GAMETOGENESIS

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Animal Gametogenesis Stages

MALE		FEMALE
	Primordial Germ Cell	
Spermatogonium	**2n**	Oogonium
Primary Spermatocyte	**2n**	Primary Oocyte
Secondary Spermatocyte	**??**	Secondary Oocyte
Spermatid	**n**	Ootid
Spermatozoon (sperm)	**n**	Ovum (egg)

2

Animal Spermatogenesis Stages

Primordial Germ Cell **2n**

Spermatogonium **2n**

Primary Spermatocyte **2n**

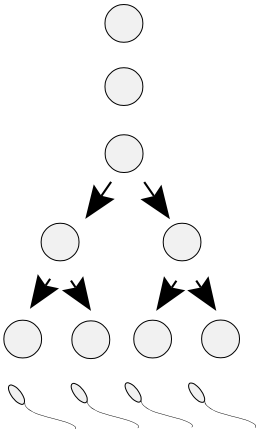
Meiosis I

Secondary Spermatocyte **??n**

Meiosis II

Spermatid **n**

Spermatozoon (sperm) **n**



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Animal Oogenesis Stages

Primordial Germ Cell **2n**

Oogonium **2n**

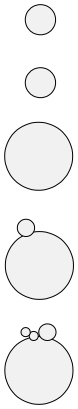
Primary Oocyte **2n**

Meiosis I

Secondary Oocyte & Polar Body **??n**

Meiosis II

Ootid – Ovum & Polar Bodies **n**



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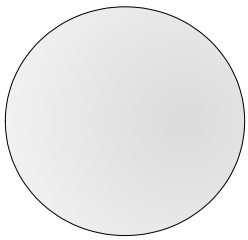
Primary Spermatocyte



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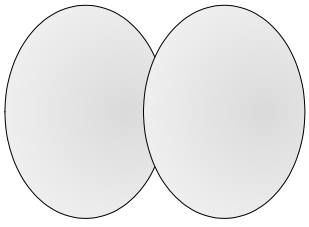
Secondary Spermatocytes



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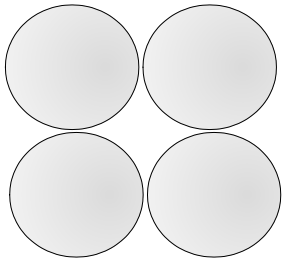
Spermatids



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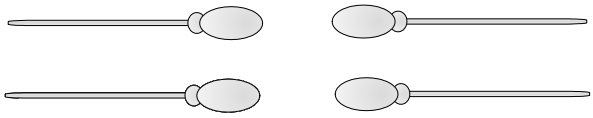
Spermatozoa



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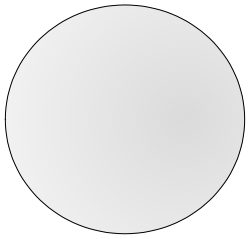
Primary Oocyte



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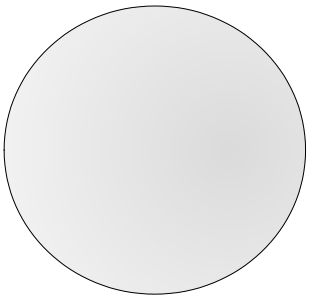
Primary Oocyte (growth)



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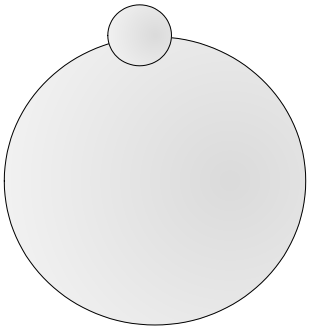
Secondary Oocyte + polar body



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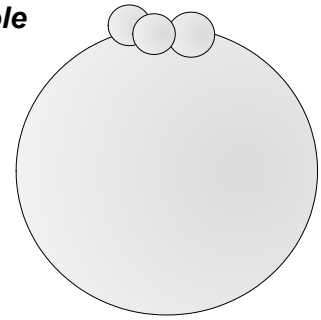
Ootid (ovum) + polar bodies

Animal Pole



Vegetal Pole

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Meiosis in Male & Female Mammals

after Handel & Eppig (1998); Gilbert (2003)

- **Male**
  - **Continuous meiosis initiation in mitotic cell population**
  - **4 gametes per meiosis**
  - **Continuous meiosis and differentiation without cycle arrest - days to weeks**
  - **Gamete differentiation in haploid stage after meiosis**
  - **Prophase I - sex chromosomes don't transcribe or recombine**
- **Female**
  - **Meiosis initiated ONCE in fixed cell population**
  - **1 gamete per meiosis**
  - **Meiosis arrest for months to years**
  - **Gamete differentiation in prophase I - diploid**
  - **Prophase I - all chromosomes equivalently transcribe and recombine**

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Primordial Germ Cells

In the Vertebrates

- **PGC differentiation**
  - **Early stage of development – no gonad yet**
  - **In endoderm far from site of gonad development**
- **PGC migration**
  - **Through circulation and/or mesentery**
  - **Homing to and colonizing mesodermal genital ridge**
- **PGC's induce full gonad differentiation**
- **Diploid PGC's divide mitotically**
  - **forming diploid gonial cells**

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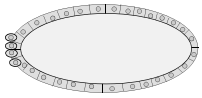
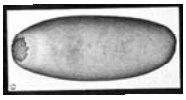
Germ Plasm and PGC Determination

- **Insects**
  - *Drosophila* (Mahowald), Dragonfly (Seidel)
  - **Pole cells - posterior end of cellular embryo**
    - Become Primordial Germ Cells





  - **Pole Plasm - determines Pole Cells**
    - prevent nuclear migration into pole plasm --> STERILE
    - UV irradiate pole before nuclear migration --> STERILE
  - **Components**
    - Gcl m-RNA (product of *gcl*$^+$)
    - Oskar and Nanos proteins (products of *oskar*$^+$ and *nanos*$^+$)
    - mtrRNA - mitochondrial ribosomal RNA

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Germ Plasm and PGC Determination

- **Amphibia**
  - *Xenopus laevis*
  - **Germ Plasm**
    - At vegetal pole of egg
    - In cortical cytoplasm
    - Cells containing it become PGC's

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Experiments on PGC origin/migration

- **Chick – Dantschakoff 1924 - Ablation Exp't**
  - **PGC's visible in "Swift's Crescent" – endoderm – by 18-20 hr**
  - **Sawed window through eggshell to expose embryo**
  - **Destroyed "PGC's" with heated steel needle**
  - **Re-sealed eggshell window and incubated egg**
  - **Some chicks hatched**
  - **When raised to adulthood – STERILE adult**
  - **Rudimentary gonad with no germ cells**
- **Conclusion**
  - **Destroyed cells were actually PGC's**
  - **PGC's form in 'extraembryonic' endoderm of Swift's Crescent**

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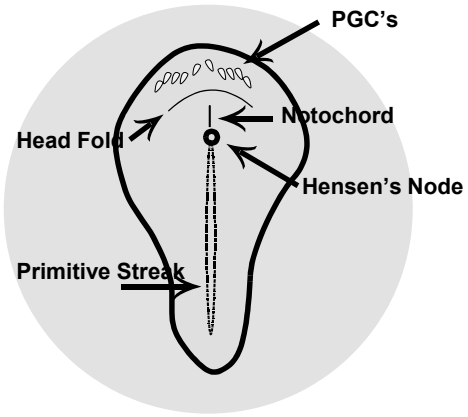
"Swift's Crescent"



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Experiments on PGC origin/migration

- **Frog – *Xenopus* – Blackler 1961**
  - **Normal - 2 nucleoli**
  - **Anucleolate heterozygote - 1 nucleolus**
- **Transplant endoderm from tailbud stage**
  - **endoderm from flank, just under ecto and meso**
  - **Donor = 1-nu Host = 2-nu**
  - **Raise through metamorphosis to sexual frog**
  - **1-nu oocytes found in otherwise 2-nu gonad**
- **Conclusion**
  - **Transplanted cells were actually PGC's**
  - **PGC's form in flank yolky endoderm of tailbud stage in frog**

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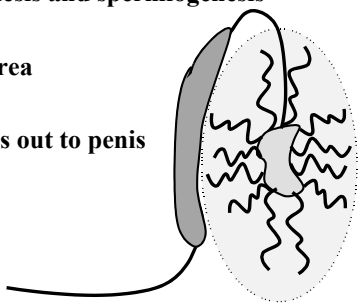
Spermatogenesis - Testis Organization

Higher Vertebrates

- **Seminiferous tubules**
  - **site of spermatogenesis and spermiogenesis**
- **Rete testis**
  - **central collecting area**
- **Vas deferens**
  - **duct from rete testis out to penis**
  - **epididymis**



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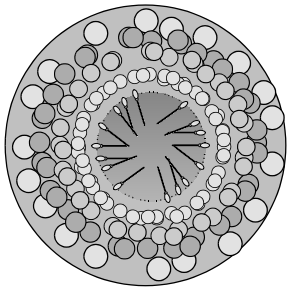
Spermatogenesis - Tubule Organization

Vertebrates

- **Seminiferous Tubules**
  - **within testis - layered stages of spermatogenesis from outer wall of tubule toward lumen**
  - **syncitial clones**

    Spermatogonia
    Primary Spermatocytes
    Secondary Spermatocytes
    Spermatids
    Spermatozoa



- **Accessory Cells**
  - **Sertoli Cells**

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Spermiogenesis

- **Spermatid ➠ Spermatozoon**
- **Removal of most cytoplasm**
- **Nuclear condensation and shape change**
  - **Change in chromatin histones**
  - **Turn off sperm gene activity**
- **Acrosome forms in Golgi apparatus**
- **Mitochondria aggregate – midpiece forms**
- **Centrioles form**
- **Tail microtubule arrangement and extension**

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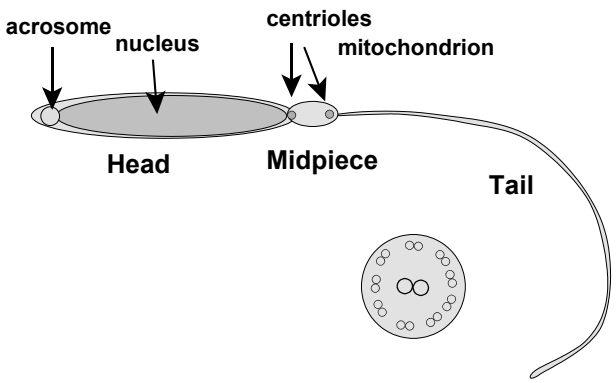
Spermatozoon



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