Oogenesis

HELENA NEJEZCHLEBOVÁ

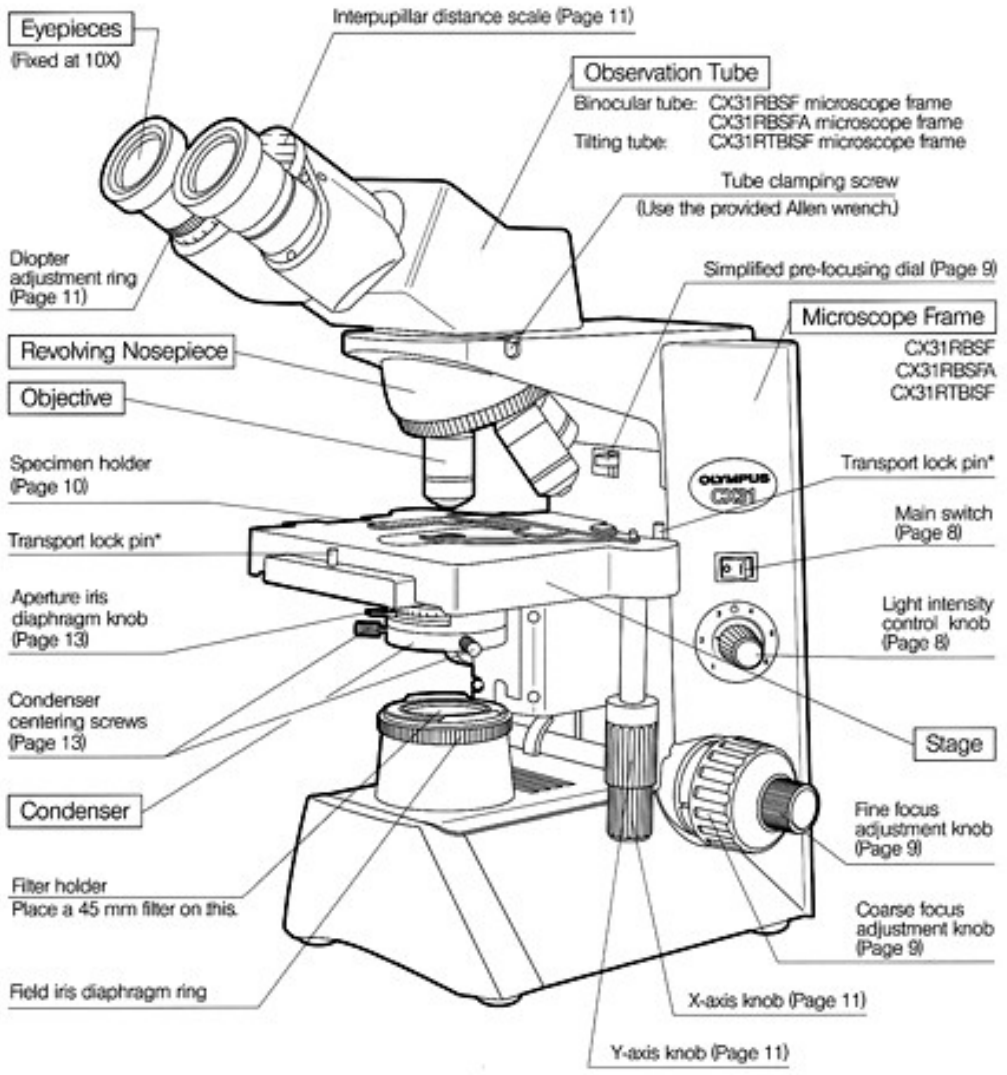
2022-03-17

How to successfully complete the course?

- 1) the attendance is compulsory. If you are absent, find a solution of this situation with the teacher individually

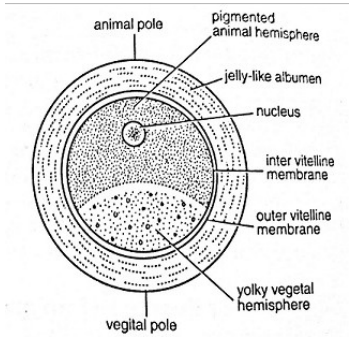
- 2) all protocols accepted by the teacher; always hand over your protocols regularly at the beginning of the next lesson

- 3) homework at the end of the semester: add labels to unlabelled schemes ☺



1. Place the microscope slide with the specimen within the stage clips on the fixed stage
2. Rotate the lowest power lens into position. While watching from the side to insure that the lens doesn't touch the specimen, turn the coarse focus knob to move the stage as close as it can get to the lens without touching the lens. (Always watch from the side whenever you move a specimen towards any objective lens to make sure the lens doesn't crash through the specimen and get damaged!)
3. Now, while looking through the ocular lens, turn the coarse focus knob carefully, and slowly move the stage away from the lens until the specimen comes into focus. Then, use the fine focus knob to bring the specimen into sharp focus.
4. Routinely adjust the light source for optimum illumination for each new slide and for each change in magnification.
5. Once you have brought the specimen into sharp focus with the first 3 lenses (from low-power to high-power), preparation may be made for visualizing the specimen under oil immersion. Place a drop of oil on the slide directly over the area to be viewed. Rotate the nosepiece until the oil-immersion objective locks into position. Care should be taken not to allow the high-power objective to touch the drop of oil. The slide is observed from the side as the objective is rotated slowly into position. This will ensure that the objective will be properly immersed in the oil. The fine-adjustment knob is readjusted to bring the image into sharp focus.

Oocytes



- *ova (plural, lat.), ovum* (singular, lat.)
- unicellular formations that contain genetic information and nutrition material in the early stages of embryo development
- spherical, with an asymmetric internal structure
- during oogenesis, animal-vegetal polarity arises, the animal pole contains germinal vesicle; vegetal pole is rich in yolk
- the amount of yolk (proteins, lipids and glycogen to nourish the embryo) correlates with the duration of development reguired before the individual can feed itself after hatching or before placental attachement with mother is established
- the envelopes: *membrana vitellina* (vitelline envelope), albumen („egg white“), shell membranes, calcium shell; zona pellucida in mammals;
- the plasma membrane of an egg is covered by a glycoprotein layer in mammals (=*zona pellucida*) and generally referred to as vitelline envelope which plays an important role in fertilization. Eggs deposited on land (reptiles, birds) have hard shells. Eg. the yolky chicken egg is surrounded initially by a vitelline envelope. Above this envelope, “egg white” (contains ovalbumin) is deposited + shell membranes are added.
- **quantity of yolk and its distribution in the eggs → different types of cleavage after fertilization**
- fertilization → holoblastic (total) cleavage (sea urchins, amphibians,…)
  → meroblastic (partial) cleavage (superficial; insects, disc-shaped in fish, reptiles and birds)
- when an egg develops in the presence of follicular cells, the oocyte is surrounded by one or more layers of epithelially arranged cells that are not its sister cells. These are somatic cells form a follicle around the oocyte. We encounter this development, for example, in insects, reptiles, birds and mammals, incl. humans.

Eggs based on yolk quantity and its distribution

- **Holoblastic (oligolecital) eggs**

a) alecital: without yolk

b) isolecital: even distribution of yolk, total cleavage → equally large blastomeres, equal cleavage (mammals, echinoderms)

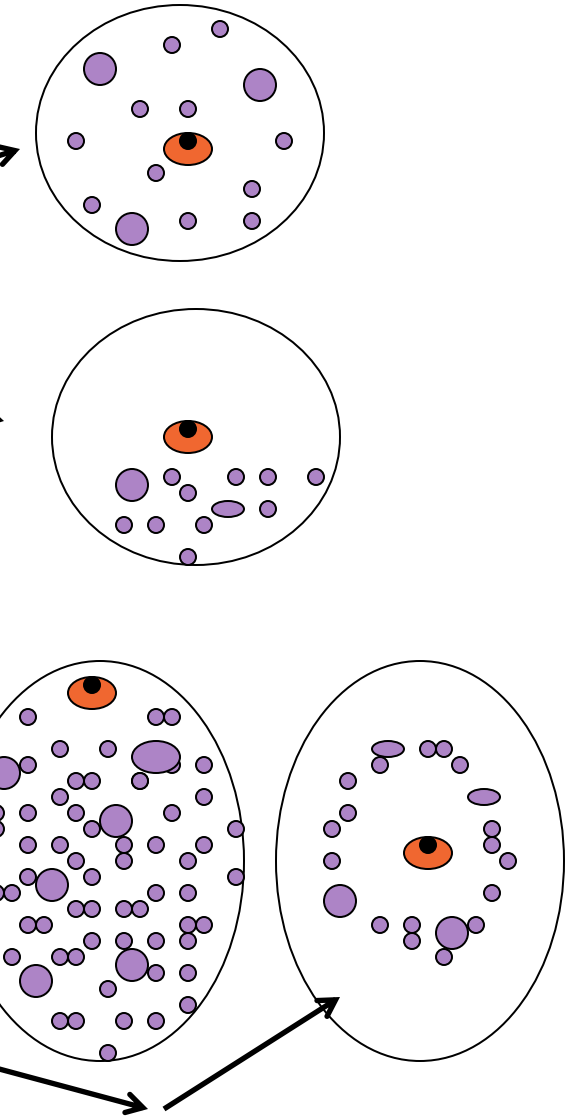
c) heterolecital: moderate yolk at vegetative pole (amphibians)

- **Meroblastic (polylecital) eggs**

a) telolecital: most vertebrates (fishes, reptiles, birds), yolk accumulated at the vegetative pole (heavier), the opposite animal pole contains the nucleus of the oocyte ⟶ inequal cleavage: animal pole → micromers, vegetative pole → macromers; special type: discoidal cleavage

b) centrolecial: arthropods, superficial cleavage

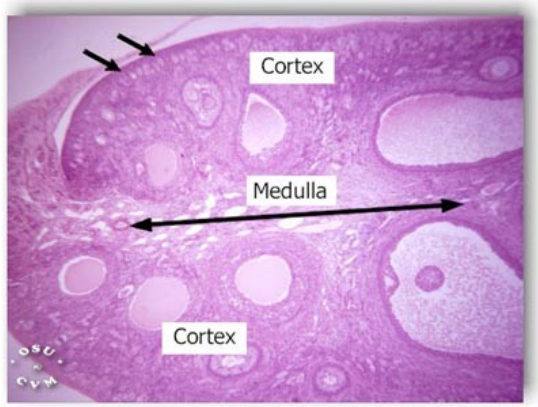
Note: humans - oligolecital, isolecital oocytes, total and equal cleavage



accordint to Knoz J., 1979

Mammalian ovary

- almond shaped organs, covered by ovarian surface epithelium and a thick connective tissue tissue = the tunica albuginea
- an outer cortex: the follicles with oocytes
- inner medulla: fibrous tissue, rich blood supply, lymphatic ducts, nerves



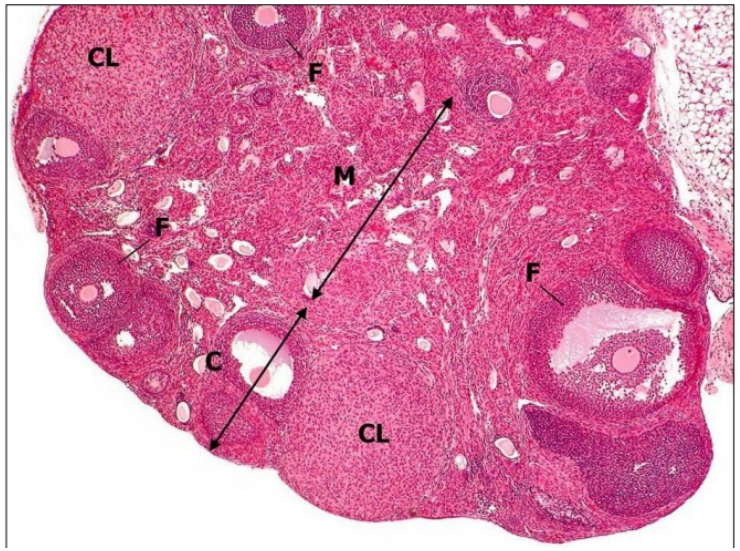


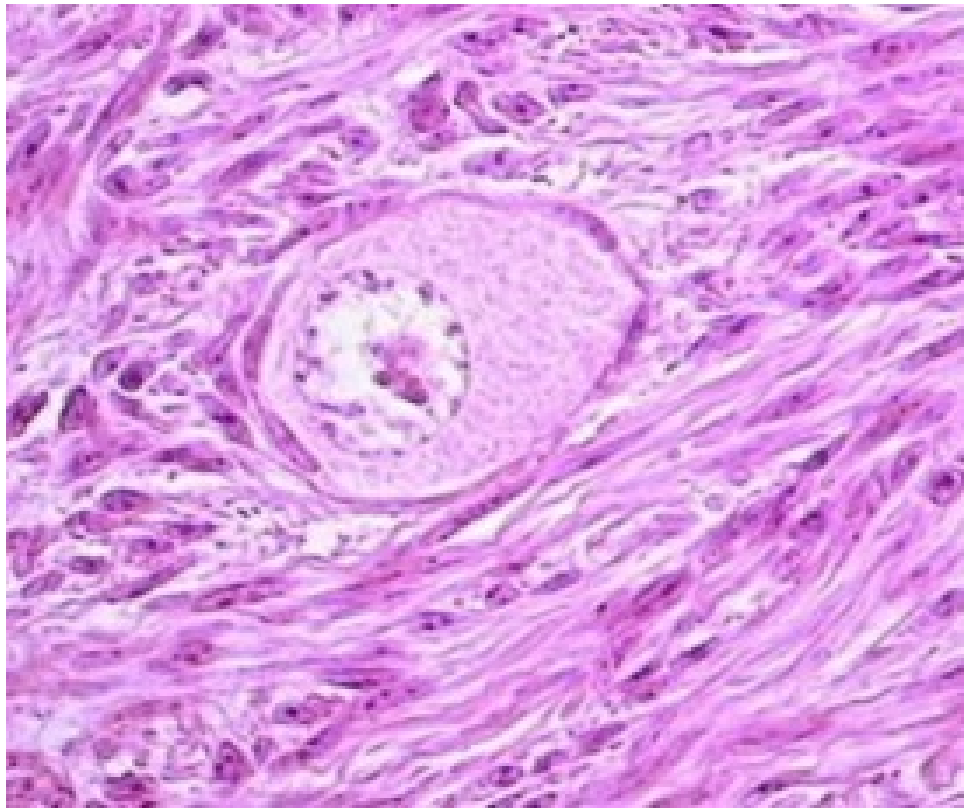
Figure 1.2 – Subgross anatomy of the normal rodent ovary (mouse, H&E x4). *The cortex (**C**) contains numerous follicles at various stages of maturation. The medulla (**M**), which is not always present in histological sections, contains lymphatics, nerves and numerous blood vessels.*

C	cortex
M	medulla
CL	corpus luteum
F	developing follicles

http://legacy.owensboro.kctcs.edu/gcaplan/anat2/notes/APIINotes2%20female%20reproductive%20anatomy.htm

A) Primordial follicles

- the earliest stage of follicular development
- they form during early fetal development
- located within the peripheral cortex (beneath the tunica albuginea)
- a large oocyte + a layer of flattened follicular cells
- arrested in prophase I



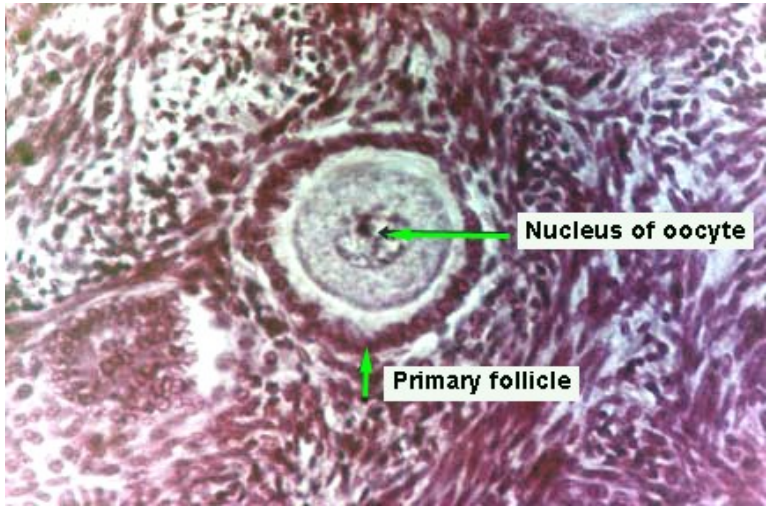
http://sprojects.mmi.mcgill.ca/menstrualcycle/primordialfollicle.html

B) Primary follicles

- a oocyte + a layer of cuboidal follicular cells
- the zona pellucida (clear zone around the oocyte in the photo) covers the oocyte and separates it from the cuboidal follicular cells

Figure 1.4 – Primary (A) and early secondary follicle (B) (rat, H&E x40).

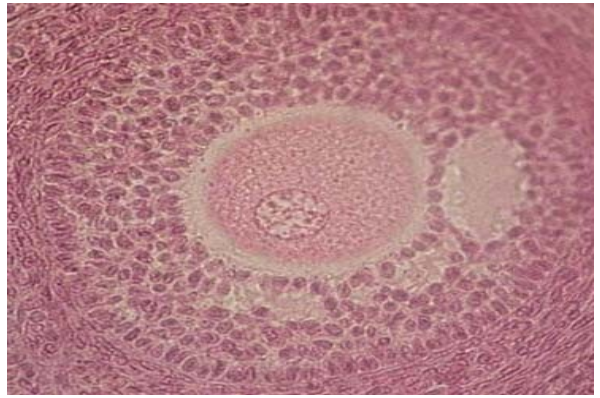
O	primary oocyte
ZG	developing zona granulosa
TA	tunica albuginea
OSE	ovarian surface epithelium (cuboidal)



http://legacy.owensboro.kctcs.edu/gcaplan/anat2/notes/APIINotes2%20female%20reproductive%20anatomy.htm

B) Secondary follicles

- the stratified granulosa cells there are large with lacunae (later → follicular antrhum - *antrum folliculi*)
- the stromal cells around the follicle → an inner layer (*theca interna*, cells → steroids + an outer layer (*theca externa*, concentrically arranged stromal cells = a support for the developing follicle)



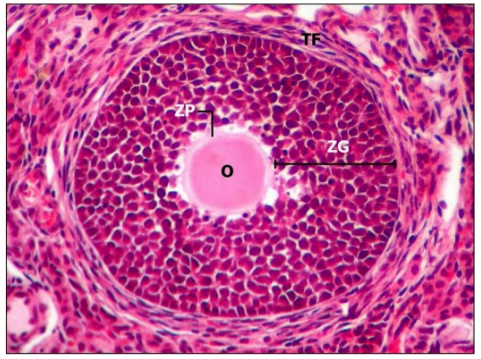


Figure 1.5 – Secondary follicle (mouse, H&E x20).

O	primary oocyte	**ZG**	zona granulosa
ZP	zona pellucida	**TF**	theca folliculi
VS	vesicular spaces		

C) Graafian /ovulatory /mature f.

- a large *anthrum folliculi* surrounded by many layers of cuboidal granulosa (follicular) cells
- the oocyte is situated eccentricaly within the follicle in a small hillock (*cumulus oophorus* which protrudes into the antrum)
- the oocyte is of its full size, ready for ovulation
- the zona pellucida is covered by a layer of follicular cells (*corona radiata*)
- the theca interna is separated from the follicle by a basement membrane and has a rich vascular supply
- the spindle-shaped cells in the theca externa are densely packed and is blend with the theca interna cells

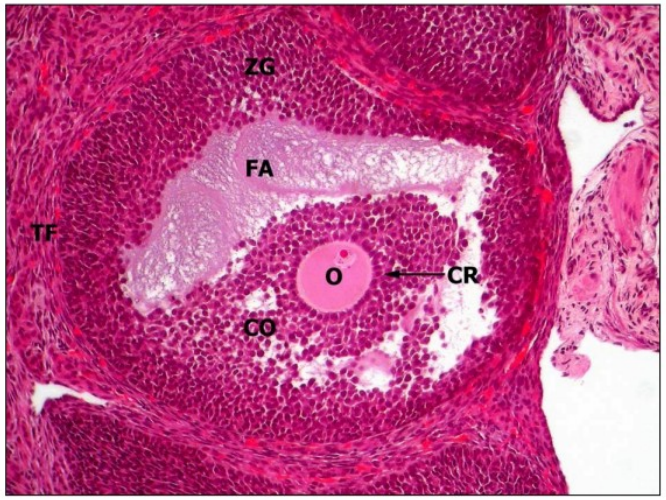
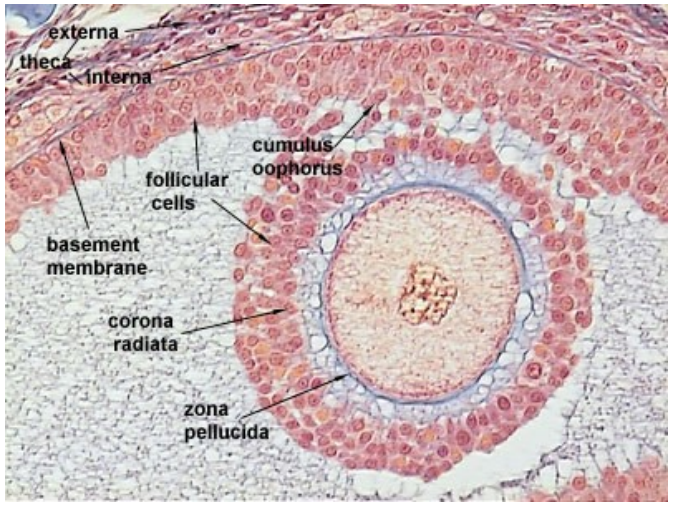


Figure 1.7 – Tertiary follicle (rat, H&E x20). *The large follicular antrum (**FA**) and eccentrically positioned primary oocyte (**O**) characterise this stage.*

O	primary oocyte	**CO**	cumulus oophorus
CR	corona radiata	**FA**	follicular antrum
ZG	zona granulosa	**TF**	theca folliculi



http://legacy.owensboro.kctcs.edu/gcaplan/anat2/notes/APIINotes2%20female%20reproductive%20anatomy.htm

Atresia

- may begin at any stage in follicular development
- shrinkage and lysis of the cytoplasm of the oocyte and granulosa/follicular cells

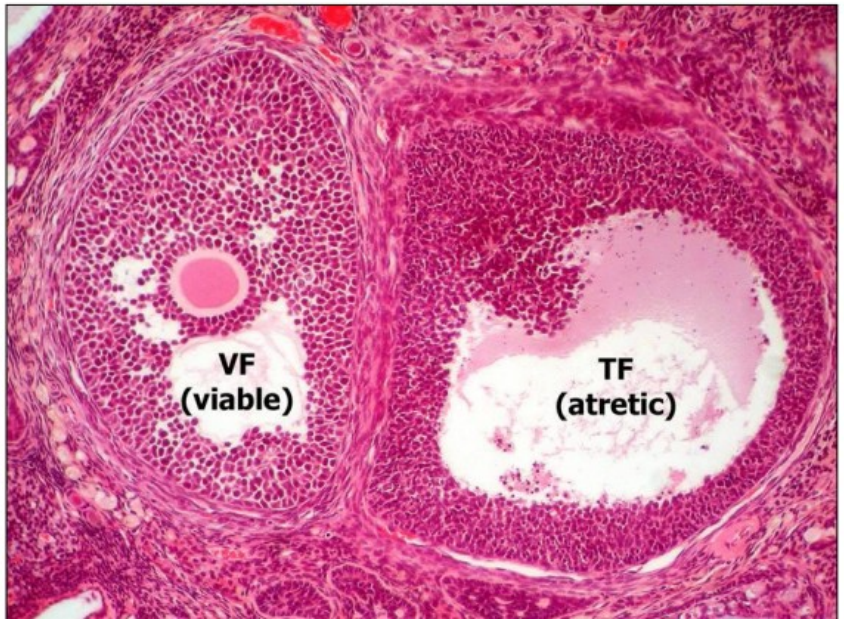
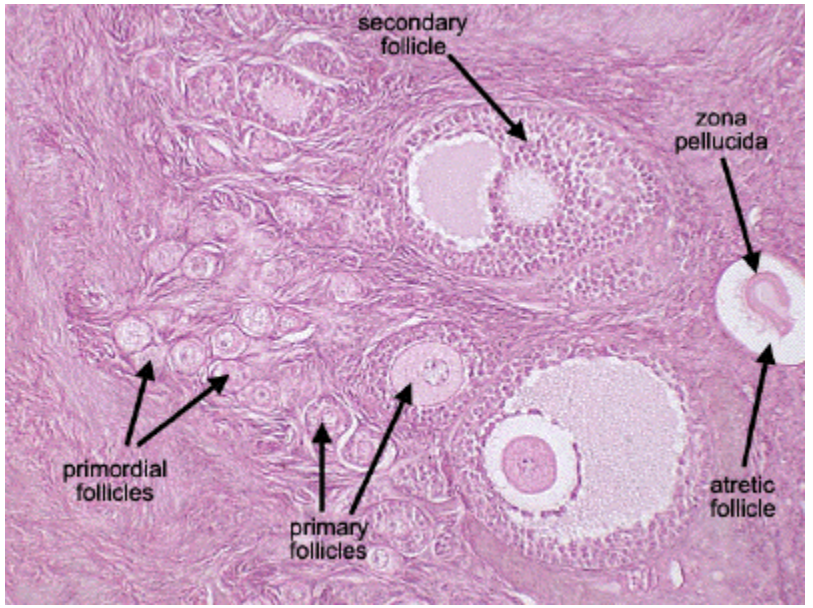


Figure 1.12 – Degenerate (atretic) tertiary follicle (TF) (rat, H&E x10). *A viable vesicular follicle (VF) is also present.*



After ovulation

- after ovulation, the Graffian follicle collapses, becomes infolded and invaded by blood vessels → corpus luteum (yellow body)
- during the luteinisation, the granulosa and thecal cells undergo hypertrophy, this is accompanied by degeneration of the basement membrane separating the theca interna and granulosa cells, and infiltration of the postovulatory follicle by blood vessels from the theca interna).
- if the egg is fertilized: the corpus luteum → corpus luteum of pregnancy (supported by hCG)
- if the egg is not fertilized: the corpus luteum degenerates, is infiltrated with collagen (and a few fibroblasts) → the corpus albicans (white body, fibrous strukture)

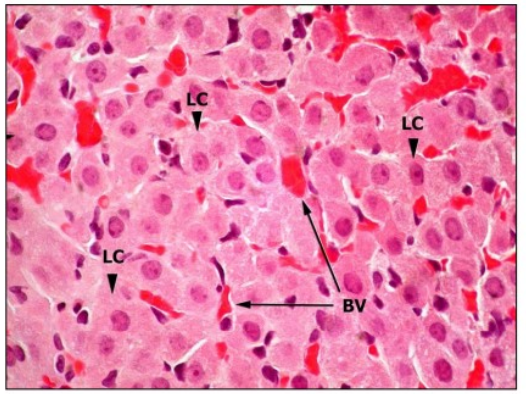


Figure 1.9 – Corpus luteum (rat, H&E x40). *The luteal cells (**LC**) comprising the corpus luteum are plump and polygonal; they contain large nuclei and moderate amounts of eosinophilic cytoplasm. Cytoplasmic vacuoles form within luteal cells as the corpus luteum matures and subsequently degenerates. Numerous blood vessels (**BV**) are present, consistent with its function as a temporary endocrine gland.*

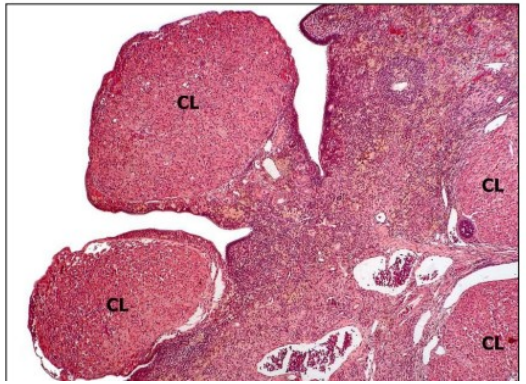
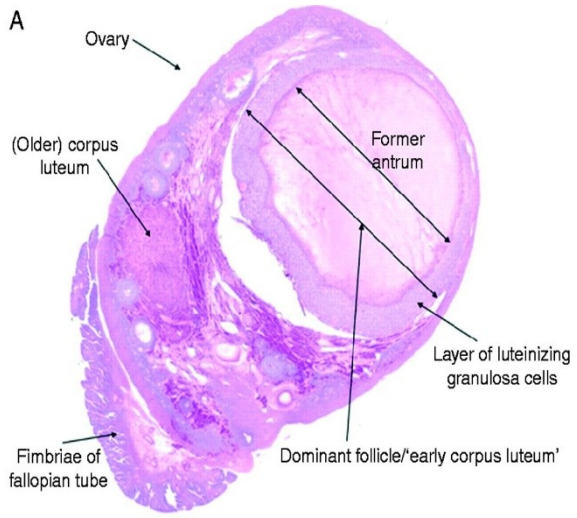


Figure 1.10 – Corpora lutea (CL) (rat, H&E x10). *Note the marked protrusion of these large postovulatory follicles beyond the surface of the ovary. Another pair of corpora lutea are present within the body of the ovary.*



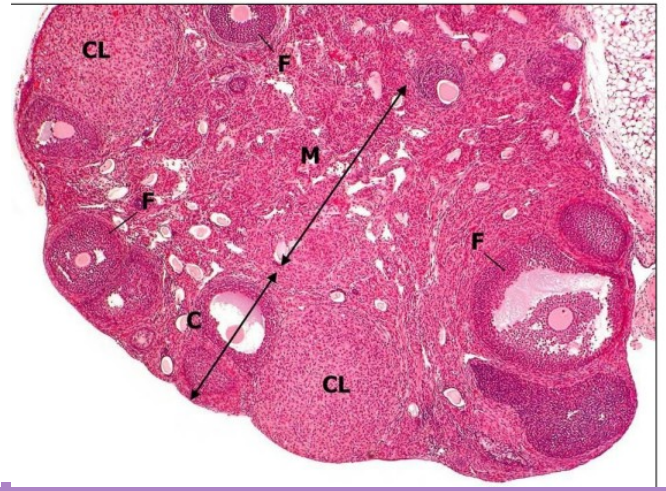
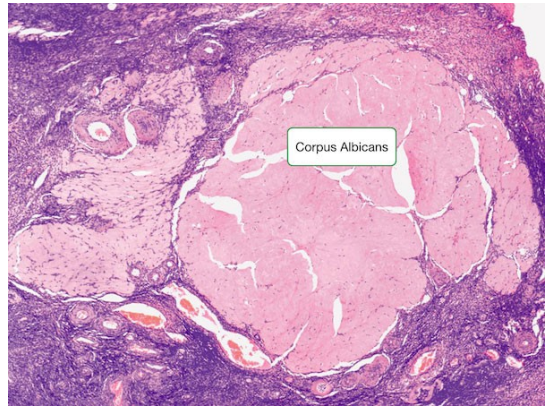


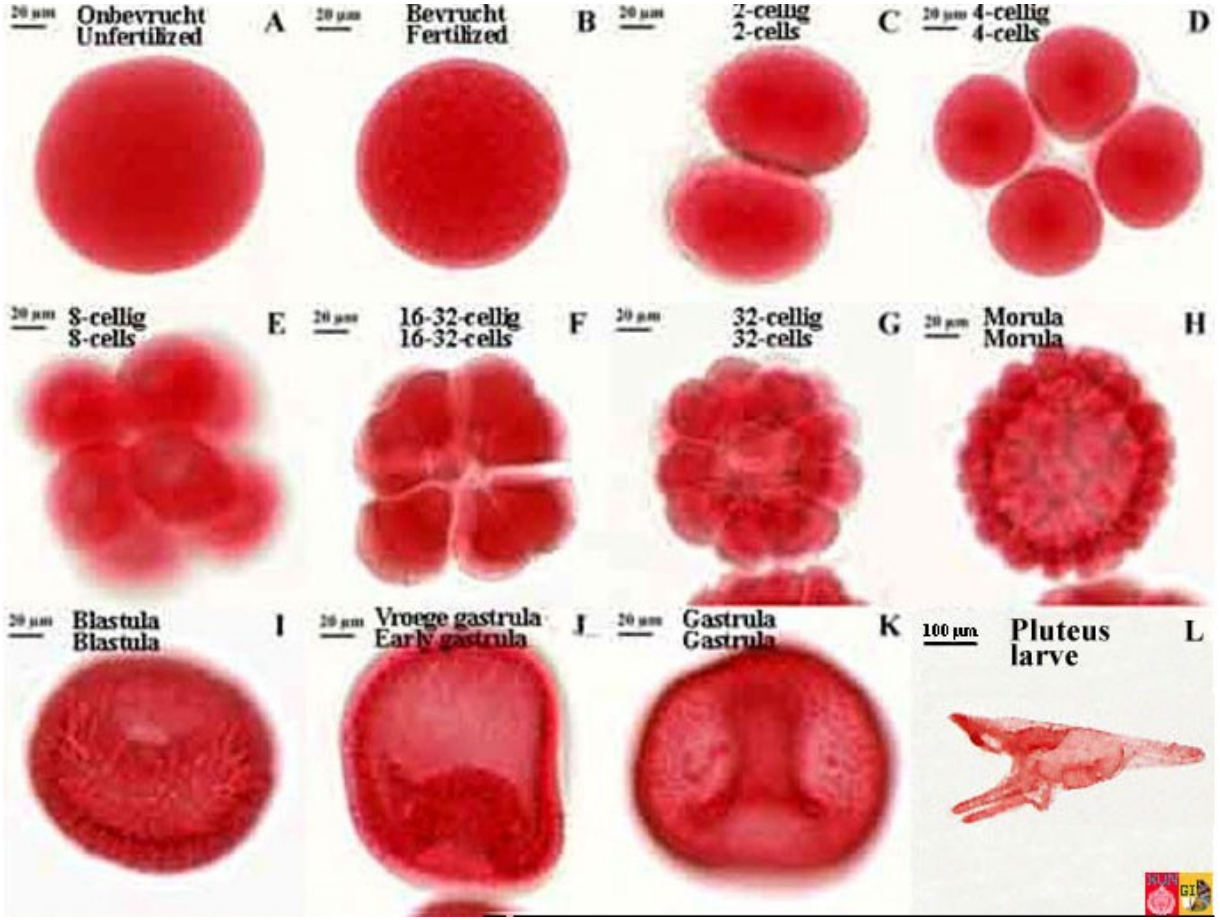
Figure 1.2 – Subgross anatomy of the normal rodent ovary (mouse, H&E x4). *The cortex (**C**) contains numerous follicles at various stages of maturation. The medulla (**M**), which is not always present in histological sections, contains lymphatics, nerves and numerous blood vessels.*

C	cortex
M	medulla
CL	corpus luteum
F	developing follicles



Example of a fertilized isolecal egg - a sea urchin

- sea urchin = a model for studying the cleavage of isolecithal eggs
- unfertilized egg coated with vitelline membrane (A)
- after fertilization: fertilization membrane, formed immediately after fertilization and prevents the penetration of other sperm (B)



Used and recommended literature

B. M. Carlson: *Human embryology and developmental biology*. 4th edition, 2009. ISBN 978-323-05385-3.
R. Hodge: Developmental Biology : from a Cell to an Organism. 1st edition, 2010. ISBN 978-0-8160-6683-4.
L. C. Junqueira, J. Carneiro,R. Kelly R. Základy histologie. H+H, Jinočany. 1997, 502 s.
R. Lüllmann-Rauch- Histologie. Překlad 3. vydání. Grada, Praha. 2012, 556 s.
K. L. Moore, T. V.N Persaud: *The developing human. Clinically oriented embryology*. 8th edition, 2008. ISBN 978-0-8089-2387-9.
J. M. W Slack: *Essential developmental biology*. 2nd edition, 2006. ISBN 978-4051-2216-0.
Z. Vacek: *Embryologie. 2006.* ISBN 978 -80-247-1267-3.

www.sci.muni.cz/ptacek
https://www.oecd.org/chemicalsafety/testing/40581066.pdf
http://medcell.med.yale.edu/histology/ovary_follicle.php
http://histol.narod.ru/atlas-en/female-01-en.htm
http://www.reproduction-online.org/content/142/6/893/F10.large.jpg
www.sci.muni.cz/ptacek
https://histology.medicine.umich.edu/resources/female-reproductive-systém
https://www.oecd.org/chemicalsafety/testing/40581066.pdf
https://zoomify.luc.edu/female/dms174/popup.html
http://legacy.owensboro.kctcs.edu/gcaplan/anat2/notes/APIINotes2%20female%20reproductive%20anatomy.htm
http://sprojects.mmi.mcgill.ca/menstrualcycle/primordialfollicle.html
https://www.vcbio.science.ru.nl/en/virtuallessons/embryology/seaurchinstage/
https://www2.hawaii.edu/~johnb/micro/m140/syllabus/week/handouts/m140.2.4.html