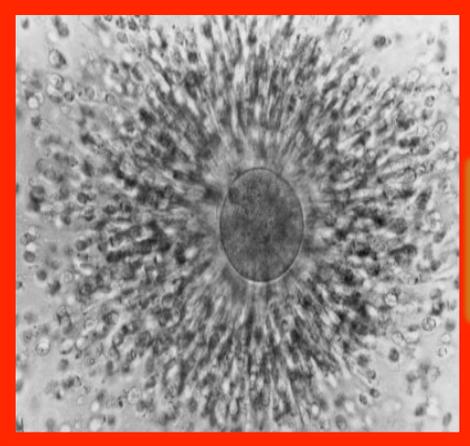




# Biotechnology of Reproduction

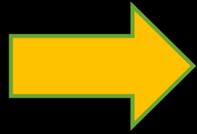
UNIVERSITY of  
TERAMO

## BIOLOGY OF GAMETES



OOCYTE  
MATURATION

# THE OOCYTE MATURATION



*What is the purpose of the process?*

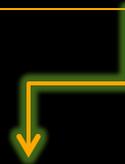
✓ The endpoint of **meiotic maturation** is the production of an **haploid oocyte**

The **endpoint of oocyte maturation** is the production of an **oocyte**, arrested at the MII stage of meiosis, but possessing the full competence after fertilization of supporting normal embryonic development

# THE OOCYTE MATURATION



◆ *What happens in the oocyte during the process of maturation?*



**MEIOSIS/NUCLEAR MATURATION**



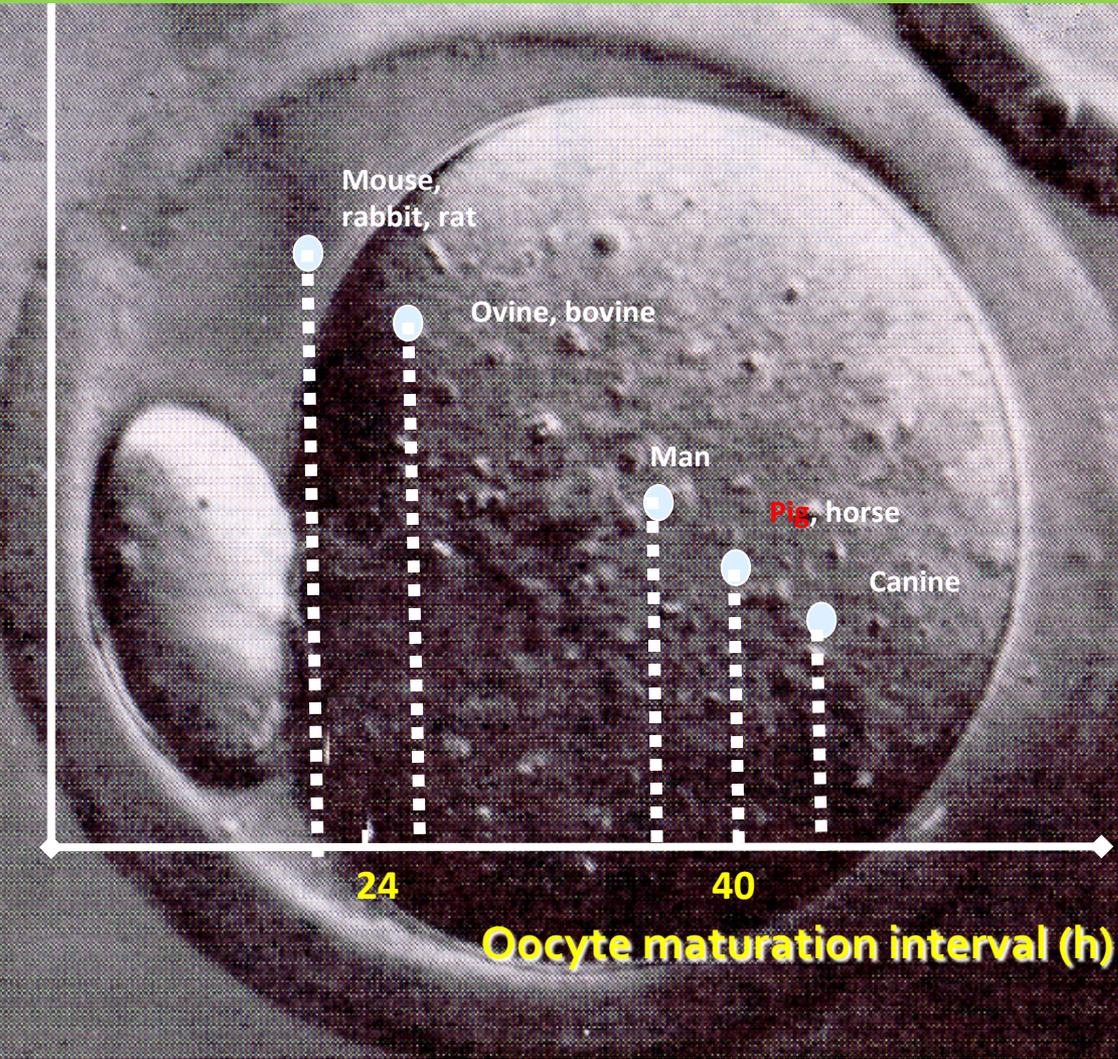
**CYTOPLASMIC MATURATION**

The process of oocyte maturation is composed of different aspects



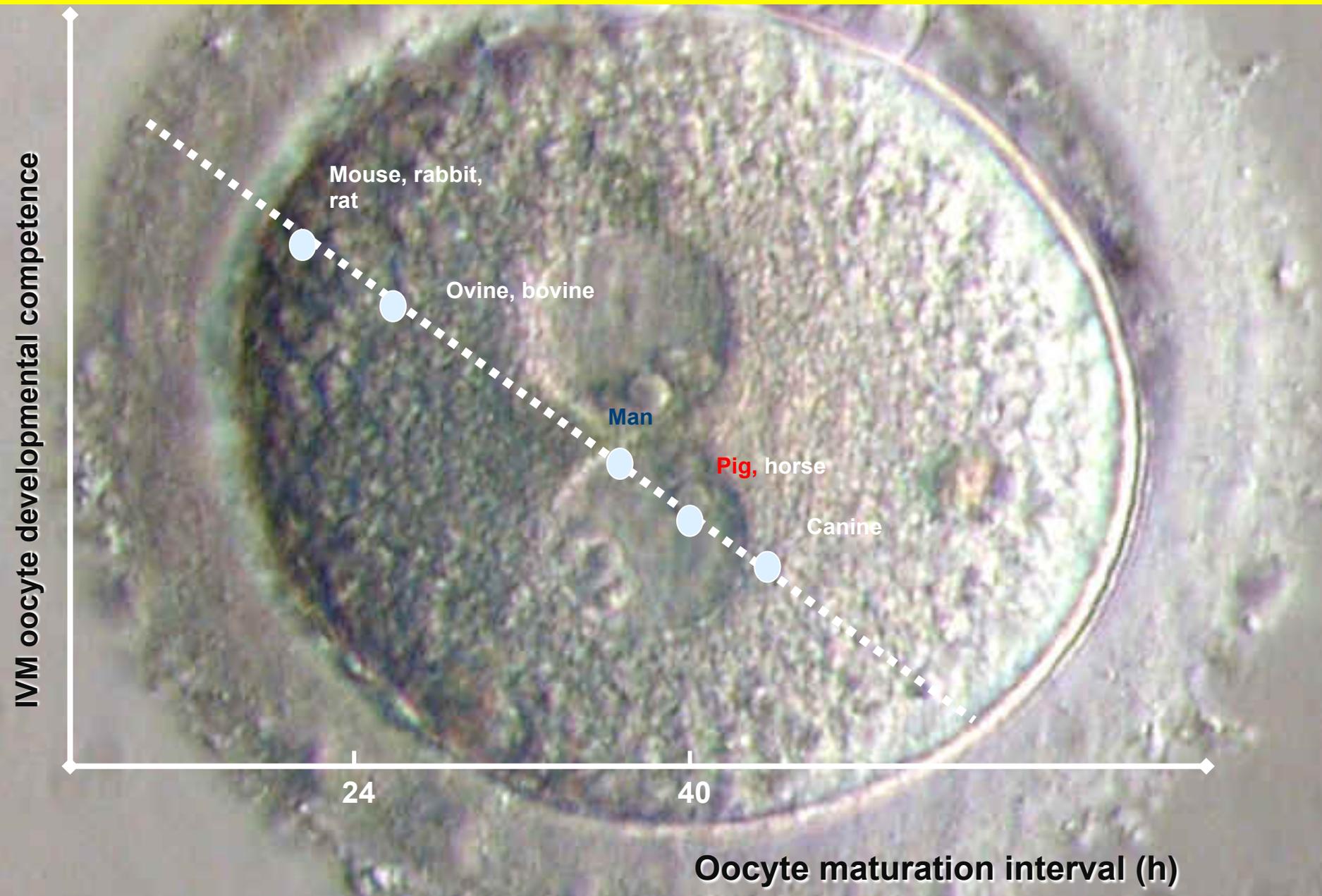
***Oocyte developmental competence***

The results obtained by IVM are strictly correlated to the duration of the process of oocyte maturation



| Species | Interval until ovulation (hours) |
|---------|----------------------------------|
| Pig     | 39-40                            |
| Sheep   | 25-26                            |
| Cow     | 28-30                            |
| Mouse   | 12-15                            |
| Rat     | 12-15                            |
| Rabbit  | 9-11                             |
| HUMAN   | 38-40                            |

Recent evidence has demonstrated that the DEVELOPMENTAL COMPETENCE of IVM oocytes is strictly correlated to the duration of oocyte maturation



# ✦ Cytoplasmic maturation

- *During the long growth phase, the oocyte acquires the molecular machinery necessary for the next processes, such as maturation, fertilization and embryo development*

The molecular steps that underlie **cytoplasmic maturation** involve: accumulation of mRNA, proteins, substrates, and nutrients, that are required to achieve the oocyte **developmental competence**



ZGA

Transition from maternal to embryonic control



# ZGA (*zygotic gene activation*) in mammals

- Degradation of oocyte specific transcripts (maternally inherited)
  - Replacement of maternal transcripts with zygotic transcripts
  - Appearance of embryo activated genes (ZGA): following fertilization the transcriptionally inactive genome becomes a transcriptionally active one
- 

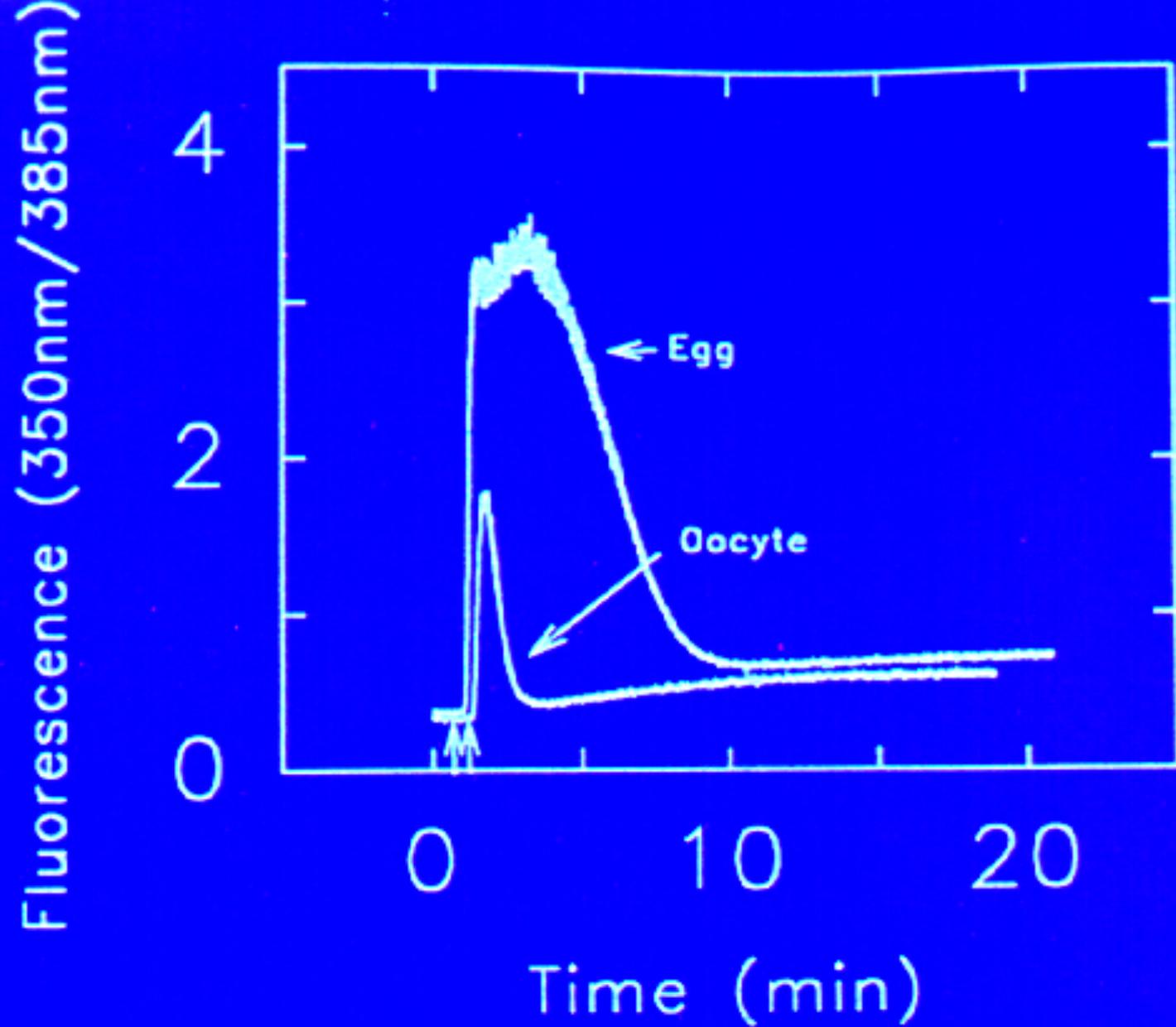
# Main important events concerning CYTOPLASM MATURATION also occur during oocyte maturation

**Ca<sup>++</sup>/ ER/ IP3 receptors**

**Oocyte cortex/Cortical granules (CGs)**

**Mitochondria**

**GSH**



LISA M. MEHLMANN and DOUGLAS KLINE (1994)

# In Mammals, high Ca levels are required for Ca-dependent events correlated to the **RESUMPTION OF MEIOSIS**

Literature shows that:

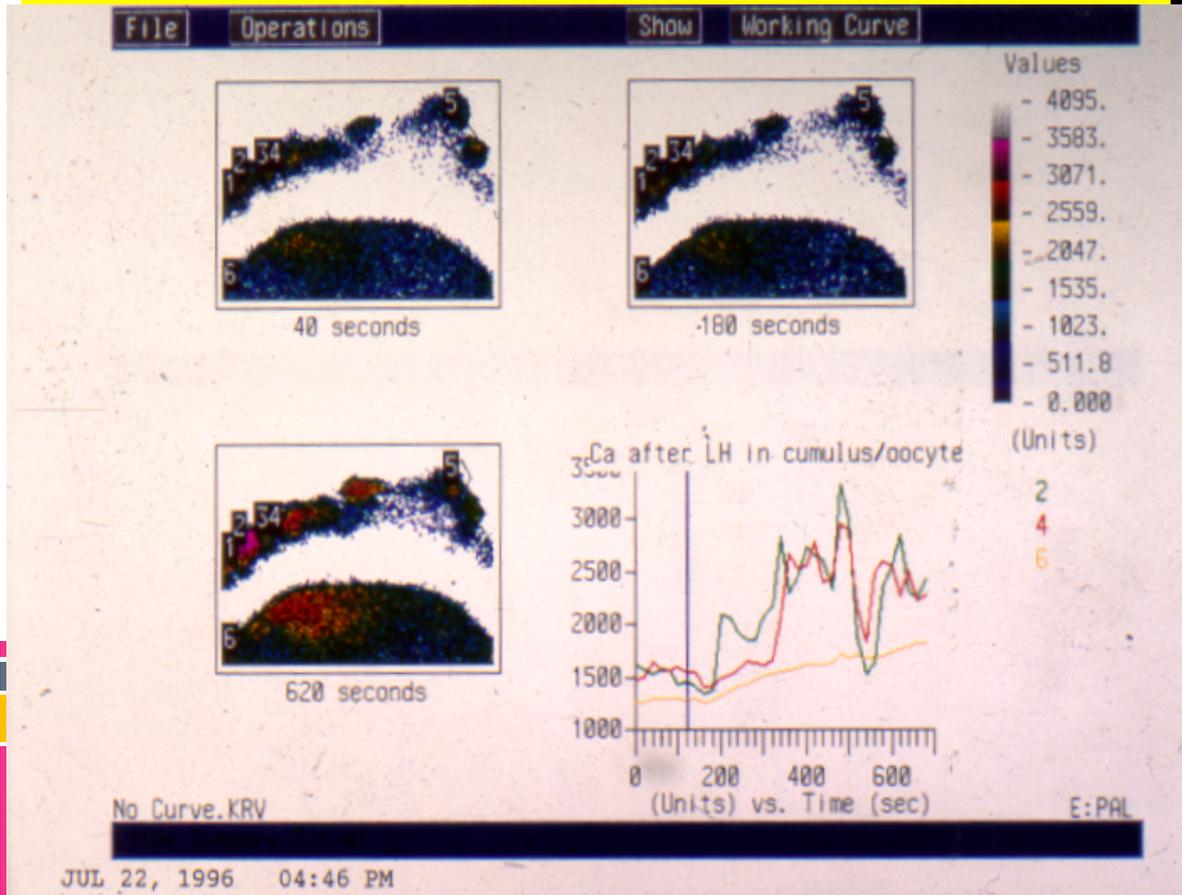
- intracellular calcium oscillation is recorded during spontaneous maturation of mouse and pig oocytes
- the **increase in calcium concentrations at the time of GVBD** confirms the relationship between intracellular calcium currents and oocyte maturation in different species

# MECHANISMS INVOLVED IN THE RESUMPTION OF MEIOSIS IN MAMMALS

1. LH induces **intracellular Ca increase** in CCs. Ca diffuses to the oocyte through GJs

Calcium elevation in sheep cumulus-oocyte complexes after luteinising hormone stimulation

M. Mattioli, L. Gioia, B. Barboni  
*Molecular Reproduction and Development* (1998)



2. Consequently, PKC is activated in CCs and oocyte. Finally, factors stimulating oocyte maturation are produced by CCs

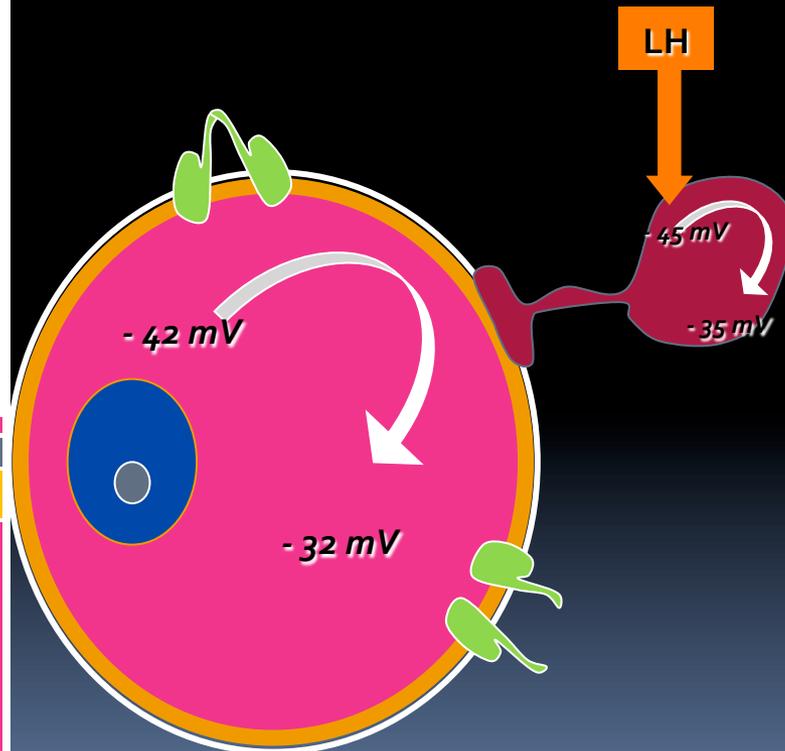
This Ca rise is recorded **soon after LH stimulation** (a few seconds) before in CCs and then in the oocyte

# Induction of oocyte maturation

Activation of protein kinase A and protein kinase C mediates the depolarising effect of LH in ovine cumulus-corona cells.

1. LH causes a **depolarization of cumulus cell membranes**
2. Cumulus cells are electrically coupled to the oocyte: the **oocyte depolarizes** as well

Mattioli M, Barboni B, Gioia L.  
*J Endocrinology* 1996

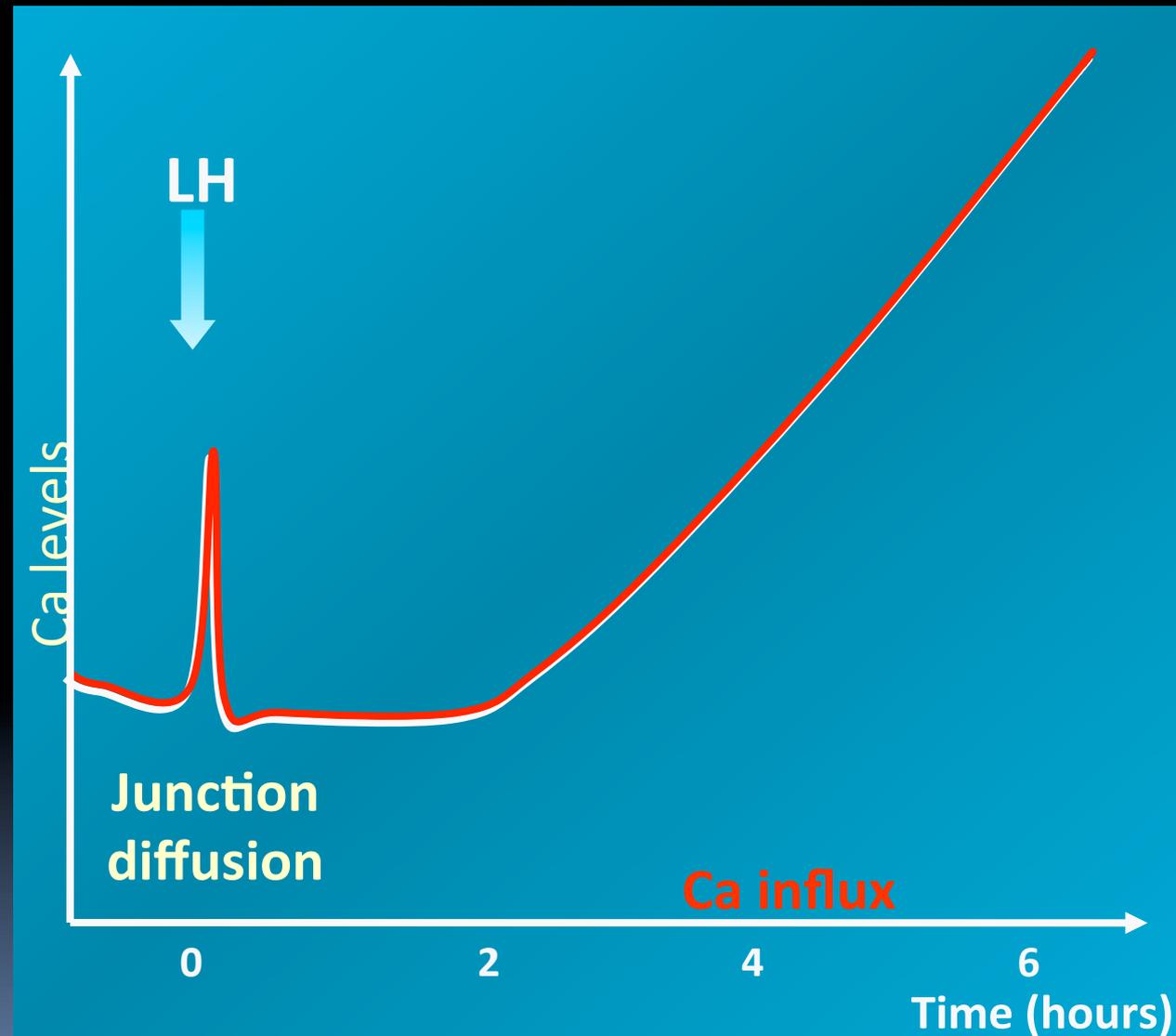


3. In the oocyte, membrane depolarization **opens voltage-gated Ca channels**
4. **Ca ions diffuses** from the extracellular environment to the oocyte throughout P type VGCC

This mechanism causing intracellular Ca rise occurs **2-4 h after LH stimulation** and requires a more complicated mechanism.

# An increase of intracellular Ca concentration occurs during oocyte maturation due to different mechanisms caused by LH surge

*High levels of Ca are important for Ca-dependent events occurring during resumption of meiosis (i.e. GVBD, PKC activation), as well as filling oocyte Ca stores, that will be used by the egg in the next steps (fertilization, early embryo development)*



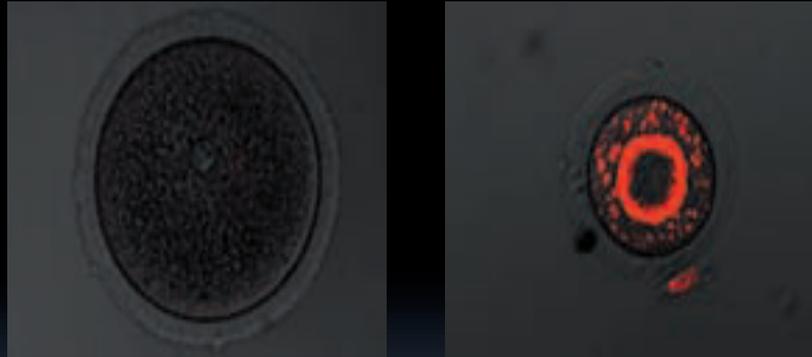
# Cytoplasmic maturation

**ER localization and expression of IP3 receptors change during oocyte maturation**

# Cytoplasmic maturation

- **Mitochondria**

Cytoplasmic maturation of the oocyte involves a complex mechanism that includes redistribution of **CHROMOSOMES** and organelles, especially **MITROCONDRIA**



*J Nippon Med Sch 2003; 70 (5)*

In the mouse the **aggregation of MT around the nucleus** is essential for maturation, fertilization and embryo development