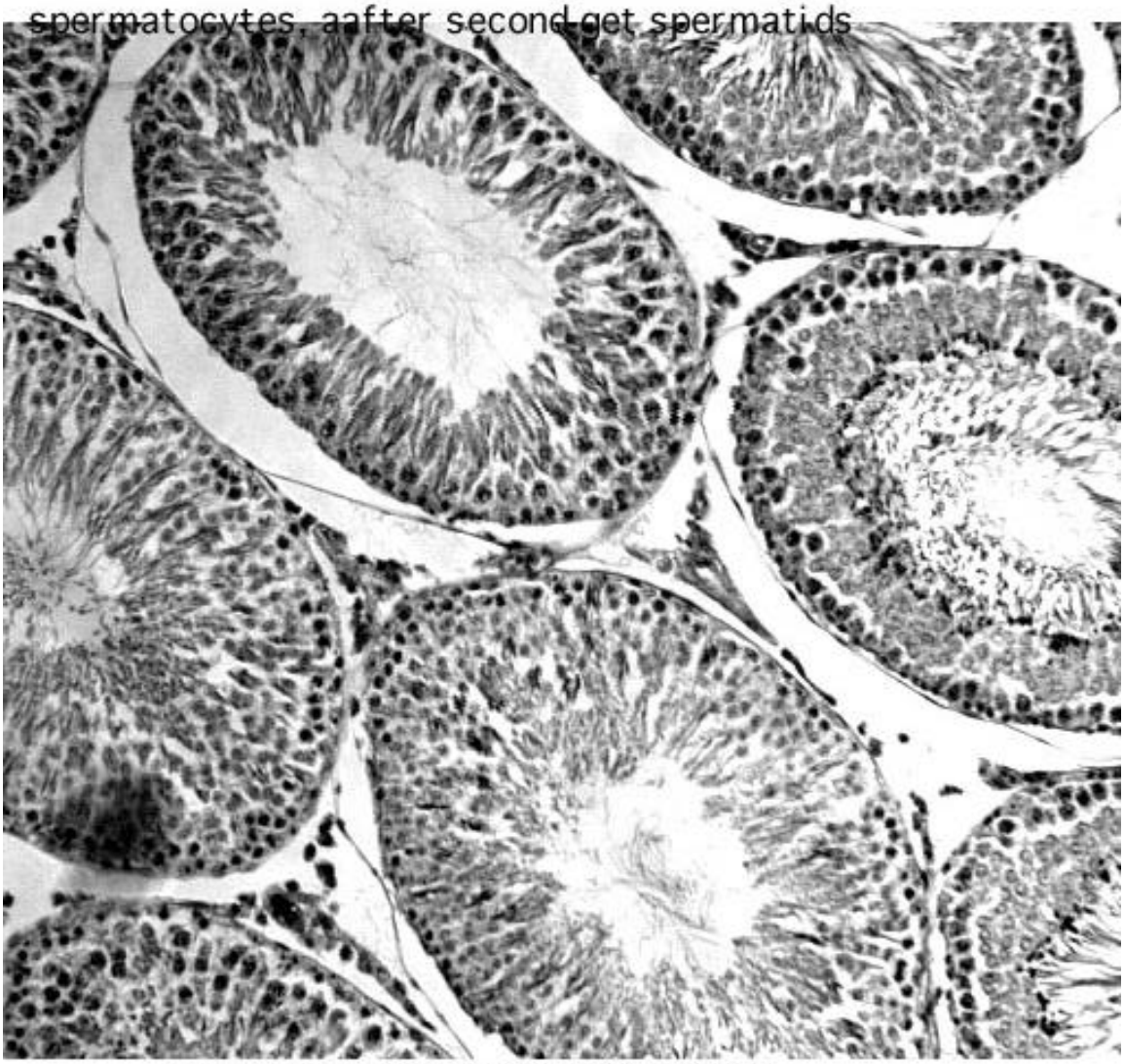
MALE GAMETOGENESIS We have already seen the process of egg maturation started in follicle production and ovulation in the female. It involved the growth of the oocyte and the production of one polar body at ovulation and another at fertilization. The nuclear maturation is separate from the cytoplasmic maturation, and the same is true in spermatogenesis. But the order is reversed: the sperm undergo nuclear maturation through two rapid meiotic divisions in succession followed by cytoplasmic changes which streamline the sperm for motility and for fusion with the egg.

SPERMATOGENESIS Differentiation starts in the male gametes at puberty, in response to hormones. The sex cords of Sertoli cells and spermatogonia hollow out with a lumen, to form the seminiferous

Rat: cross-sections of seminiferous tubules in testis of mature male

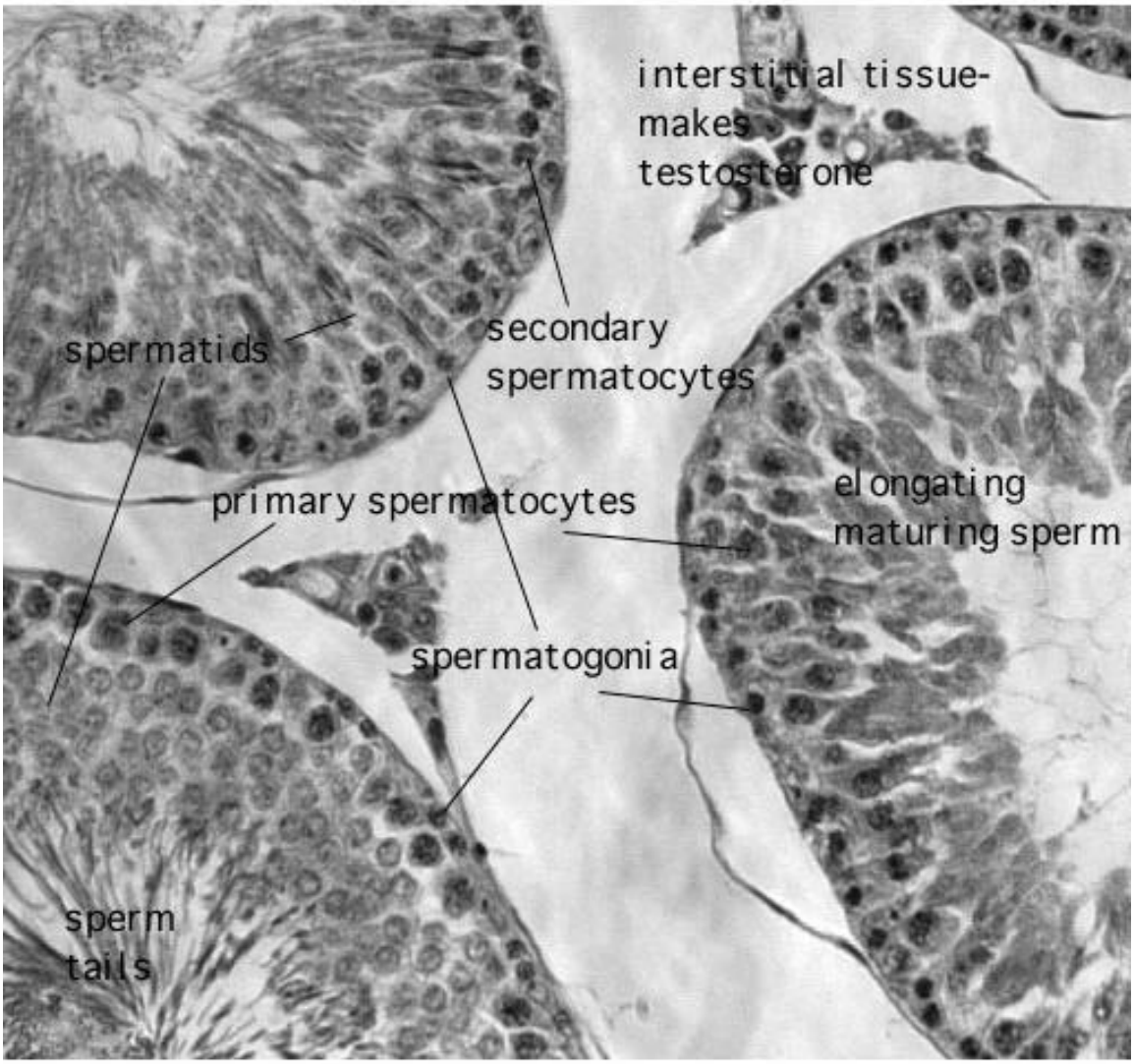
Outer layer is spermatogonia which divide by mitosis
Next layer is primary spermatocytes which can divide by meiosis, 2 divisions to reduce chormosome number. After first division get secondary spermatocytes, aafter second get spermatids



tubules. The interstitial cells between the tubules, called Leydig cells secrete testosterone and other androgens and there is a general increase in testis size. The interstitial cells have vacuolated cytoplasm (clear areas

inside the cell) and visible nuclei. The spermatogonia initiate mitosis at puberty to increase the number present. When you look at your slide, you will see lots of round circles in the slide under low power, each is a section of a seminiferous tubule. Inside the tubules, the youngest stages in spermatogenesis, the spermatogonia, are found toward the outside of the tubule. In every tubule, periodically a few cells of the spermatogonia are activated to enter meiosis instead of mitosis, and this process proceeds in waves down the tubules, so that in any one tubule, you will not see all the stages of spermatogenesis, since all the primary spermatocytes at that level may have divided twice in rapid succession.

Rat testis seminferous tubules with various stages of sperm production

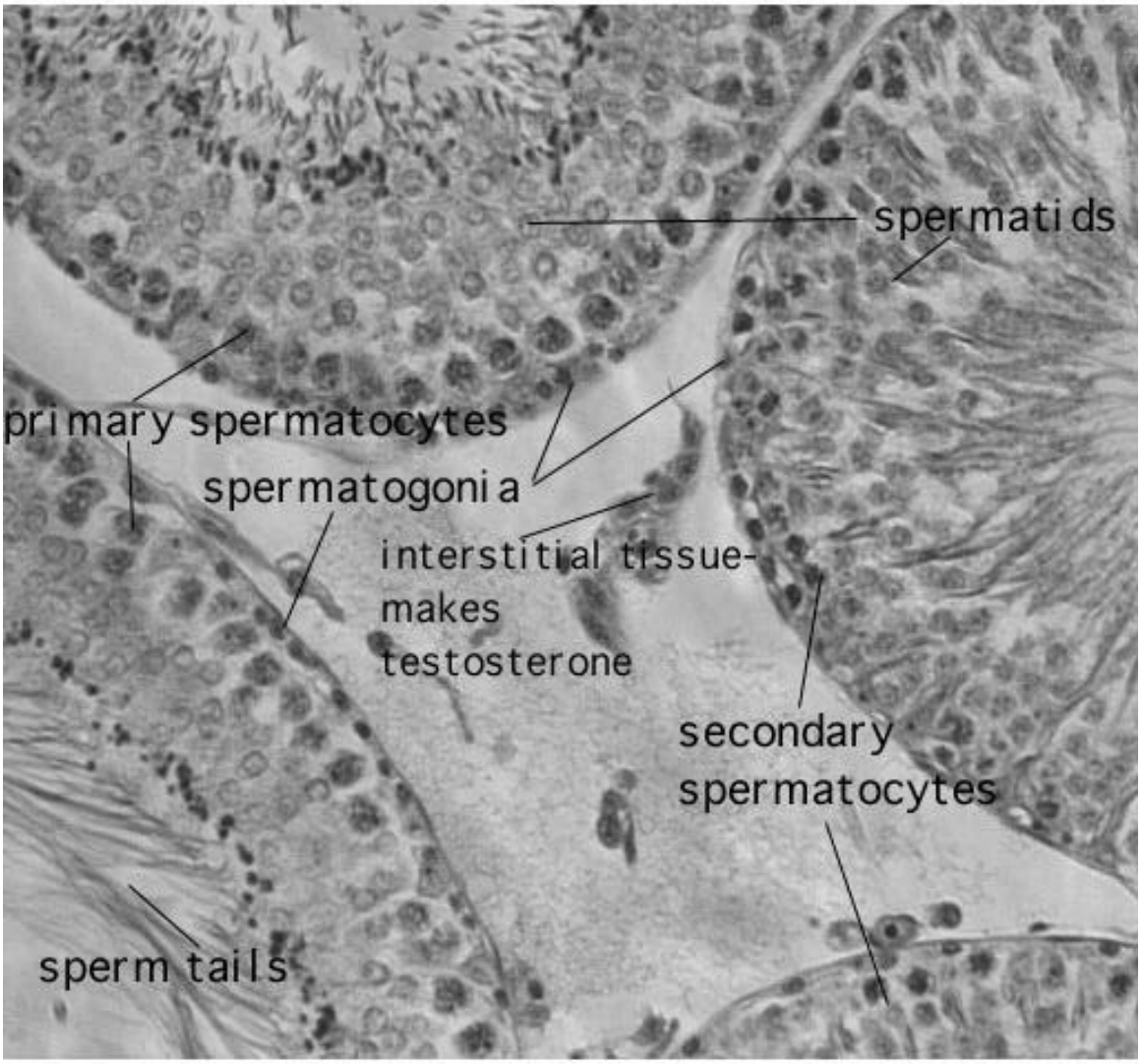


sperm mature after meiosis is complete

The first stage of meiosis is the conversion of spermatogonia to primary spermatocytes, which are committed to proceed through two meiotic divisions. They undergo DNA synthesis prior to the first prophase so their

nuclei are full of duplicated chromosomes. No further DNA duplication will occur at the second division so the two divisions will result in reduction of the chromosome number to half that of the other cells in the body; but at fertilization, the egg and sperm will both donate half the number when they fuse to make a zygote with the proper diploid number again. The primary spermatocytes are larger than the spermatogonia, and the primary spermatocyte has nuclei which are more rounded, not ovoid as in spermatogonia. This prophase lasts about 16 days. You may see some evidence of crossing over as the chromosomes condense prior to the first meiotic division. The nuclear membrane breaks down and then there is a rapid metaphase, anaphase, and telophase to result in two secondary spermatocytes from each primary spermatocyte. Find the secondary spermatocytes by looking interior in the tubule for cells which have nuclei one half the size of the primary spermatocytes. To distinguish between these and the cells resulting from the next division, the spermatids, find cells which have nuclei one fourth the size of the primary spermatocytes, and one half the size of the secondary spermatocytes, these are the spermatids, then you can see the three sizes and compare them, to distinguish them more easily.

Rat testis seminiferous tubules showing various stages of meiosis and sperm maturation



Spermatids have 23 chromosomes, and have completed the maturation of the nucleus but not the cytoplasm. One primary spermatocyte produces two secondary spermatocytes and these produce four spermatids.

DRAW SPERMATOGONIA, PRIMARY AND SECONDARY SPERMATOCYTES AND SPERMATIDS, COMPARING THEIR SIZES and POSITIONS IN THE SEMIFEROUS TUBULES.

SPERMIOGENESIS The maturation of the cytoplasm results in the production of spermatozoa or sperm as we know them. The changes which occur result in the production of the acrosome from the Golgi material, the flagellum organized by the centriole, the loss of most of the cytoplasm such as endoplasmic reticulum, ribosomes, and loss of most of the nuclear fluid during the condensation of the nucleus. This takes 61 days. The spermatids become associated with the Sertoli cells which will nourish them as they lose their cytoplasm and become dependent on these nurse cells. They will grow a flagellum, elongate the nucleus and flatten it, and lose the rest of the cytoplasm. Find some cells with short flagellum, condensing nuclei, early midpiece formed by mitochondria wrapping around the flagellum in the midpiece and dark acrosome over the tip of the head of the spermatozoa. **DRAW AT LEAST TWO STAGES OF SPERMIOGENESIS, LABEL.**

The spermatozoa leave their association with the Sertoli cells to migrate to the lumen of the tubule where they are pushed along by contractions of the tubules to the epididymis where there are further contractions to force the sperm out in the ejaculated semen. Look at a sperm smear. Identify three parts, head, midpiece and tail. Compare the size of these parts. They will be difficult to see- cut down on your light and locate them first with low power, then look at them with the 45x power, or the 100x with oil.

DRAW AND LABEL SPERM. There can be abnormal sperm present in semen, usually about 10% of the time. They can have two heads, or two tails, or very small head or tail.

TESTIS VARIATION WITH AGE. Look at testes from a young boy or an old man. (these were taken in autopsy.) What are the differences from the mature male? DRAW A SECTION OF EACH KIND OF TUBULE.

Differentiation starts in the male gametes at puberty, in response to hormones. The sex cords of Sertoli cells and spermatogonia hollow out with a lumen, to form the seminiferous tubules. The interstitial cells between the tubules, called Leydig cells secrete testosterone and other androgens and there is a general increase in testis size. The spermatogonia initiate mitosis. When you look at your slide, you will see lots of round circles in the slide under low power, each is a section of a seminiferous tubule. Inside the tubules, the youngest stages in spermatogenesis, the spermatogonia, are found toward the outside of the tubule. In every tubule, a few cells of the spermatogonia are activated to enter meiosis instead of mitosis, and this process proceeds in waves down the tubules, so that in any one tubule, you will not see all the stages of spermatogenesis, since all the cells at that level may have divided at the same time. The first stage of meiosis is the primary spermatocyte which undergoes DNA synthesis.

Name_____

Make drawings on this sheet:
Draw two different tubules which between them have all the stages of sperm production:
Spermatogonia, primary spermatocyte, secondary spermatocyte, spermatid, intermediate spermatozoan, mature sperm, Sertoli cells. Show the difference in size. Draw some interstitial cells- Leydig cells.

How can you tell the difference between each subsequent stage:

spermatogonia: primary spermatocyte

Primary from secondary spermatocyte

Secondary from spermatid

spermatid from spermatozoan

How can you distinguish a Sertoli cell from a Leydig cell and from the gametes?

After looking at the human slides, what can you say about them in comparison to the cat or rat slides?

What is the difference between the young, adult, and old man's testes?