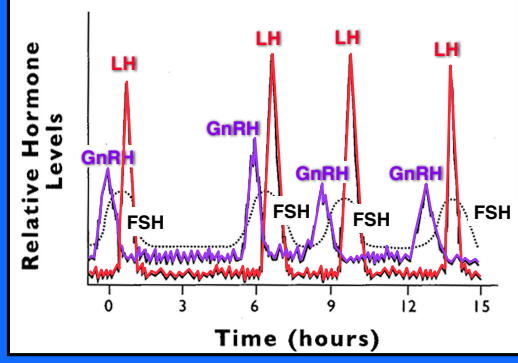
Animal Science 434

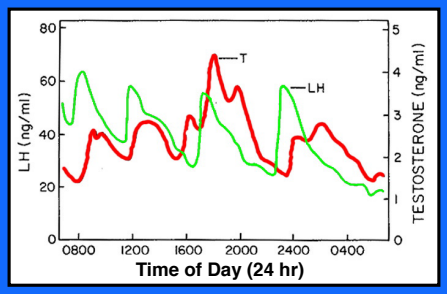
Spermatogenesis

Production of Fertile Sperm

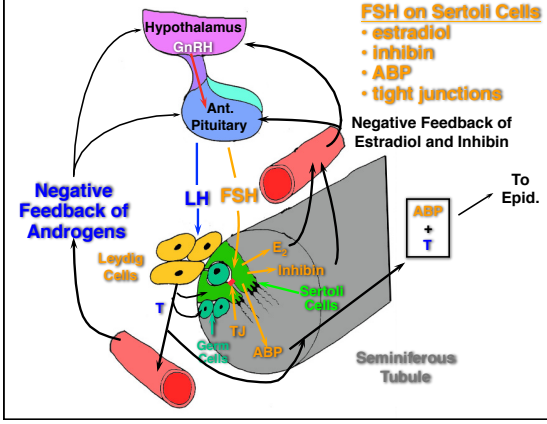
- hormonal regulation of the testis
- mitotic division of spermatogonia
- meiotic divisions of spermatocytes
- morphologic transformation of spermatids into spermatozoa

Hormonal Regulation of the Testis

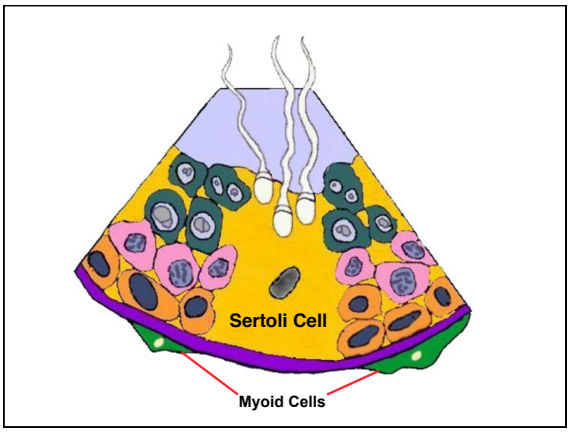




Pulses are important !

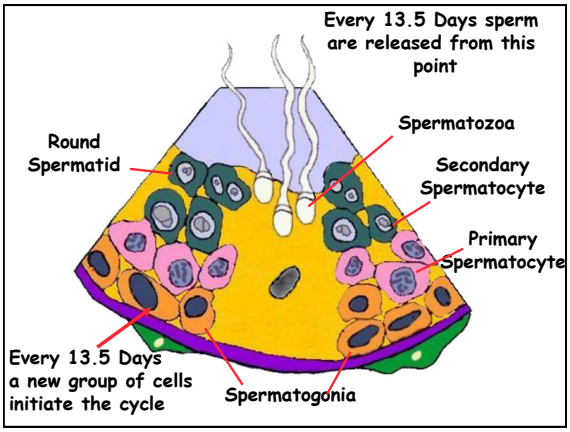


Spermatogenesis

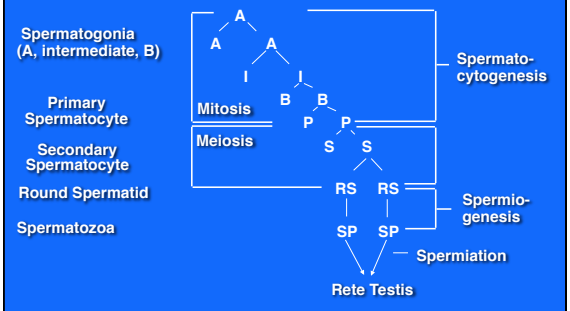


Sertoli Cell

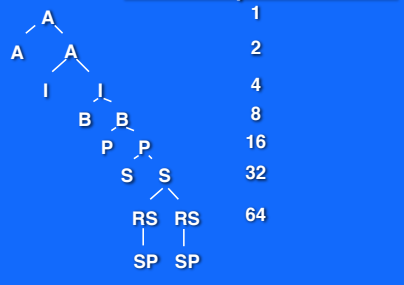




Typical Sequence of Spermatogenesis



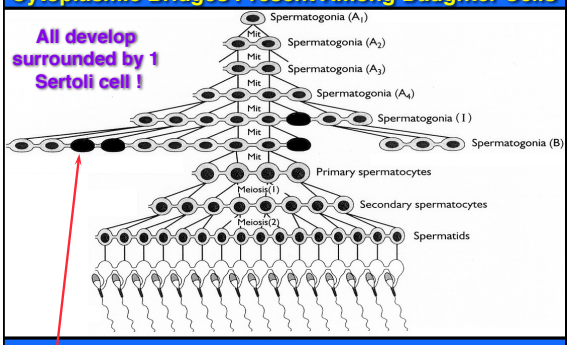
Many Sperm are Produced



Mitotic Divisions

- species dependent
  - between 2 and 6 divisions (4 to 64 potential daughter cells produced)
- classifications vary among species and investigators
  - A_1, A_2, A_3, A_4, B_1, B_2, P
  - A_d, A_p, B, P
  - A_s, A_0, A_1, A_2, I, B, P
- cytoplasmic bridges form between daughter cells

Cytoplasmic Bridges Present Among Daughter Cells



Degenerating Spermatogonia (Apoptosis, as high as 75%)

Germ Cells / Sertoli Cell

Species Potential	Primary Spermatocytes	Round Spermatids	Max. Spermatids
Equine	3.0 ± 0.2	10.9 ± 0.9	64
Bovine	1.2 ± 0.1	5.2 ± 0.6	64
Human	1.3 ± 0.1	4.2 ± 0.2	16

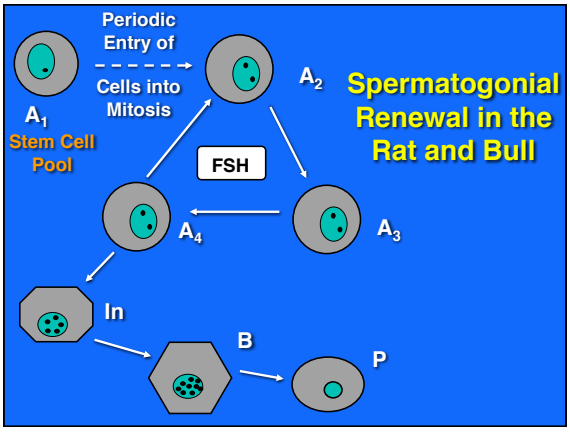
Apoptosis of Germ Cells

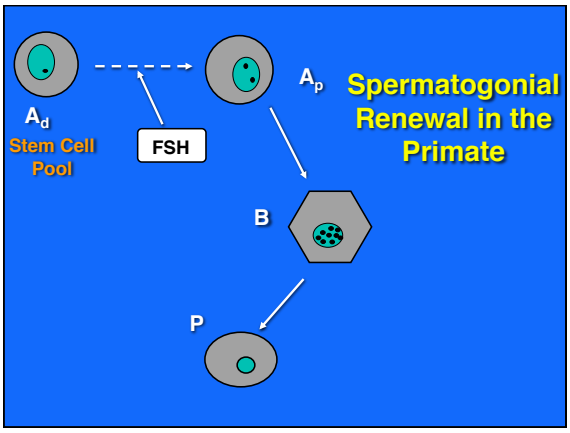
- Season
- Disease
- Trauma or heat
- Hormone levels
- Normal part of spermatogenesis

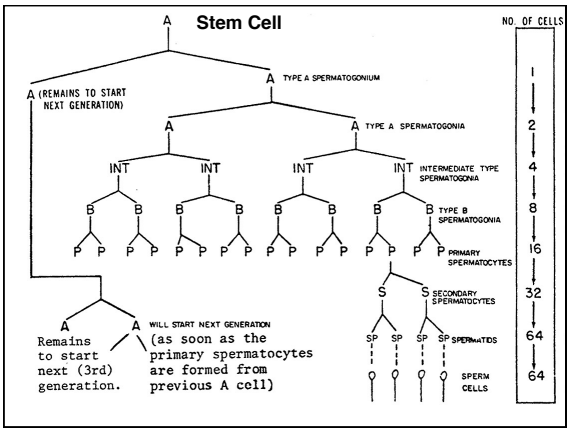
Stem Cell Renewal

- To keep spermatogenesis going indefinitely
- Replenish testis incase of injury, trauma, or high heat

Spermatogonial Renewal in the Rat and Bull

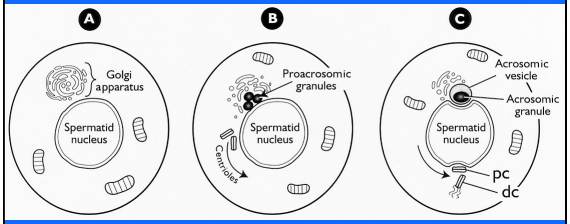






Spermiogenesis

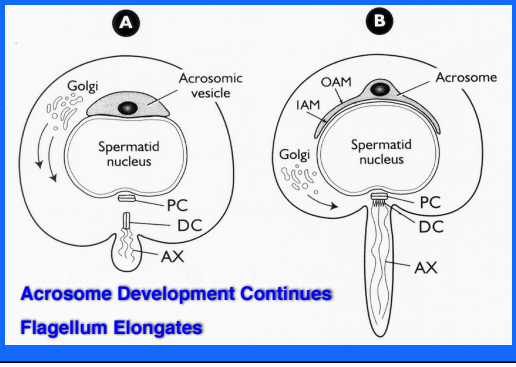
Golgi Phase



Development of Acrosome

Migration of Centrioles

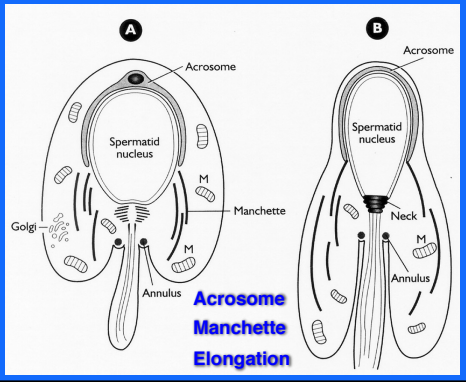
Cap Phase



Acrosome Development Continues

Flagellum Elongates

Acrosomal Phase



Acrosome

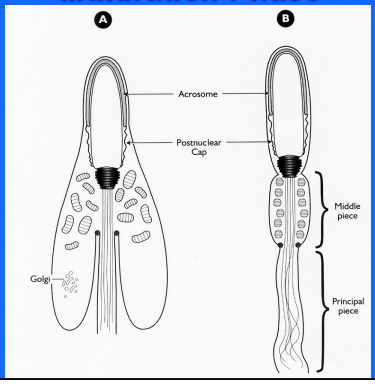
Manchette

Elongation

Manchette

- A series of microtubules
- Associated with nuclear elongation

Maturation Phase



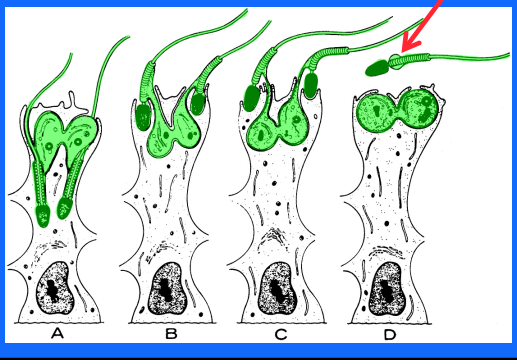
Manchette disapears

Mitochondria migrate

Dense fibers form

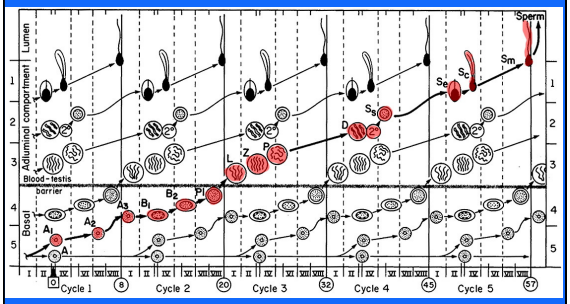
Spermiation

Spermiation



Temporal Relationships of Spermatogenesis

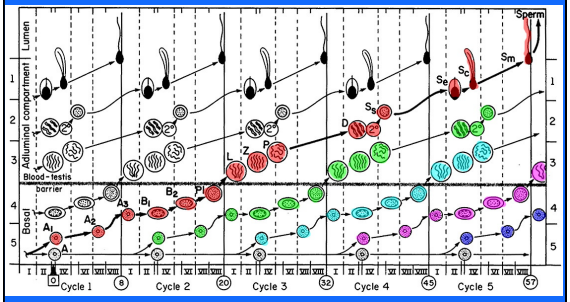
Spermatogenesis



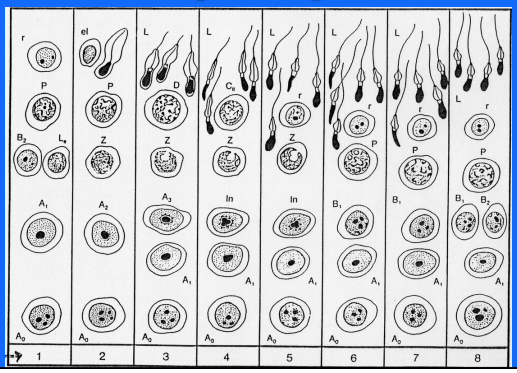
57 days

Stallion

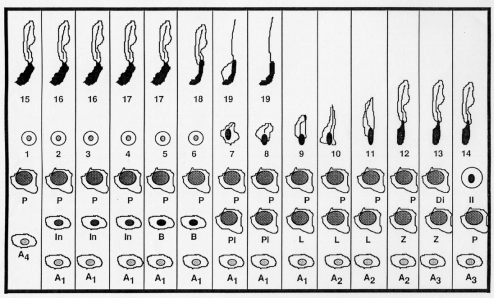
Multiple Generations of Germ Cells



Bull Spermatogenesis



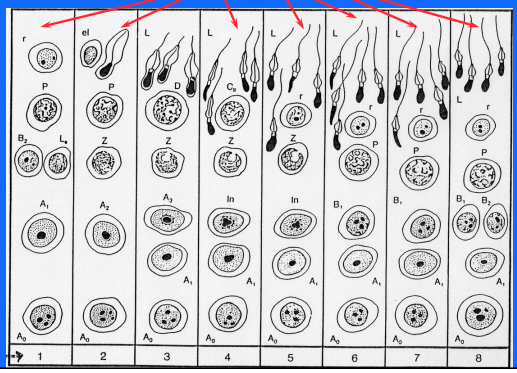
SPERMATOGENESIS IN THE RAT



Stages

- Specific cellular associations within a small segment of a seminiferous tubule
- stages are not the same length in time

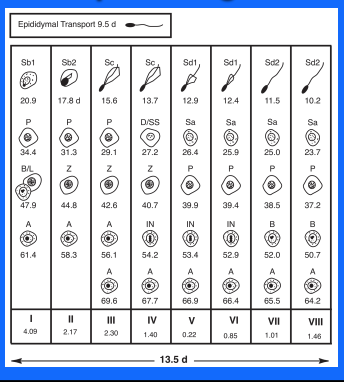
Bull Spermatogenesis - Stages



Stages

- Specific cellular associations within a small segment of a seminiferous tubule
- stages are not the same length in time

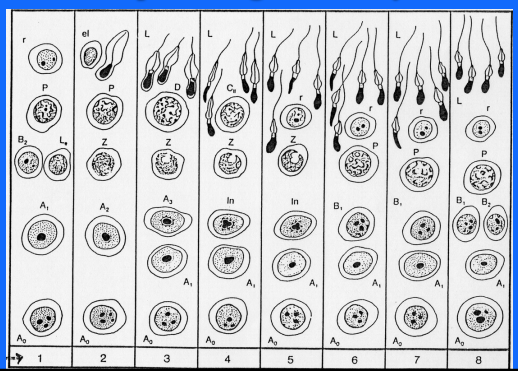
Bull Spermatogenesis



Cycle

- progression through sequence of all stages

Bull Spermatogenesis - Cycles



Cycle

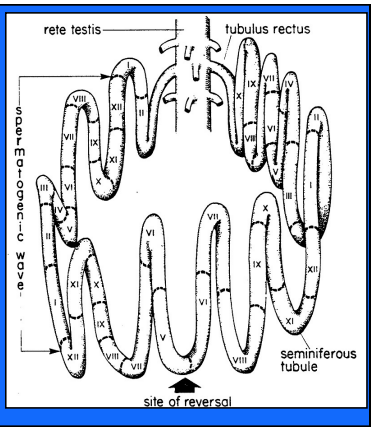
- progression through sequence of all stages
- 4.5 cycles to form spermatozoa
  - some species variation

Duration of Spermatogenesis

	Bull	Ram	Boar	Stallion	Man
cycle (days)	13.5	10.4	8.3	12.2	16
Spermatogenesis	61	47	39	57	75

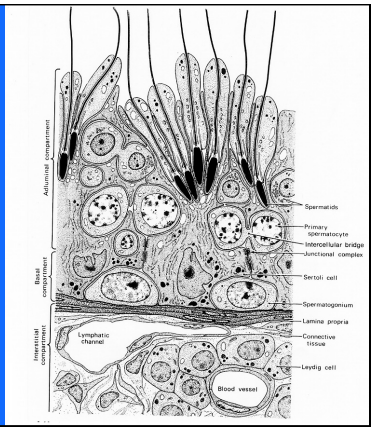
Coordination of Stages Form Waves

- some portion of seminiferous tubule is always releasing sperm

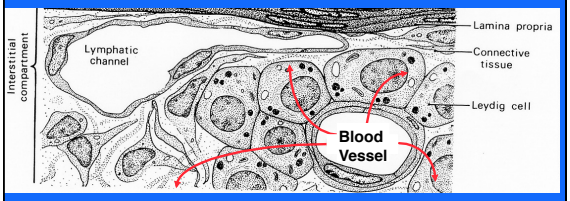


Compartmentalization of Spermatogenesis and the Blood Testis Barrier

Seminiferous Tubule and Interstitial Tissue

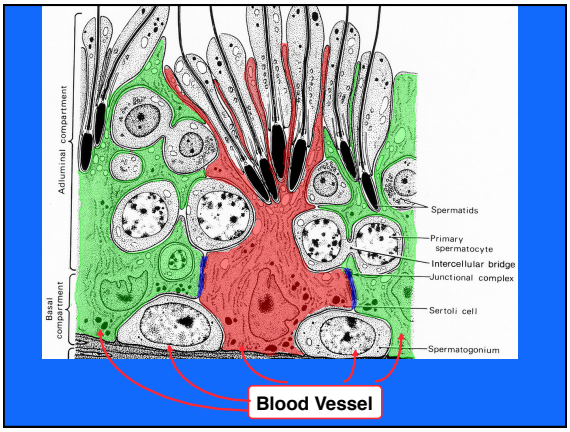


Interstitial Tissue

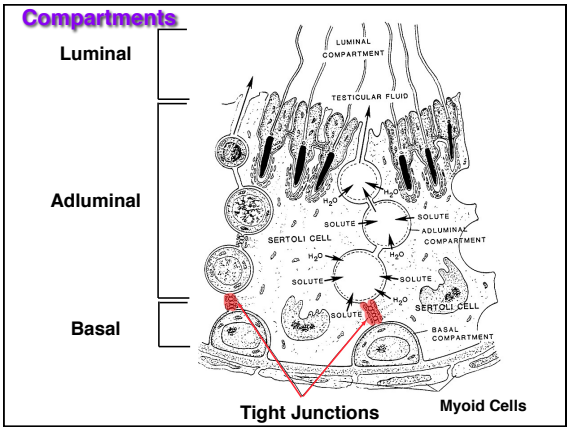


Vascular System Provides

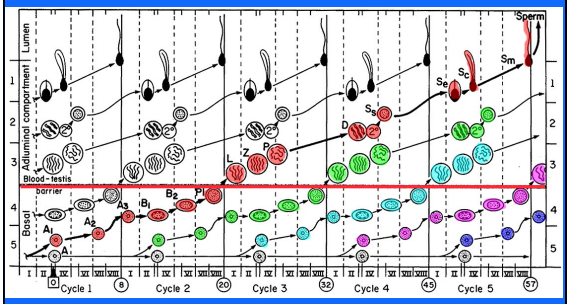
- Nutrients
- Oxygen
- Growth Factors
- Hormones



Compartments



Cycles and Stages



Compartmentalization

- Basal
  - mitosis
    - spermatogonia (A, I, B)
    - primary spermatocytes
- Adluminal
  - meiosis
    - primary spermatocytes
    - secondary spermatocytes
    - spermatids
  - spermiogenesis
- Lumen
  - spermiation

Blood Testis Barrier

- Sertoli cells and associated tight junctions
- first appears at puberty
- induced by FSH
- after puberty can be maintained by FSH and/or testosterone
- essential for meiosis !!!!!

Tight Junction Role in Meiosis

- Sertoli cells can manipulate environment around 1° spermatocyte
  - Enters meiosis
  - Completes meiosis
- Destruction of TJ causes impairment of meiosis
  - Heat, heavy metals, endocrine disruptors, pesticides, lack of FSH or Testosterone

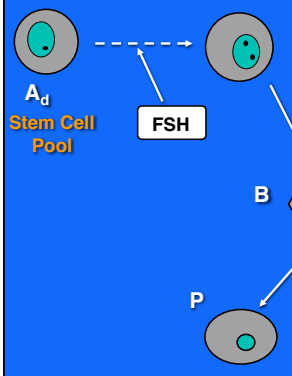
Capacity for Sperm Production

Species	Testis Weight (gm)	Sperm/gm (X 10^6)	DSP (X 10^9)
Dairy Bull	650	18	10
Beef Bull	500	18	8
Ram	550	26	14
Boar	750	30	25
Stallion	165	18	3
Man	40	4	.045 - .2

Duration of Spermatogenesis

	Bull	Ram	Boar	Stallion	Man
cycle (days)	13.5	10.4	8.3	12.2	16
Spermatogenesis	61	47	39	57	75

Spermatogonial Renewal in the Primate



Capacity for Sperm Production

Species	Testis Weight (gm)	Sperm/gm (X 10^6)	DSP (X 10^9)
Dairy Bull	650	18	10
Beef Bull	500	18	8
Ram	550	26	14
Boar	750	30	25
Stallion	165	18	3
Man	40	4	.045 - .2

Variation in Sperm Production

- Testis Size
- Efficiency of spermatogenesis
  - mitotic division
  - degeneration of germ cells
- Length of spermatogenesis

Apoptosis of Germ Cells

- Season
- Disease
- Trauma or heat
- Hormone levels
- Normal part of spermatogenesis

