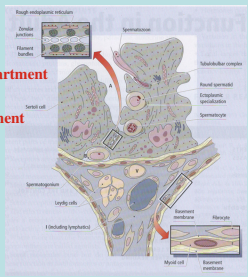
The Leydig cell

Found in the interstitial compartment of the testis they contain large quantities of smooth endoplasmic reticulum and lipid.
Source of Testosterone and may contain Reinke crystals.



The Testis in section illustrating the relationship between cell types forming compartments

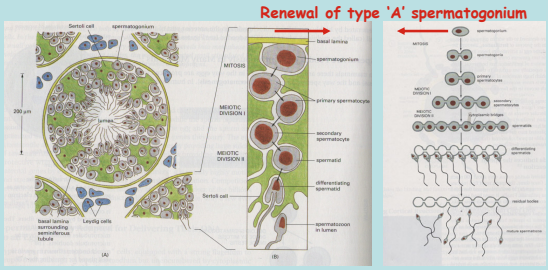
•The Endocrine matrix
1- The intravascular compartment
-communication to body.
2-The interstitial compartment
containing Leydig cells
and lymphatics



•The gamete producing tubules
1-Basal intratubular compartment with Sertoli cells and spermatogonia
2-The adluminal compartment
containing Sertoli cells; Spermatocytes ,spermatids
and spermatozoa

From Essential Reproduction.

Summary of spermatogenesis



Useful references

and acknowledgements

- Johnson & Everitt, (2007) Essential Reproduction
- Knobil & Neill eds (ed 2, 1994, ed 3,2005) The Physiology of Reproduction.