Ovulation

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Ovulation

- Mammalian ovary can ovulate at any point except at hilus.
- In mare, limited to ovulation fossa.
- In cattle, sheep and mare occurs at random between the two ovaries.

- Three major changes that a preovulatory follicle undergoes:
  - Cytoplasmic and nuclear maturation of oocyte.
  - Disruption of cumulus cell cohesiveness among cells of granulosa cell layer.
  - Thinning and rupture of external follicular wall.

- After the ovulatory surge of gonadotropins, blood flow increases to all classes of follicles.
- The follicle destined to ovulate, receives the largest volume of blood in absolute terms.

Cellular events during ovulation

- Before ovulation, all tissue layers are broken down-
  - Surface epithelium
  - Collagen rich tunica albugenia
  - Theca interna
  - Thin basement lumina
  - Membrana granulosa

- Follicular elasticity increases during growth, which is required for corpus luteum organisation.
- Enlarging follicle protrudes out from the ovarian surface, its vascularity increases except at its centre.

Oocyte

- Cumulus cells anchored in zona pellucida remain, form corona radiata.
- Cumulus cell dissociation frees oocyte from granulosa layer and meiosis resumes 3 hrs after Gonadotropin surge.
- Cumulus cells secrete glycoproteins, which form viscous mass enclosing oocyte and corona.
- As follicle ruptures, viscous mass spreads over ovarian surface to facilitate “pick up”.

Granulosa Cells

- Granulosa layer completely dissociates only at follicular apex, finally disappears.
- About 2 hrs before ovulation, granulosa cell growth processes penetrate through basal lamina, preparing invasion of theca cells and blood vessels into granulosa.
- Associated with production of Early Pregnancy Factor.

Theca cells

- In a few hours before ovulation, follicular volume increases causing elasticity of the follicle.
- Invasive oedema of theca cells and collagen fiber dissociation causes looser cohesion of the theca externa.

Apex changes

- Rupture involves interaction of ovarian epithelium and underlying follicular wall.
- Wall of the follicle apex becomes exceedingly thin in an are called **stigma.**
- Stigma thins out, bulges on ovarian surface and becomes avascular.

Mechanisms of Ovulation

- Ovulation occurs in response to a combination of physiologic, biochemical and biophysical mechanisms:

- Neuroendocrine/Endocrine mechanisms

  GnRH, Steroids and PGs

- Neurobiochemical/Pharmacological mechanisms

- Neuromuscular and neurovascular mechanism and enzymatic interactions.

- A gonadotrophin-induced pre ovulatory increase in follicular prostaglandins, produced by granulosa cells is needed for ovulation.

- PGs may stimulate ovarian contractions and activate thecal fibroblasts to proliferate and release proteolytic enzymes.

- Steroids, esp. progesterone, may also be involved.

Biochemical Mechanisms

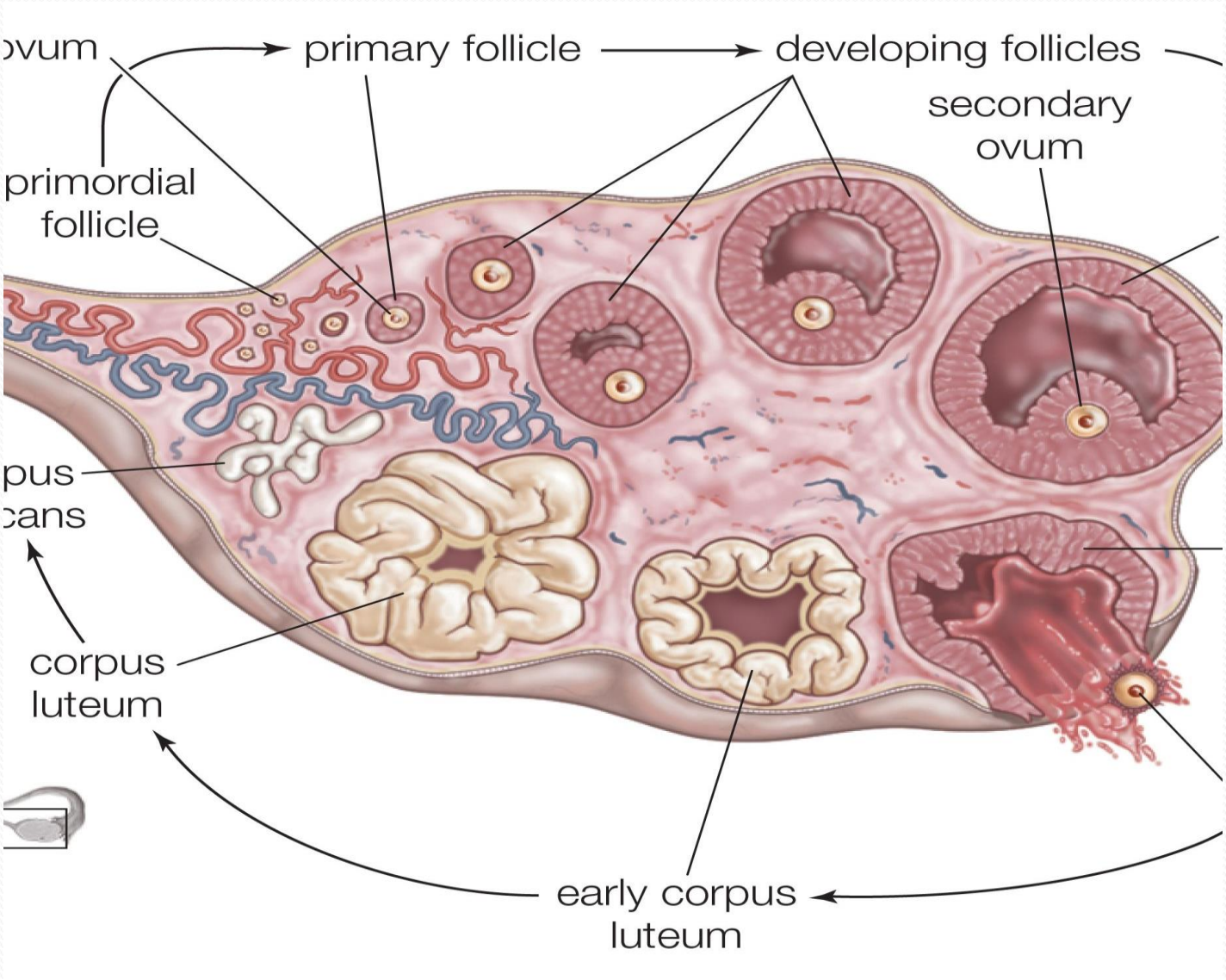
- Preovulatory gonadotropin surge induces immediate and temporary rise in progesterone and related progestins.
- Later, Estradiol and PGs secretion are augmented.
- P_4 stimulates collagenase activity in follicular wall.
- Inhibition of progesterone synthesis prevents ovulation.
- $PGF_{2\alpha}$ causes follicular rupture and PGE_2 causes remodelling of follicular layers forming CL.

Neuromuscular Mechanisms

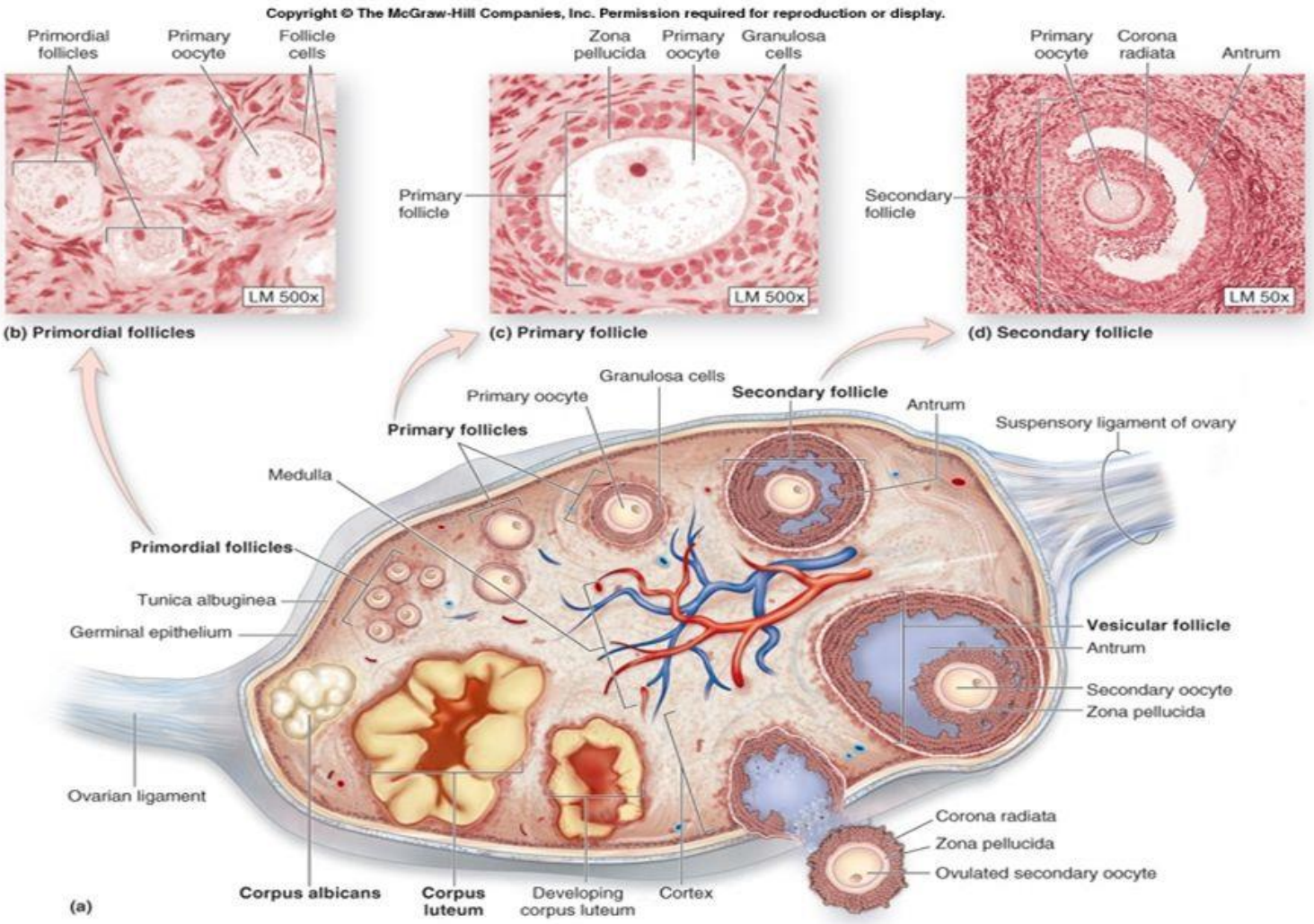
- Ovarian stroma and concentric layers of theca externa contain smooth muscle cells innervated by autonomic nerve terminals.
- Ovarian contractions facilitate follicular rupture.
- After rupture, $PGF_{2\alpha}$ stimulates the thecal neuromuscular system causing extrusion of the oocyte.

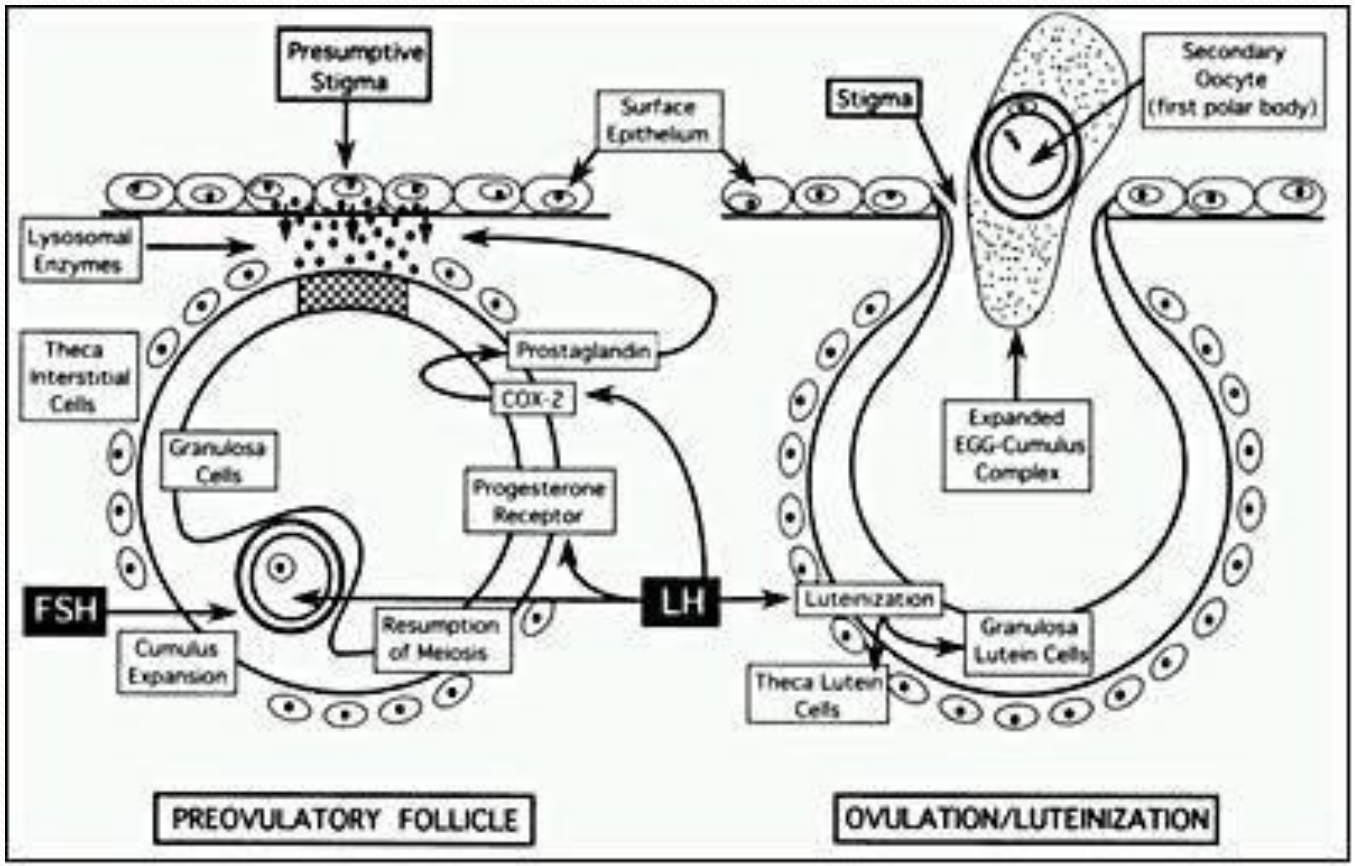
Neuroendocrine Control

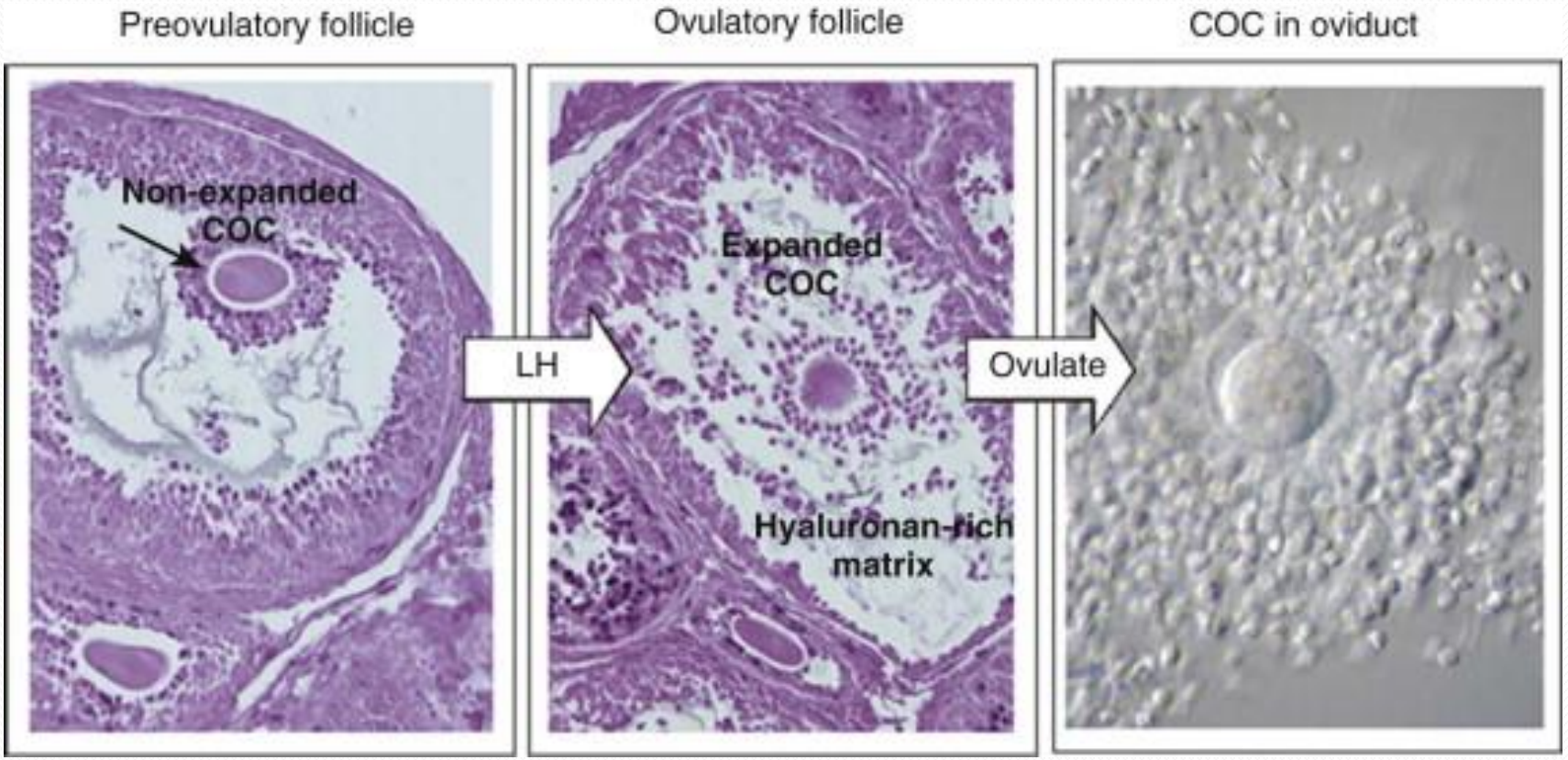
- Preovulatory gonadotropin surge occurs at the start of estrus when P_4 falls to minimal and E_2 reaches highest level.
- E_2 acts on both pituitary and hypothalamus.
- E_2 increases sensitivity of the pituitary gonadotropin-producing cells to the competent hypothalamus hormone GnRH.

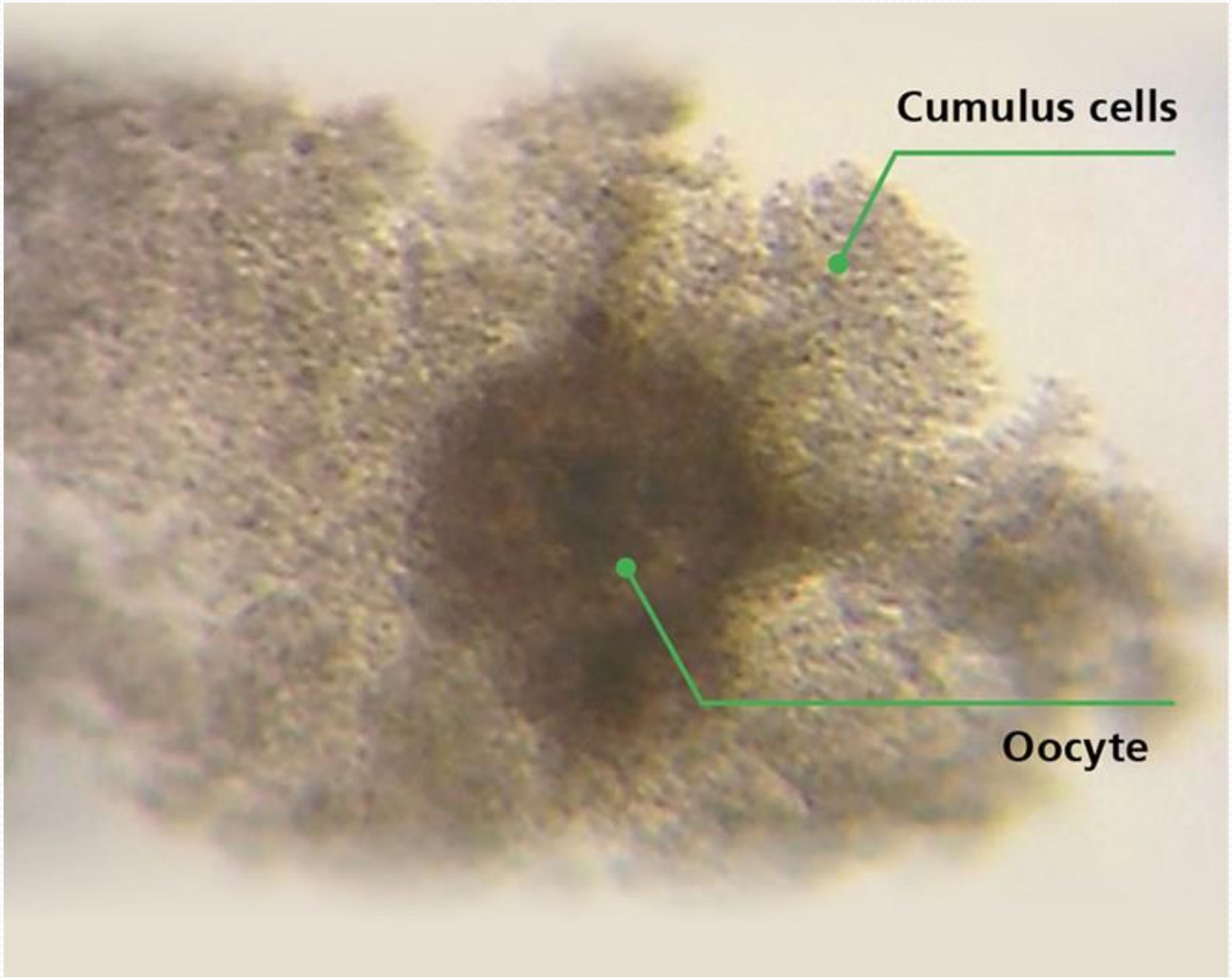

ovum
primary follicle
developing follicles
secondary ovum
primordial follicle
pus
cans
corpus luteum
early corpus luteum

Oocyte Maturation




Presumptive Stigma
Surface Epithelium
Stigma
Secondary Oocyte (first polar body)
Lysosomal Enzymes
Theca Interstitial Cells
Prostaglandin
COX-2
Granulosa Cells
Progesterone Receptor
Expanded EGG-Cumulus Complex
FSH
LH
Luteinization
Resumption of Meiosis
Cumulus Expansion
Granulosa Lutein Cells
Theca Lutein Cells
PREOVULATORY FOLLICLE
OVULATION/LUTEINIZATION


Preovulatory follicle
Ovulatory follicle
COC in oviduct
Non-expanded COC
LH
Expanded COC
Hyaluronan-rich matrix
Ovulate


Cumulus cells
Oocyte