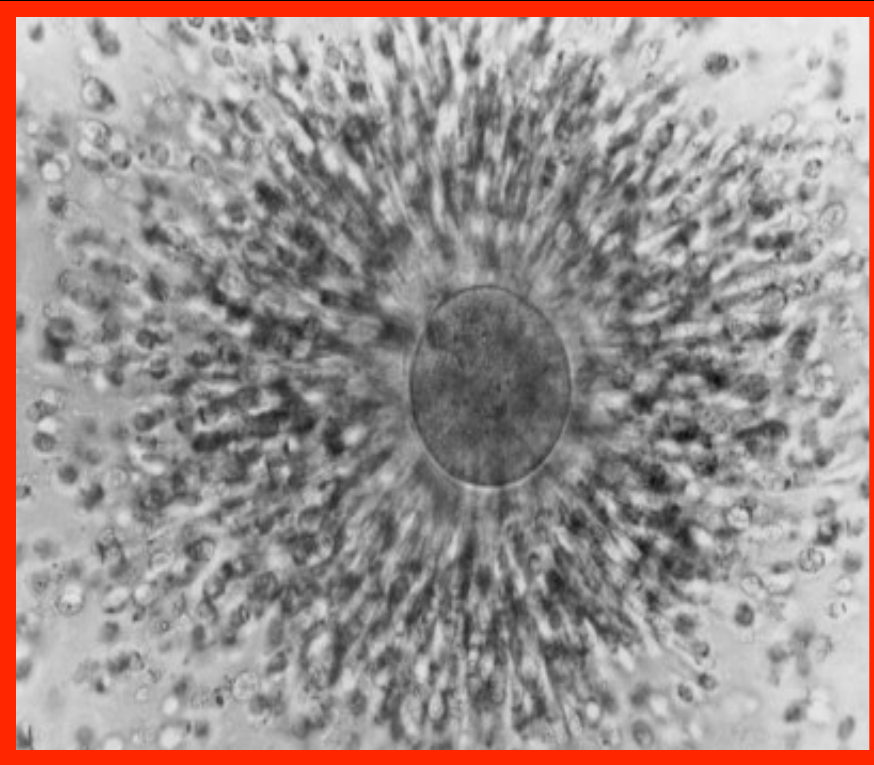




Biotechnology of Reproduction

UNIVERSITY of
TERAMO



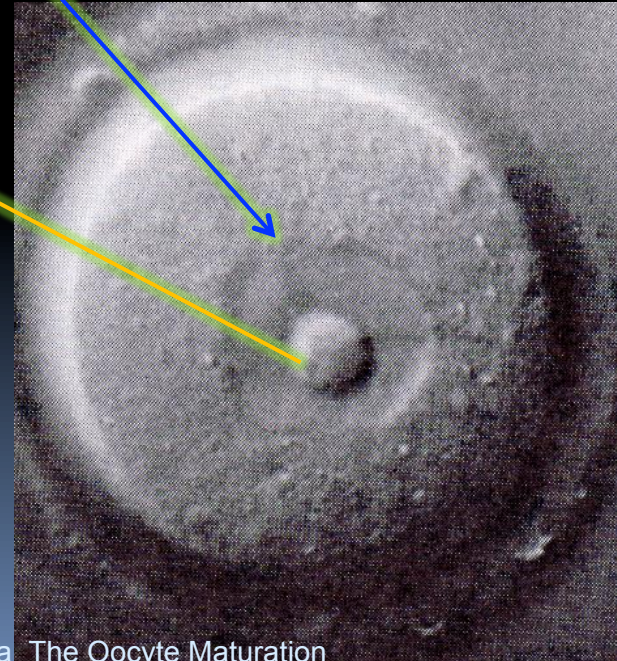
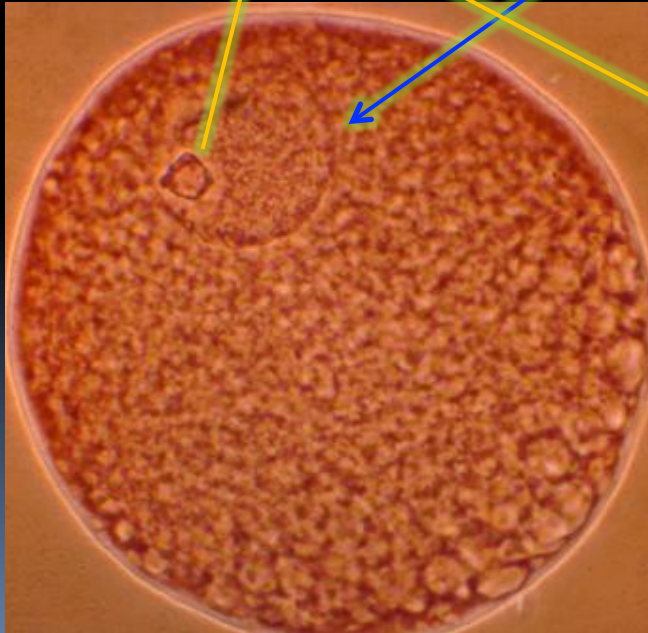
MEIOTIC MATURATION

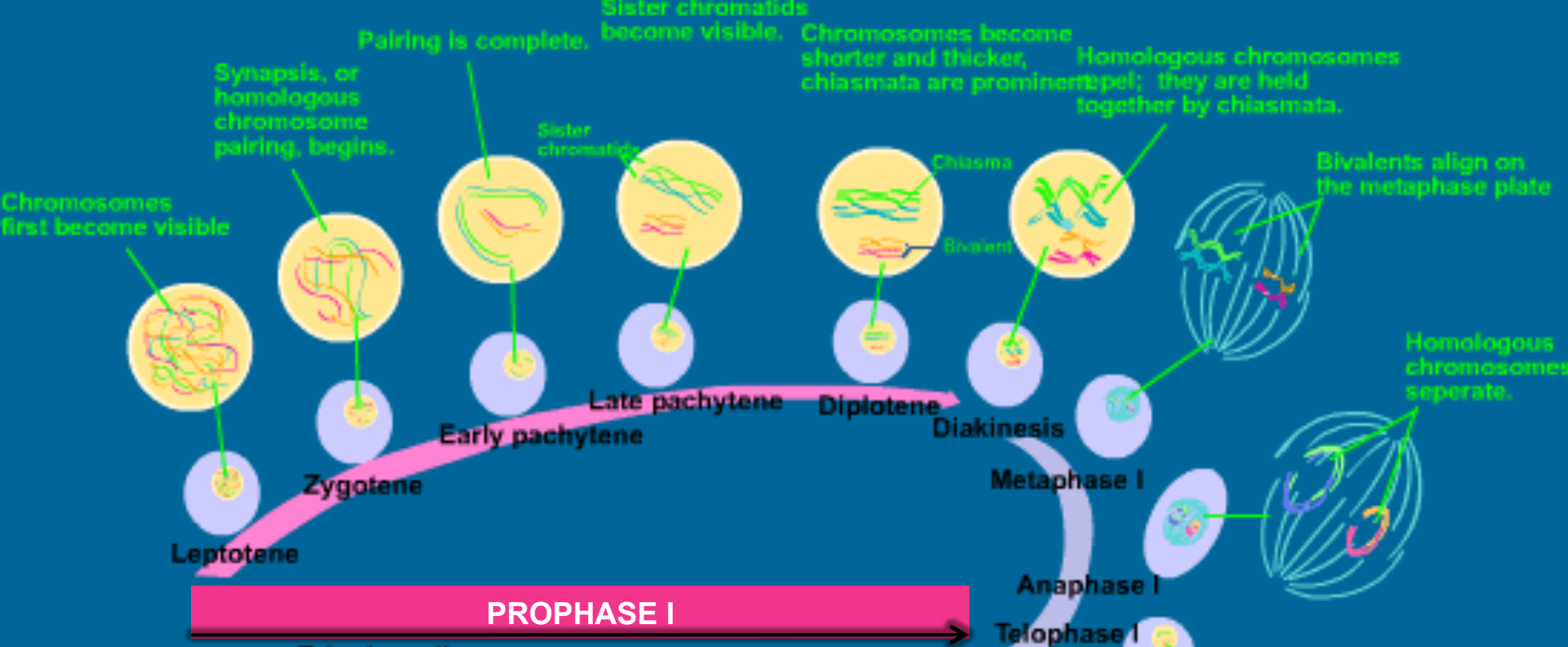
Prof. Luisa Gioia

OOCYTE MEIOSIS

Concerning **MEIOTIC MATURATION**, germ cells enter the first stage of meiosis (**PROFASÉ I**), progress through the initial sub-stages (**leptotene** and **zygotene**) and then **arrest** at late **pachitene** or more frequently at **diplotene stage**.

In **fully grown oocyte**, which is in a **resting condition**, the large vesicular nucleus is referred to as a **dictyate nucleus** or **GERMINAL VESICLE (GV)**, and it usually contains a conspicuous **nucleolus**



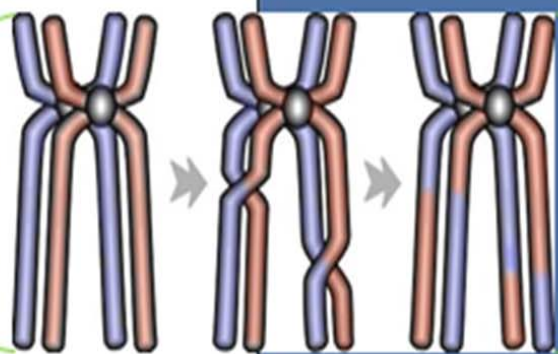


The first prophase is the longest stage of meiosis and it consists of several sub-stages corresponding to different organization of the germinal material.

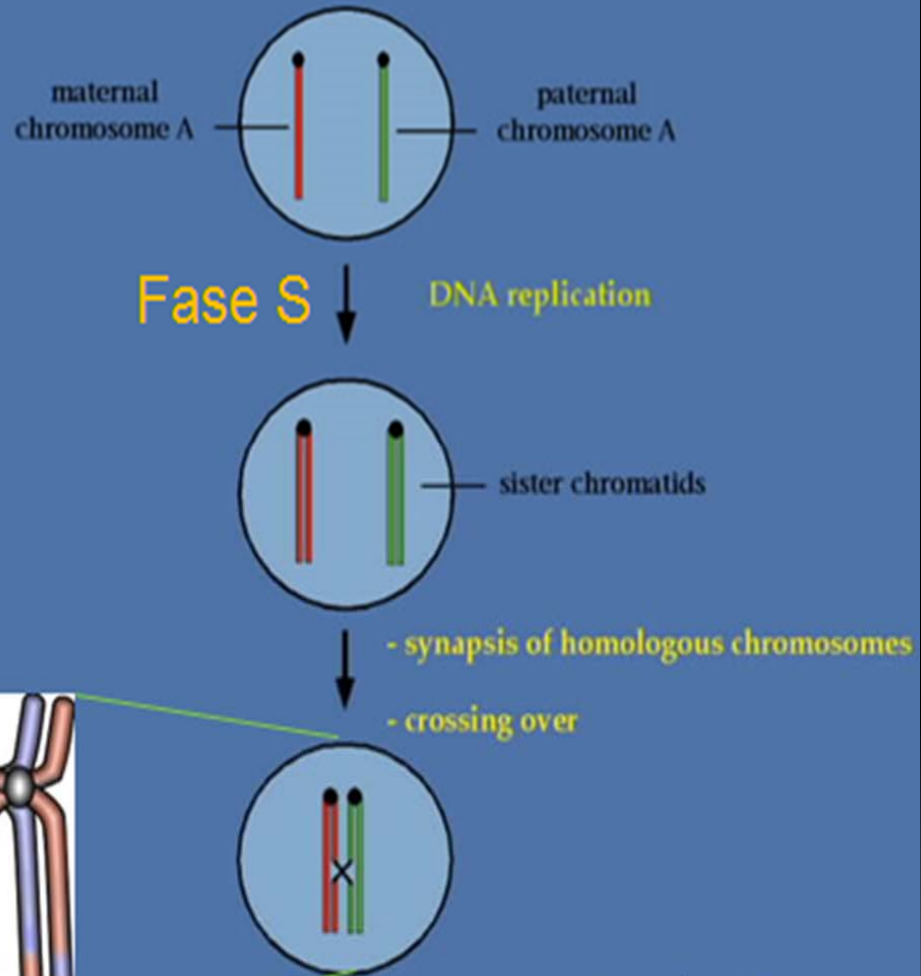
During prophase I, **CROSSING-OVER** occurs, which is a crucial process that ensures the genetic variability to gametes

During **PROPHASE I**,
CROSSING OVER occurs
between the chromatids of
homologous chromosomes

• Crossing over

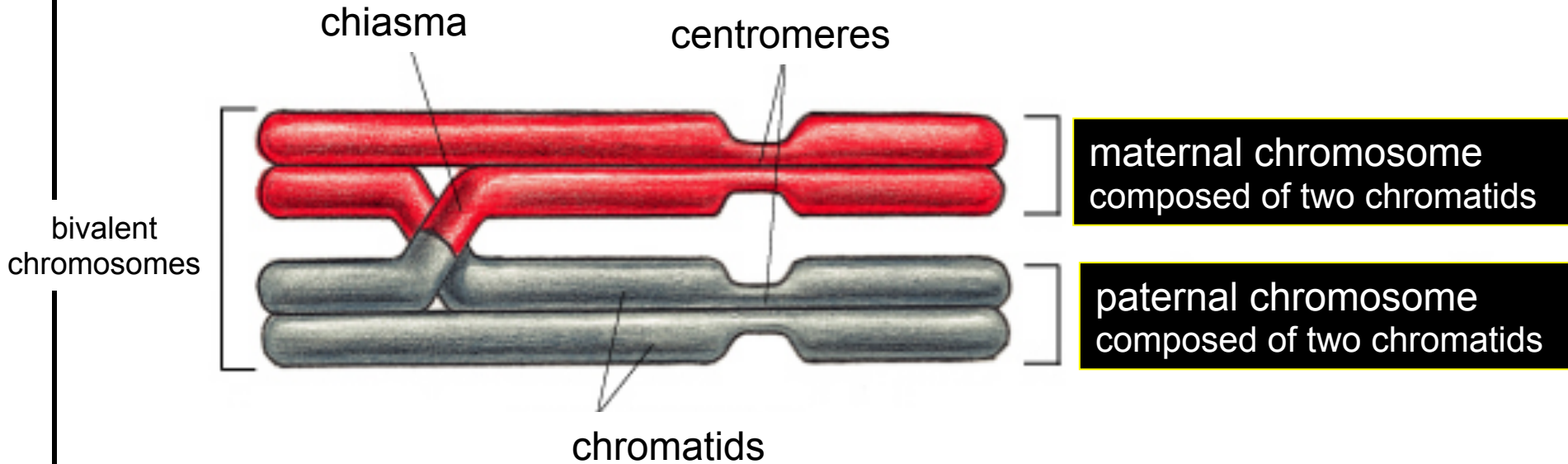


The meiotic cell division



HOMOLOGOUS RECOMBINATION

Chiasmata allow the crossing over of genetic material during prophase I of meiosis



The chromosomes are cut and resealed at points called **chiasmata** (singular **chiasma**) so that lengths of maternal chromosomes are transferred to a maternal one and vice versa.

The end result of meiosis is that the gametes contain chromosomes that are neither completely paternal nor completely maternal but are **recombination** of the two

GAMETES



**SEXUAL
REPRODUCTION**

BIOLOGICAL ADVANTAGE:

it allows organisms to possess a random selection of the genes from their ancestors.

Evolution by natural selection of the individual possessing the better genes.

**Without crossing over
this could not happen!**

IMMATURE OOCYTE

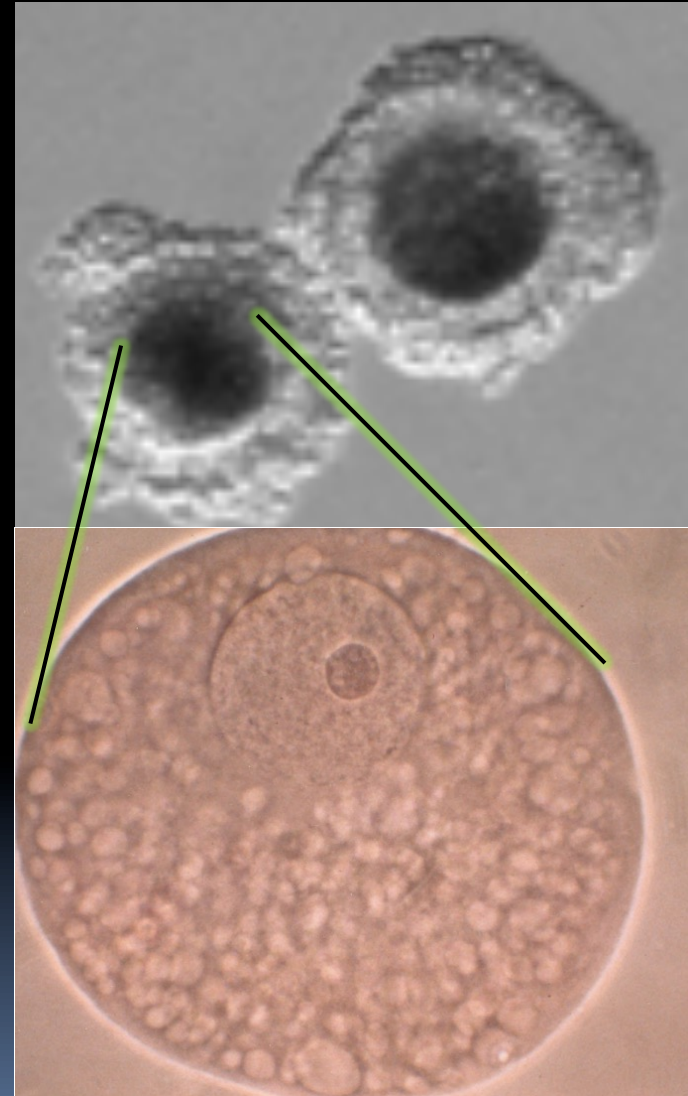
In immature fully grown oocyte, DNA replication as well as crossing-over have already occurred



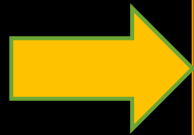
Experimental evidence of meiotic competence

- In the mammalian system, **isolated fully grown oocytes undergo SPONTANEOUS MATURATION *in vitro***
- (*Pincus and Enzmann, 1935*)

Follicle cells continuously send inhibitory factors to the GV oocyte, thereby causing its meiotic arrest



THE OOCYTE MATURATION



◆ *What triggers the process of oocyte maturation?*



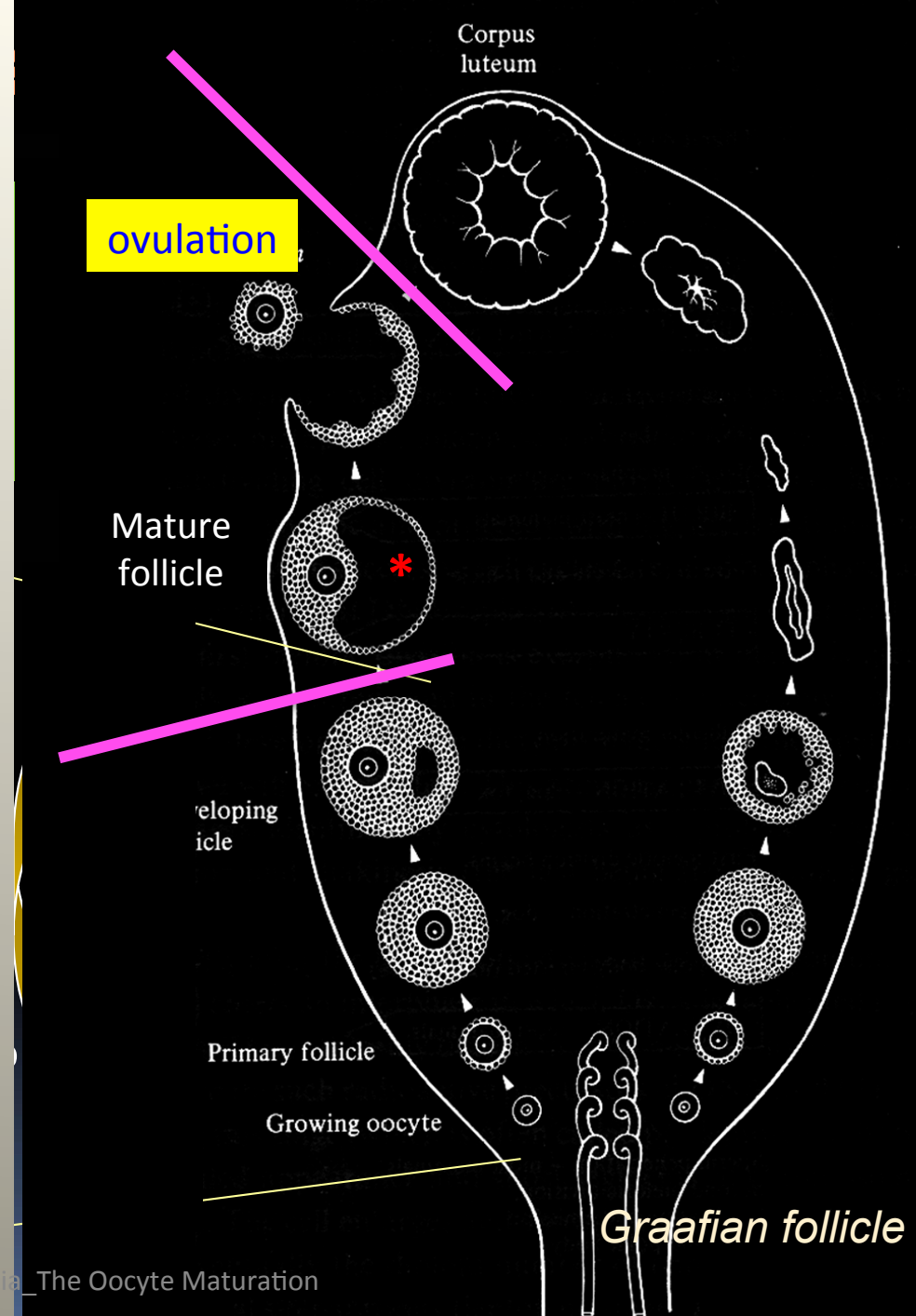
Graafian follicle

OOCYTE MATURATION

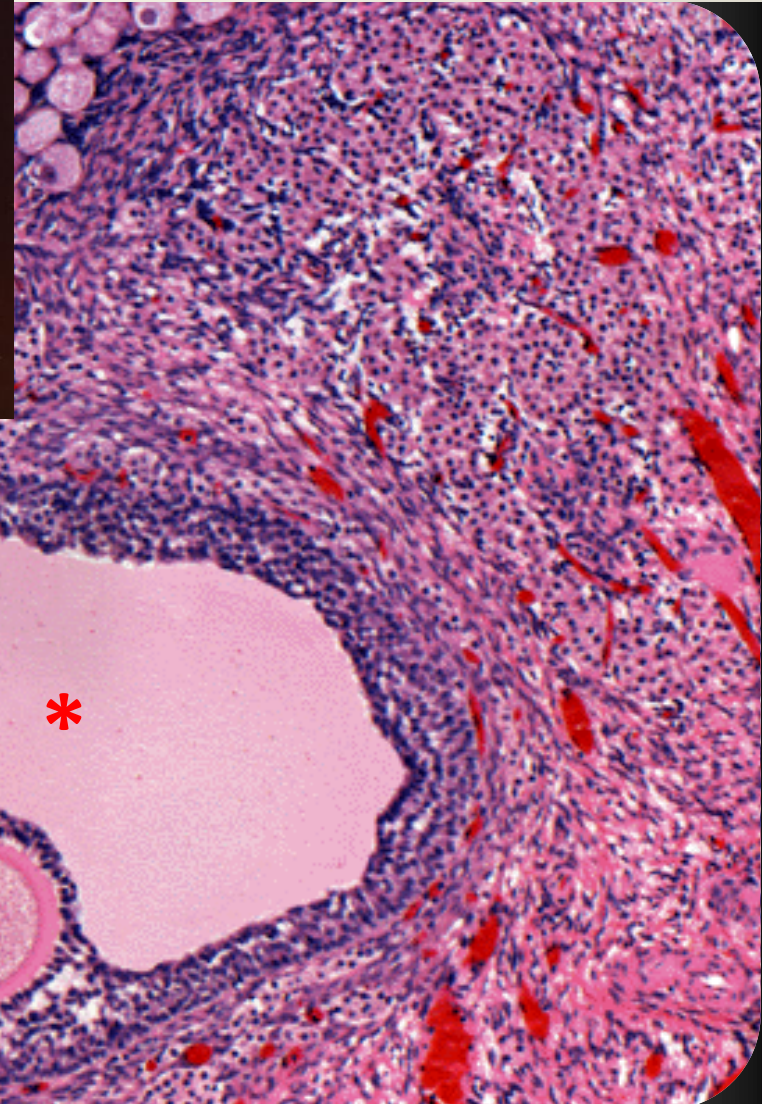
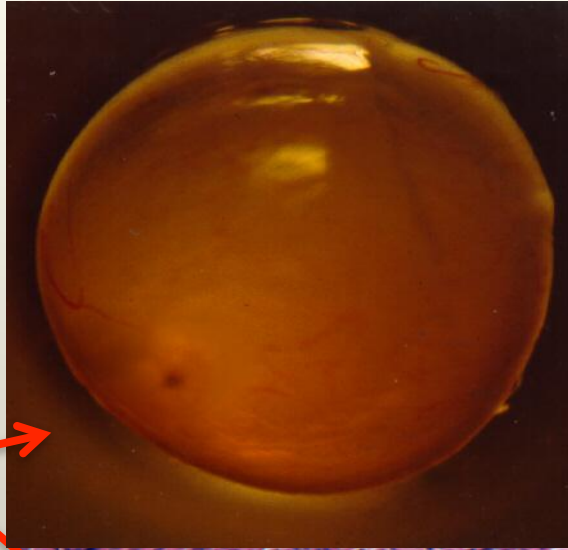
-Final phase of folliculogenesis

The fate of most germ cells is degeneration but a small proportion will progress through the steps of ovarian folliculogenesis.

Only when included within a well-developed antral follicle * (named *mature follicle* or *Graafian follicle*) does liberation of an oocyte from the ovary at **OVULATION** become a possibility



Final phases of folliculogenesis/oogenesis can be reached only after PUBERTY, when in the ovary fully developed follicles* (mature follicles/Graafian follicles) can be observed.



The antral follicles stage is regulated by gonadotropins (LH/FSH)

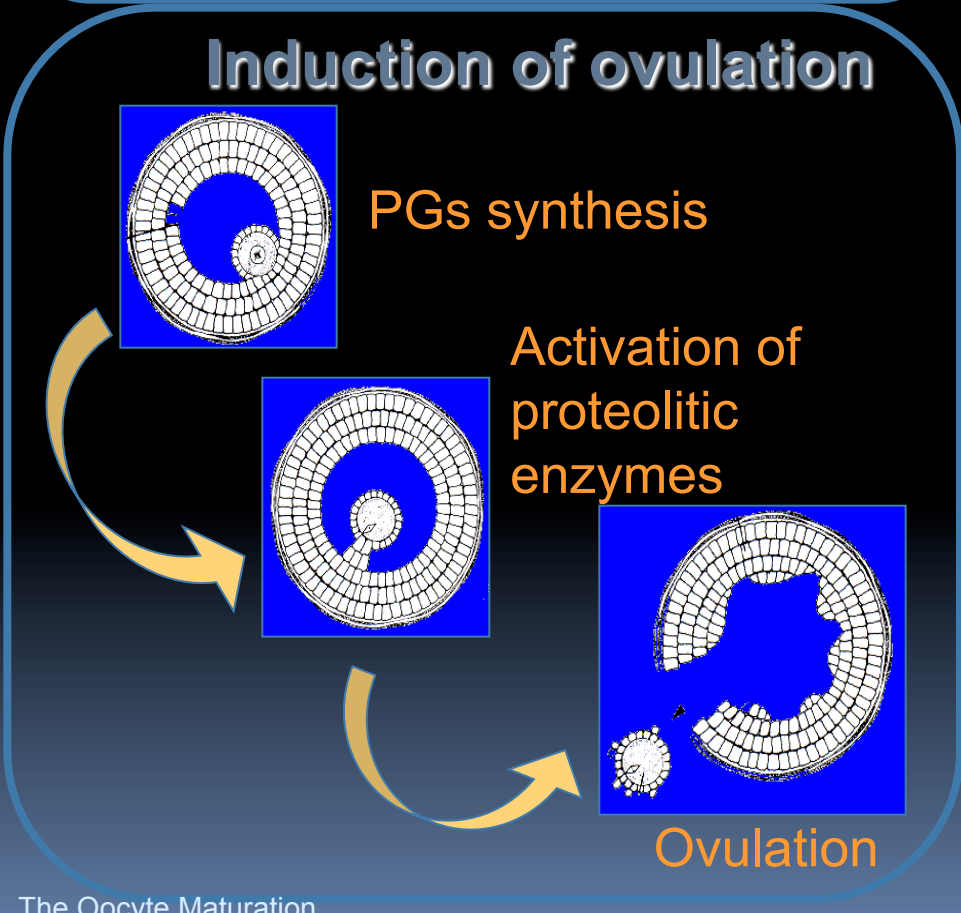
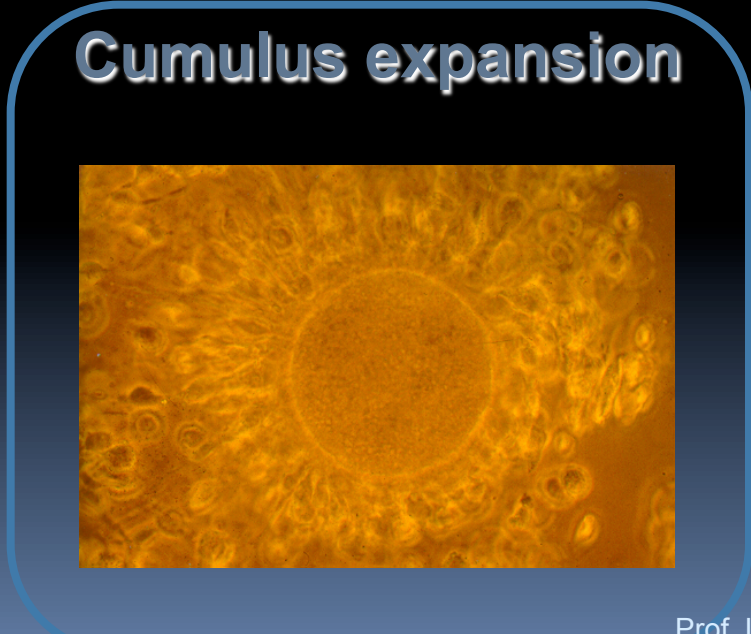
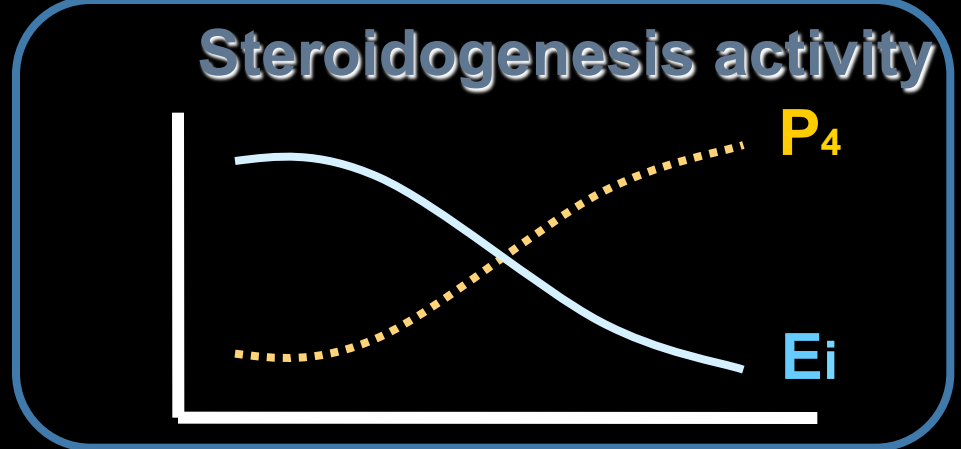
M.A. Hill, 1999

Only in the final stage of pre-ovulatory maturation of a follicle is meiotic arrest in the primary oocyte overcome to permit completion of the first meiotic division and formation of a secondary oocyte with first polar body (PB) by the time of ovulation

THE OOCYTE MATURATION

Specific responses to the pre-ovulatory surge of gonadotrophic hormones are noted in both the oocyte and its surrounding follicle cells.

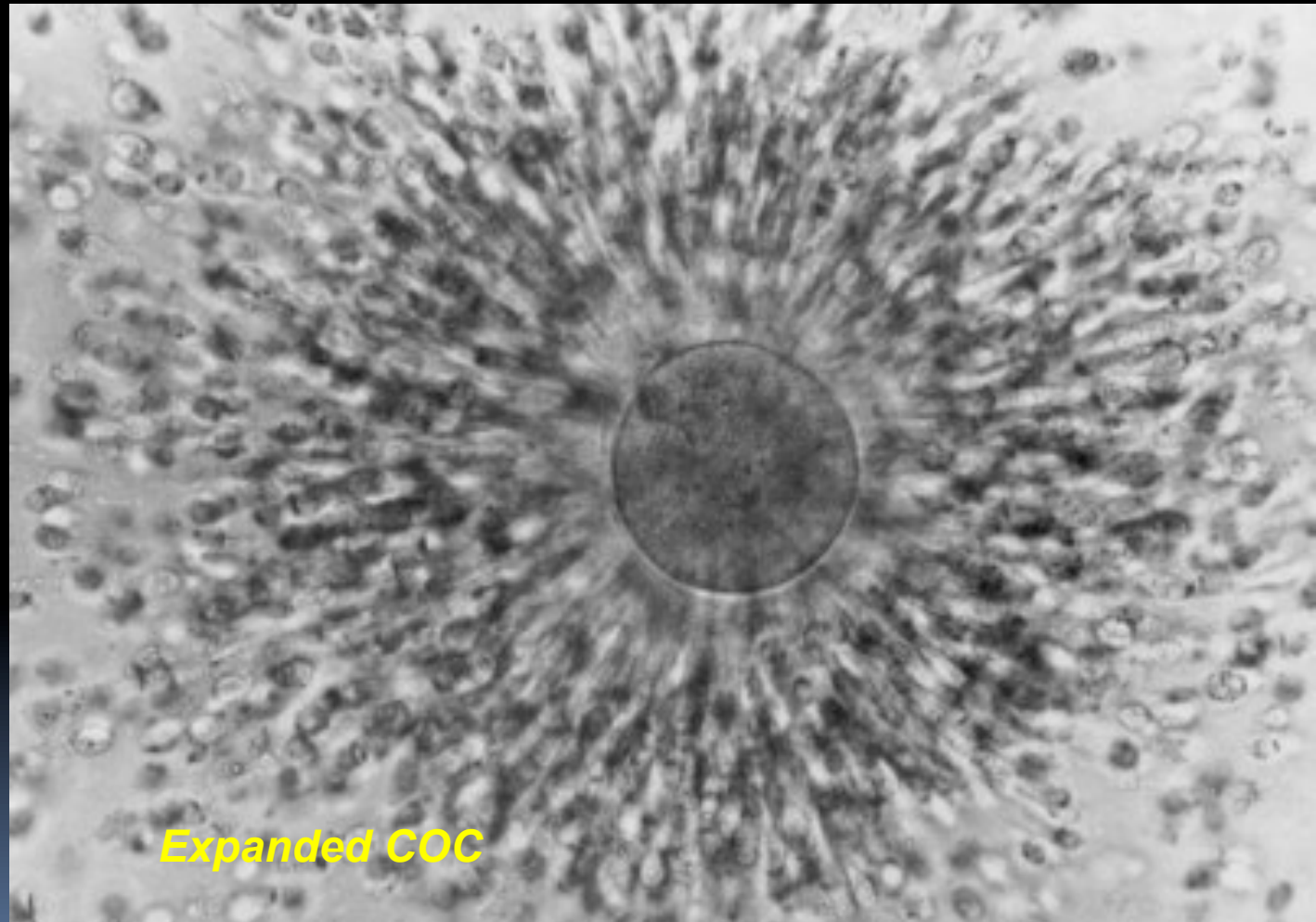
- **LH does not act directly on the oocyte**



Prof. Luisa Gioia_ The Oocyte Maturation

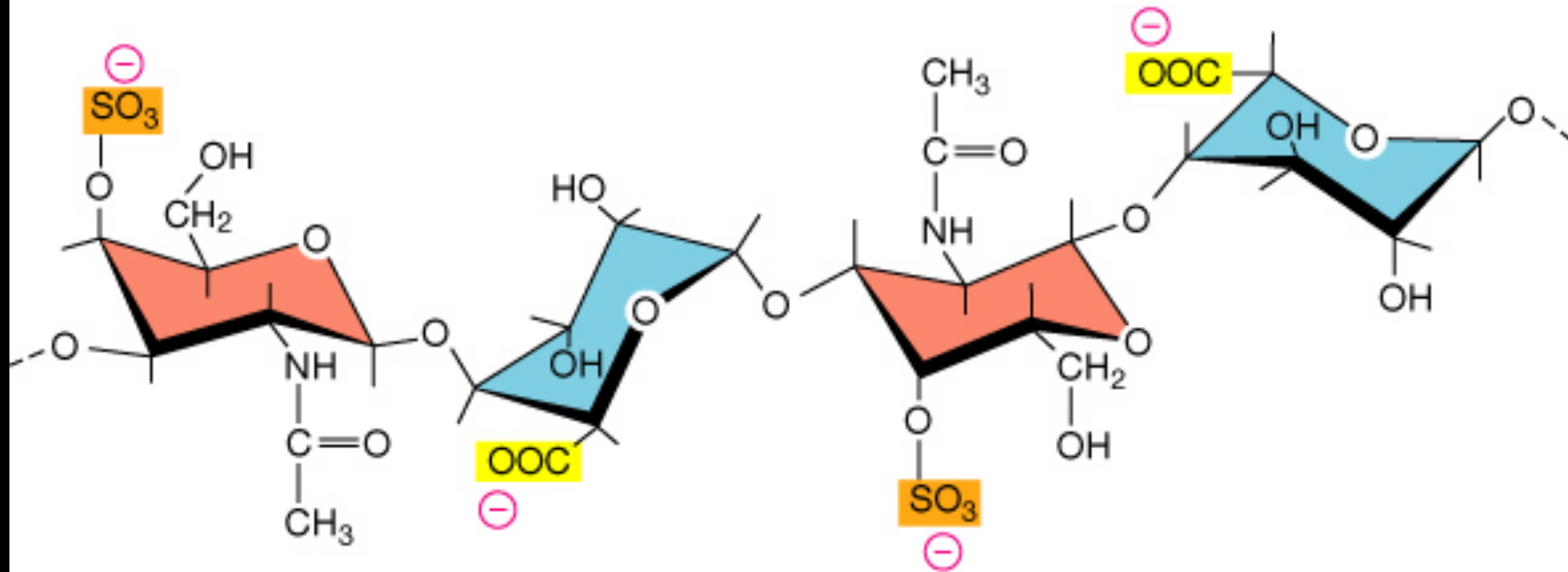
LH surge induces crucial processes in somatic compartment of the follicle.....

Mucification of the cumulus mass within pre-ovulatory follicles is represented by deposition of an extracellular matrix that is **sensitive to the action of hyaluronidase** (Schuetz and Schwartz, 1979,; Eppig, 1980) being rich in **hyaluronic acid**. Hyaluronic acid is the major structural macromolecule of the ECM.



Expanded COC

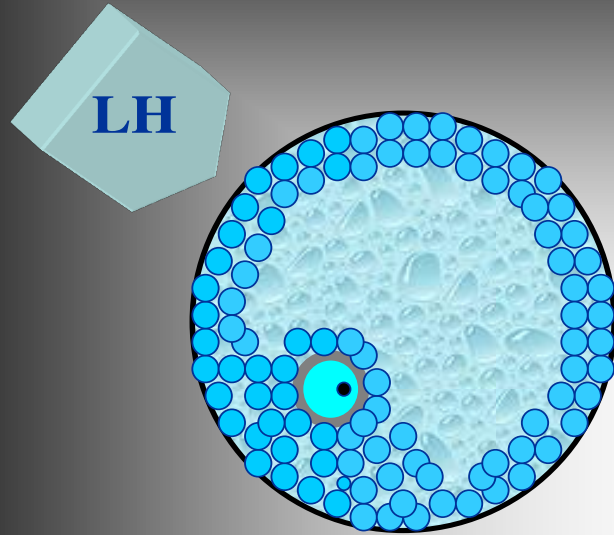
repeated disaccharide



Hyaluronic acid is the major structural macromolecule of the ECM

It is a large polyanionic polymer belonging to the family of Glicosaminoglicane (GAG), it is highly hydrophilic and thus able to attract water and expand as a coil, hence pre-ovulatory enlargement of the cumulus mass seen at mucification

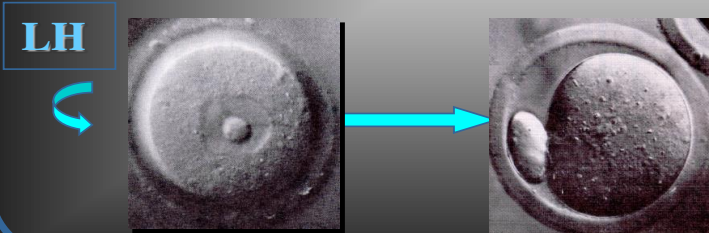
...and even in the oocyte



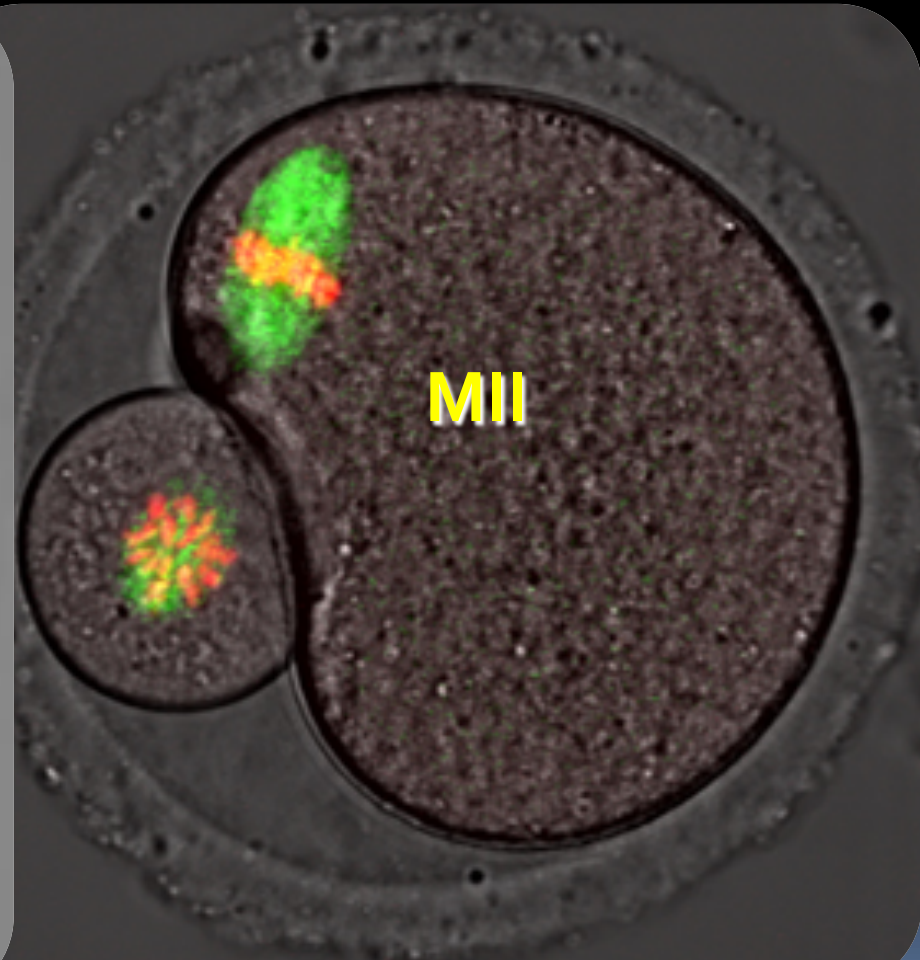
In Mammals due to LH peak the oocyte can overcome the first meiotic arrest **resuming meiotic progression.**

That happens only in **fully grown/ meiotic competent oocytes** enclosed within pre-ovulatory follicles.

Oocyte maturation



MEIOTIC MATURATION



Following LH stimulation the oocyte resumes meiosis and again stops at MII stage

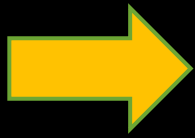


Pay attention!

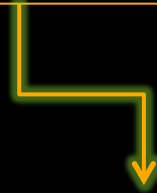
MEIOSIS

- Consists of **two consecutive cell divisions** (meiosis I and II) **without an intermediate S phase**. The result is that **gametes are haploid**
- Female meiosis is a **long and discontinuous process**

THE OOCYTE MATURATION

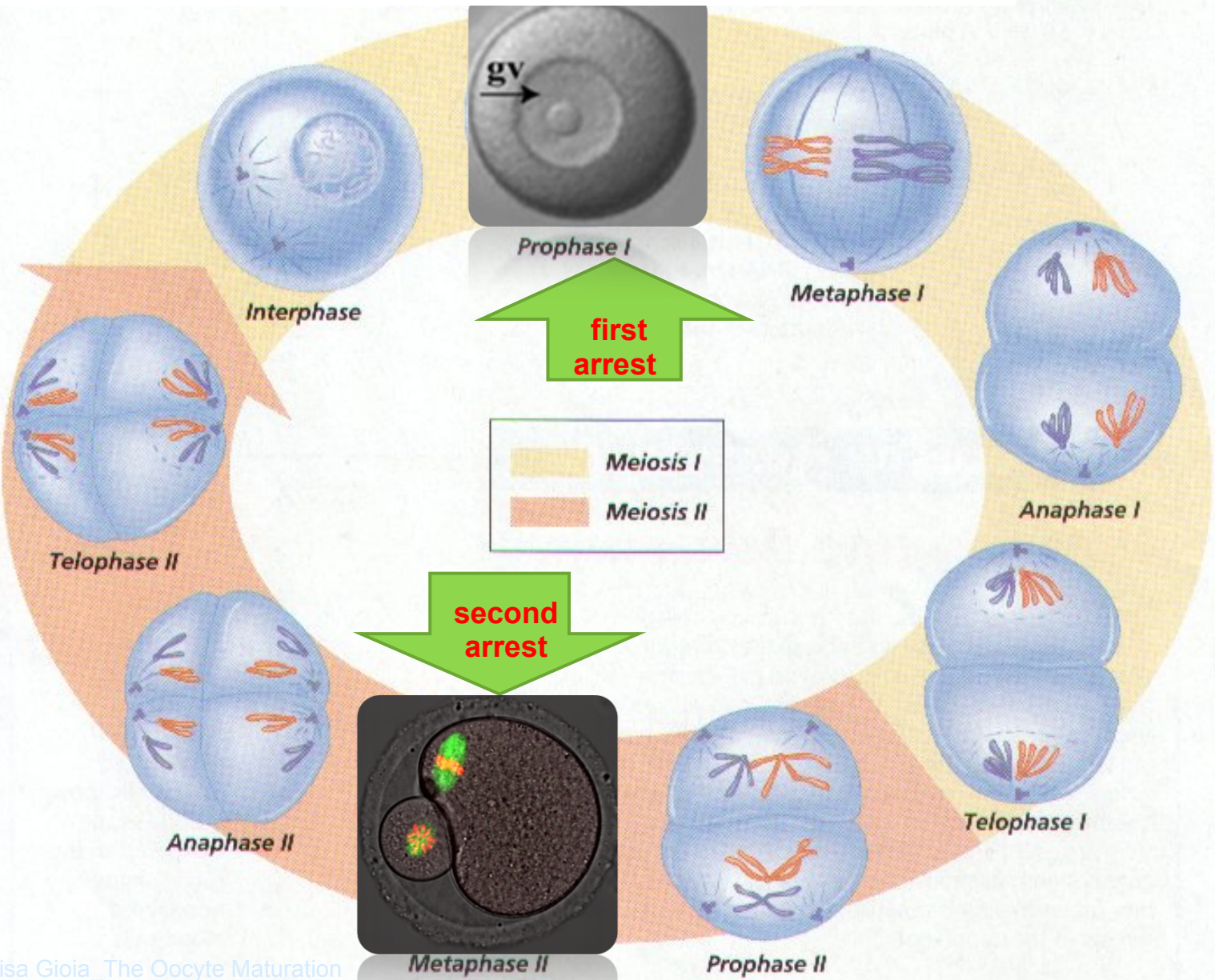


How long is oocyte meiosis?



When it starts and when it finishes?

Female meiosis is a long and discontinuous process



Fetal period

Oogonium

(proliferation phase)

Before or at birth

Meiosis in progress

After birth

Arrested in
diplotene
of Meiosis I

After puberty

Meiosis I
complete

Arrest at
Metaphase II

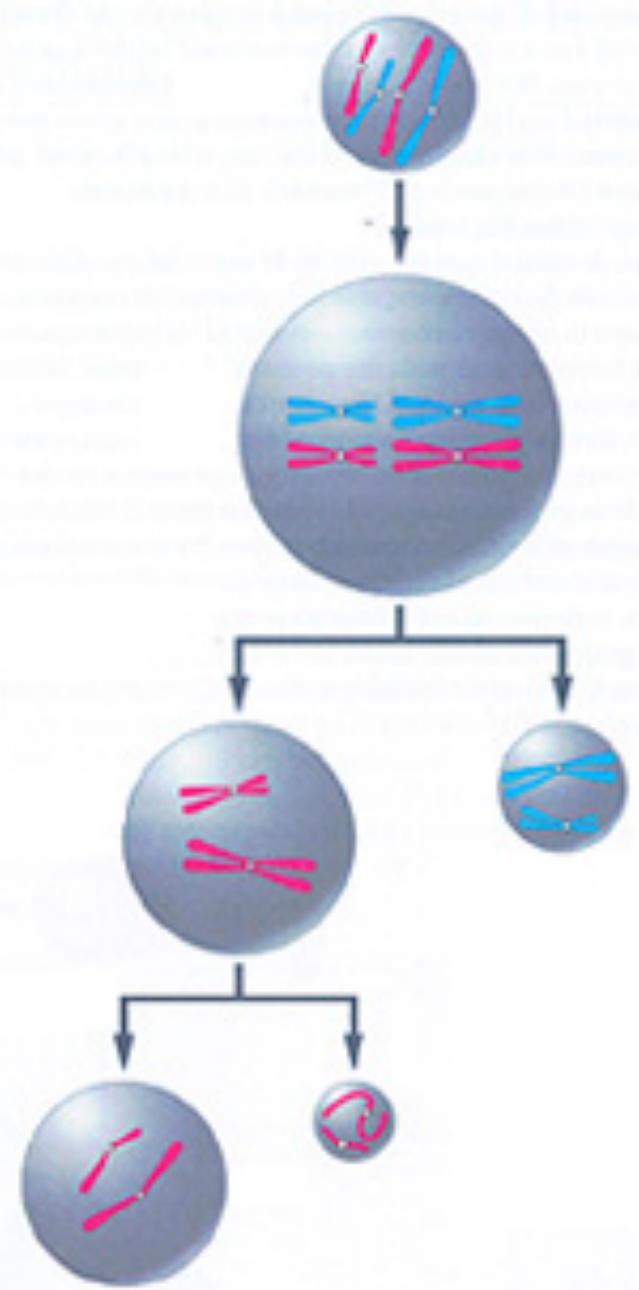
At fertilization

Meiosis II
complete

Primary Oocyte

**Secondary Oocyte
& Polar Body I**

**Fertilized Ovum
& Polar body II**



LH

spz

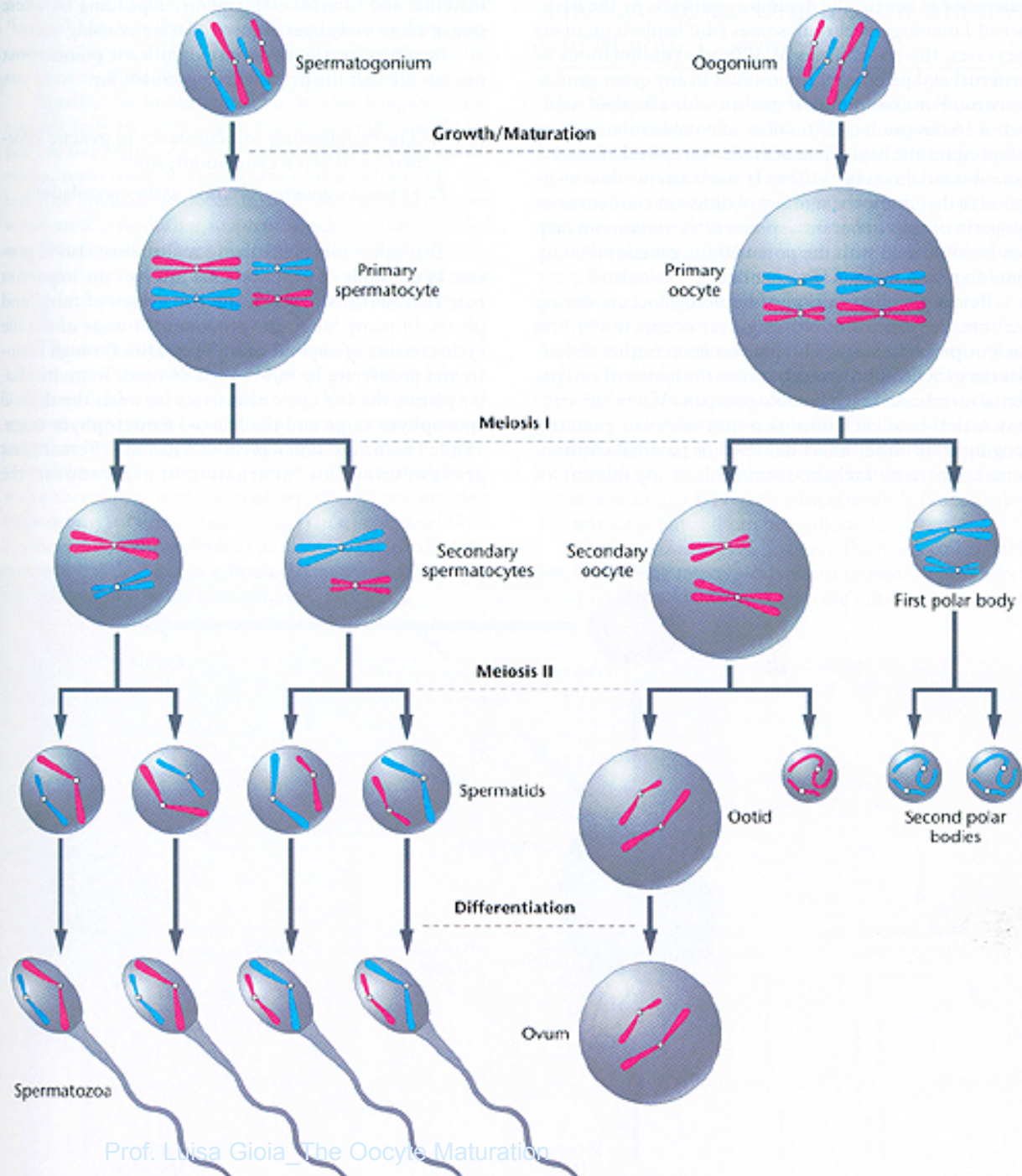


Pay attention!

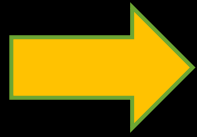
- **Male meiosis is definitely shorter than female meiosis**

Gametes and meiosis

Although **meiosis in male and female** animals follows roughly the same lines, there are some important distinctions



Unit 1: Biology of gametes



THE OOCYTE MATURATION

✓ *Definition*

✓ *What is the purpose of the process?*

✓ *What triggers the process?*

✓ *How long is the process?*

◆ *What happens to the oocyte during maturation?*