Applications of Animal Biotechnology

By

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Classical Biotechnology

- 19th and Early 20th century
- Microbial-based fermentation process such as alcohol, beer, wine, dairy products, various types of organic acids such as vinegar, citric acid, amino acids, and vitamins

Modern Biotechnology

- During the twentieth century
- Introduction of a large number of new techniques that has changed the face of classical biotechnology forever

Biotechnology definitions:

- ***Biotech*** in farm animals can be categorized as the biological, chemical and physical techniques that influence animal health (survival), nutrition, breeding, and reproduction.

- Controlled use of biological agents like cells or cellular components for beneficial use

Reproductive Biotechnology……

Why?

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Reproductive Biotechnology……

Why?

- To improve animal productivity and performance
- To overcome the increasing of human demands
- To increase the superior animal population
- To save endangered species
- To……

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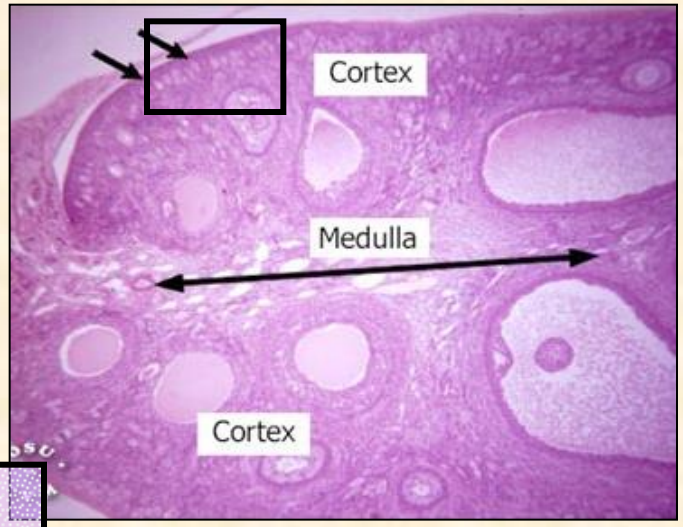
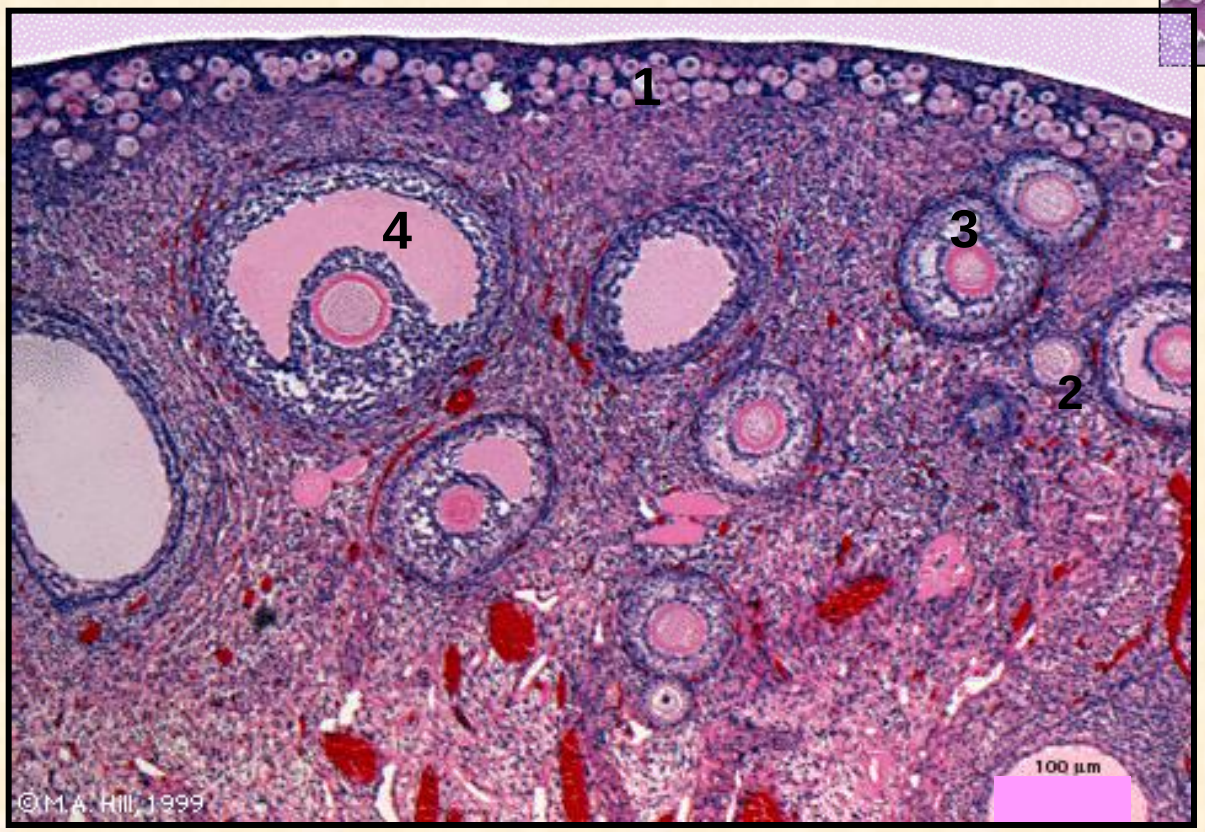
Ovary





1 Premordial follicles

2 Primary follicles

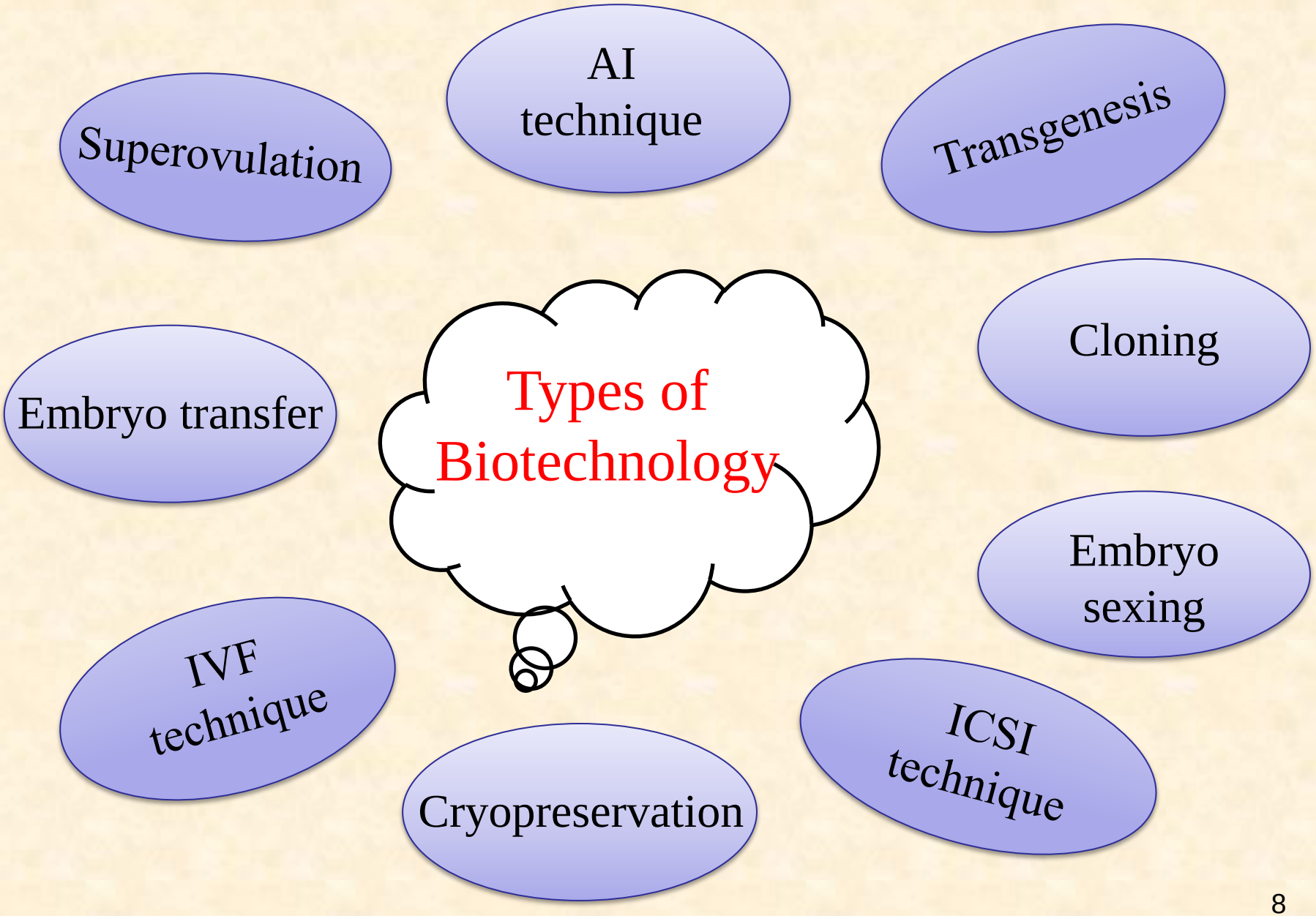
3 Secondary follicles

4 Grafiaan follicles

Reproductive Biotechnology……

Why?

The ovary, from birth, contains a huge number of follicles, the vast majority of these follicles become atretic, but they do represent a potential source of ova for embryo production.


Types of Biotechnology
Superovulation
AI technique
Transgenesis
Embryo transfer
Cloning
Embryo sexing
IVF technique
ICSI technique
Cryopreservation

Animal reproductive characteristics

Estrus cycle ……. Producing one ovarian follicle (Graafian follicle) by the end of the cycle

- Follicular phase

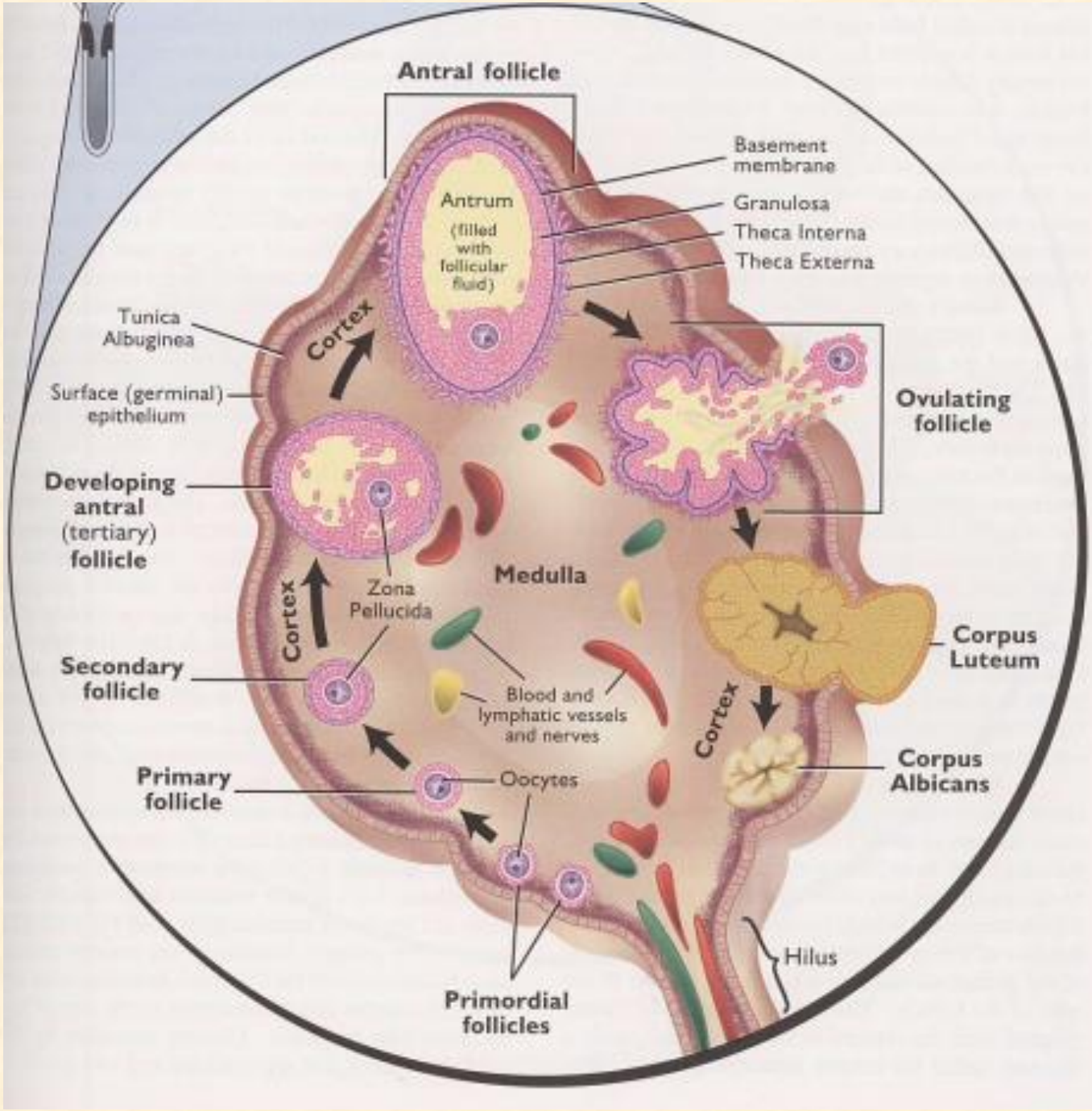
Ovarian follicles growth and development

FSH- Follicular Stimulating Hormone

- Luteal phase

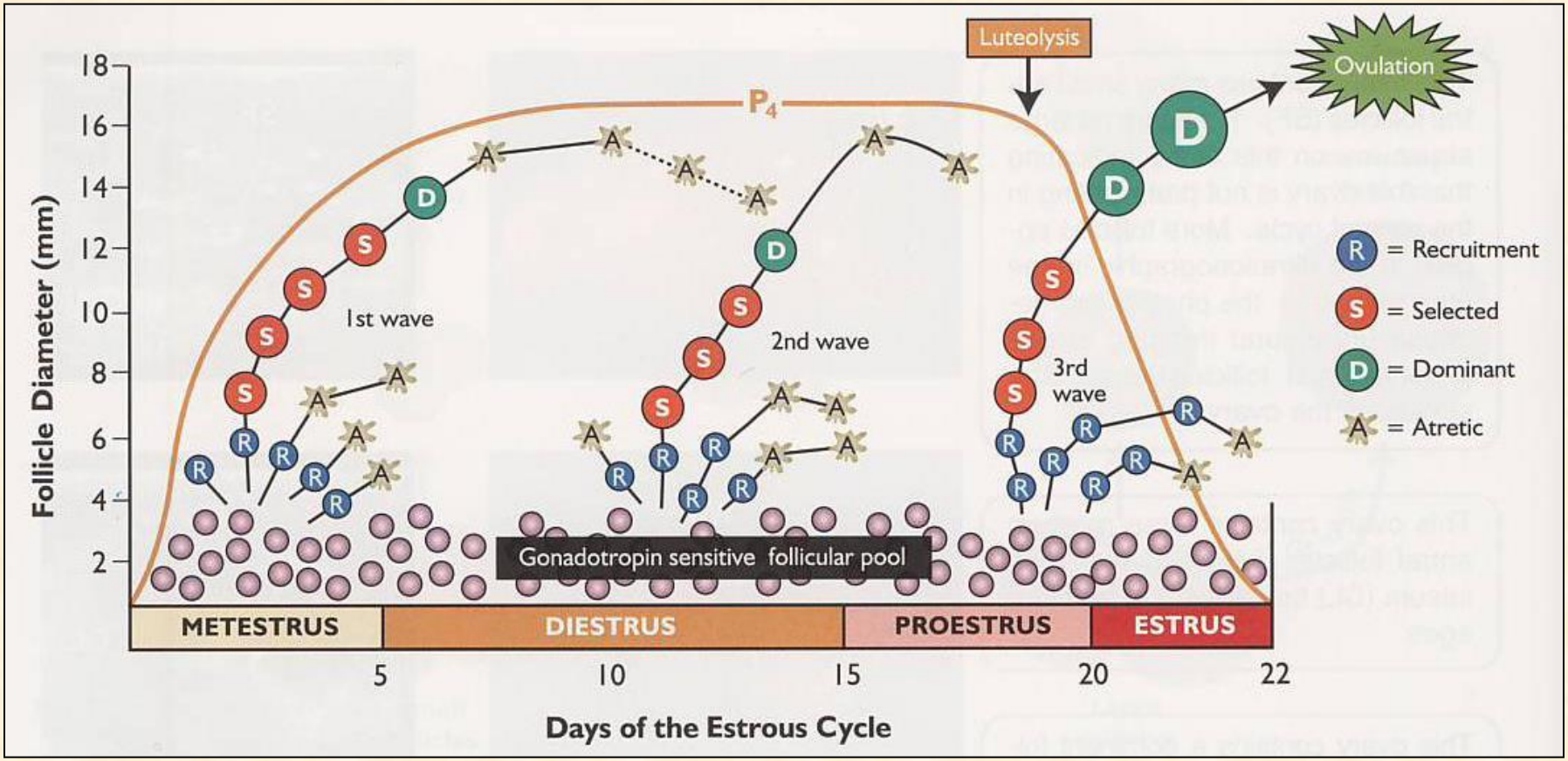
Corpus Luteum growth and development

LH- Luteinizing Hormone

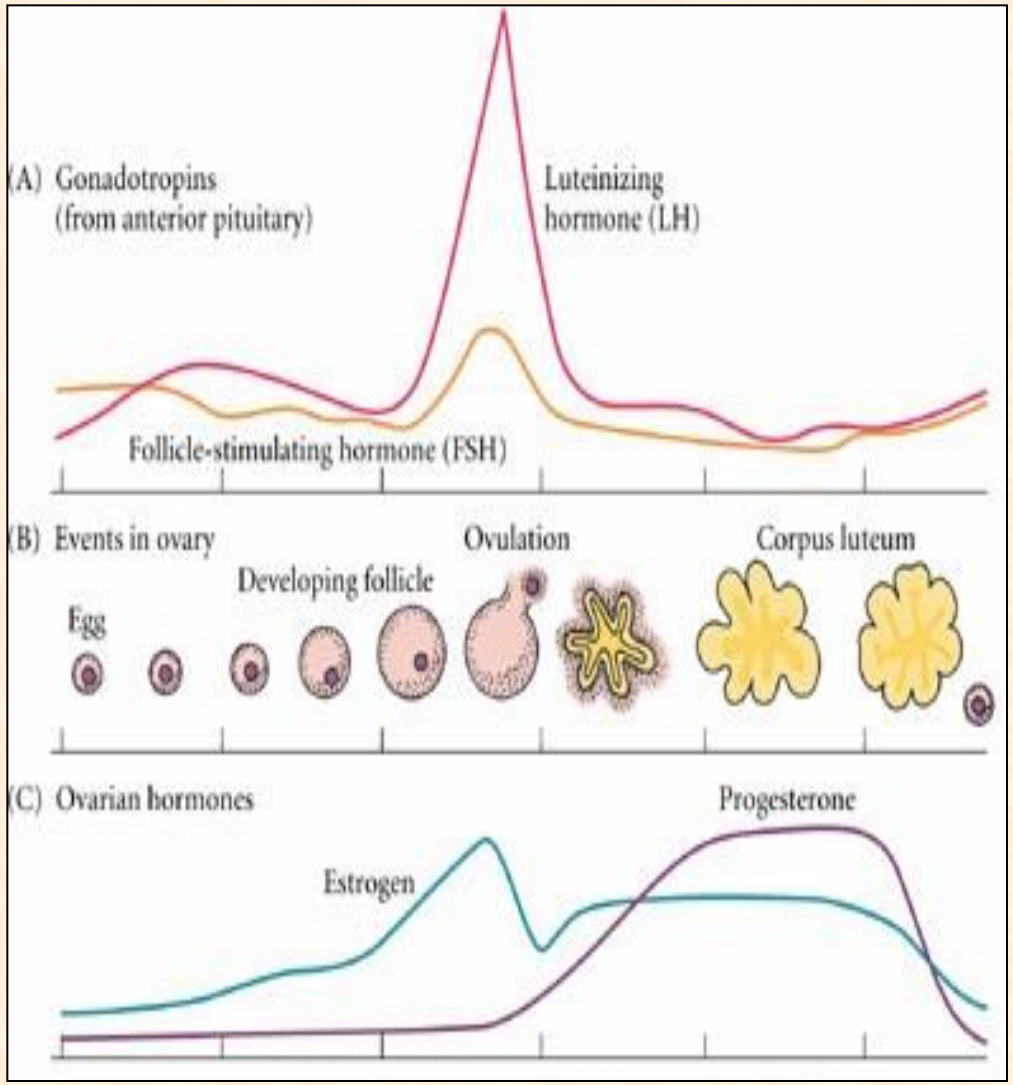

Antral follicle
Antrum
(filled with follicular fluid)
Basement membrane
Granulosa
Theca Interna
Theca Externa
Tunica Albuginea
Cortex
Surface (germinal) epithelium
Ovulating follicle
Developing antral (tertiary) follicle
Medulla
Zona Pellucida
Cortex
Secondary follicle
Corpus Luteum
Blood and lymphatic vessels and nerves
Cortex
Corpus Albicans
Primary follicle
Oocytes
Hilus
Primordial follicles

1- Superovulation:

The natural mechanism normally allow only one follicle to become dominant and ovulate.



Superovulation:



FSH

- The half-life of FSH is relatively short (0.5–1 hour)
- Repeated injections are required

PMSG (Pregnant Mare Serum Gonadotropins)

- FSH-like and LH-like properties
- longer half life in the body (50 hours)

Prostaglandins (PGF2α)

The timing of ovulation

can be controlled!!!

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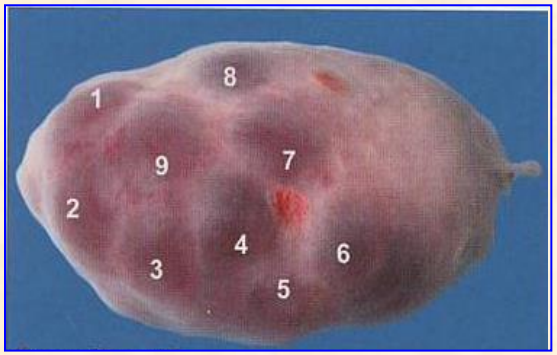
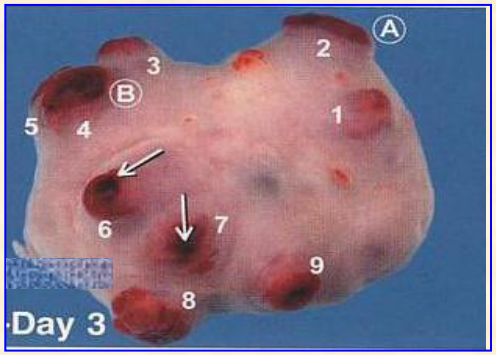
Superovulation



Up to 20 oocytes

Fertilization

Embryos



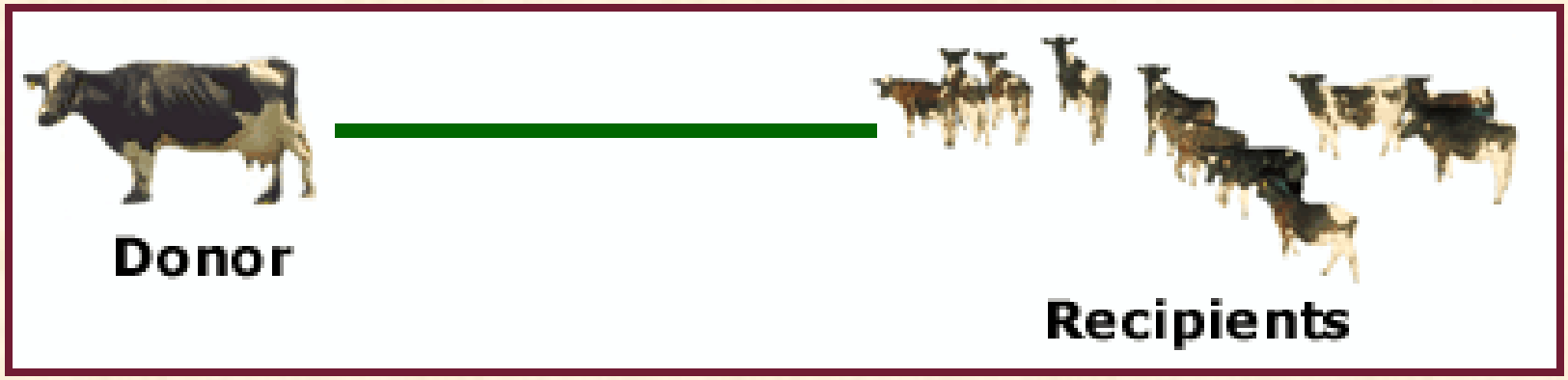
Cryopreservation

In Vitro Fertilization

Embryo Transfer

2- Embryo Transfer (ET):

ET definition: is a process by which an embryo is collected from a donor female and then transferred into a recipient female where the embryo completes its development



2- Embryo Transfer (ET):

ET benefits:

1. Through ET a genetically superior female produces more offspring than she could by natural reproduction
2. ET offers more rapid genetic gain
3. Prevents disease transmission
4. ET preserves superior genetics for future generations due to embryo freezing
5. Frozen embryos can be shipped almost anywhere
6. Extend the productive life of some older cows

2- Embryo Transfer Steps:

1. Selection of the donor – Identifying the recipients cows
2. Synchronization of estrus cycle
3. Superovulation
4. Insemination – A.I
5. Flushing of the embryos – followed by embryos evaluation
6. Fresh embryos transfer or can be frozen

Donor cow

Recipients cow

PGF2α

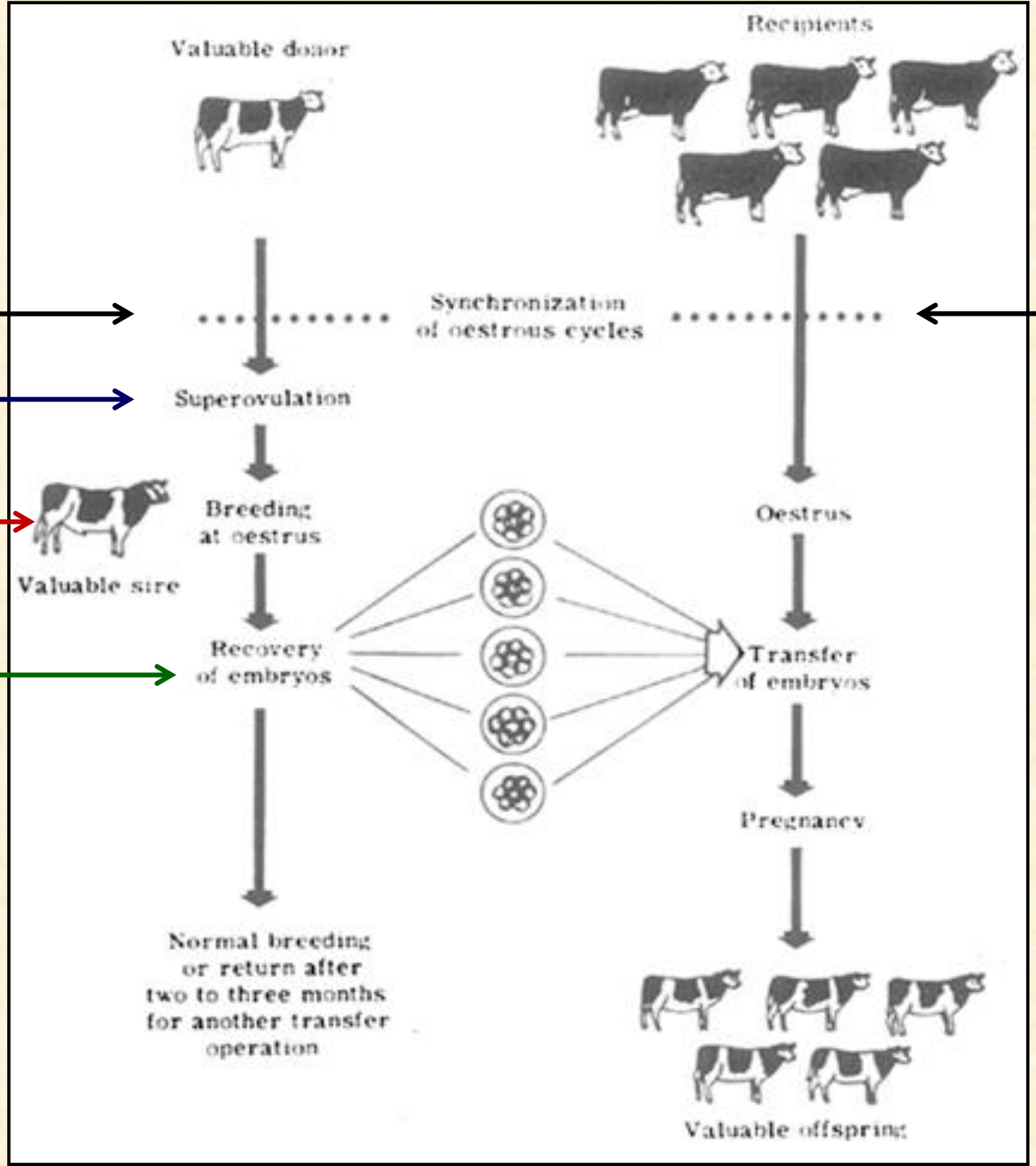
FSH (PMSG)

A.I

Embryo evaluation

PGF2α

After two days the animal will be in heat (estrus)

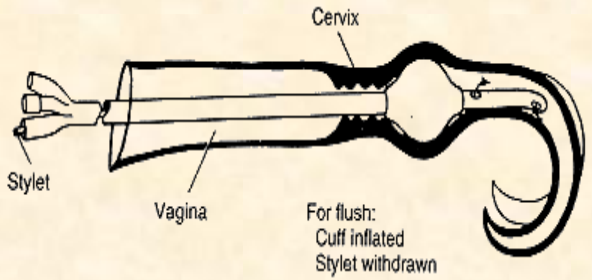


Donor cow:

- Insemination – A.I

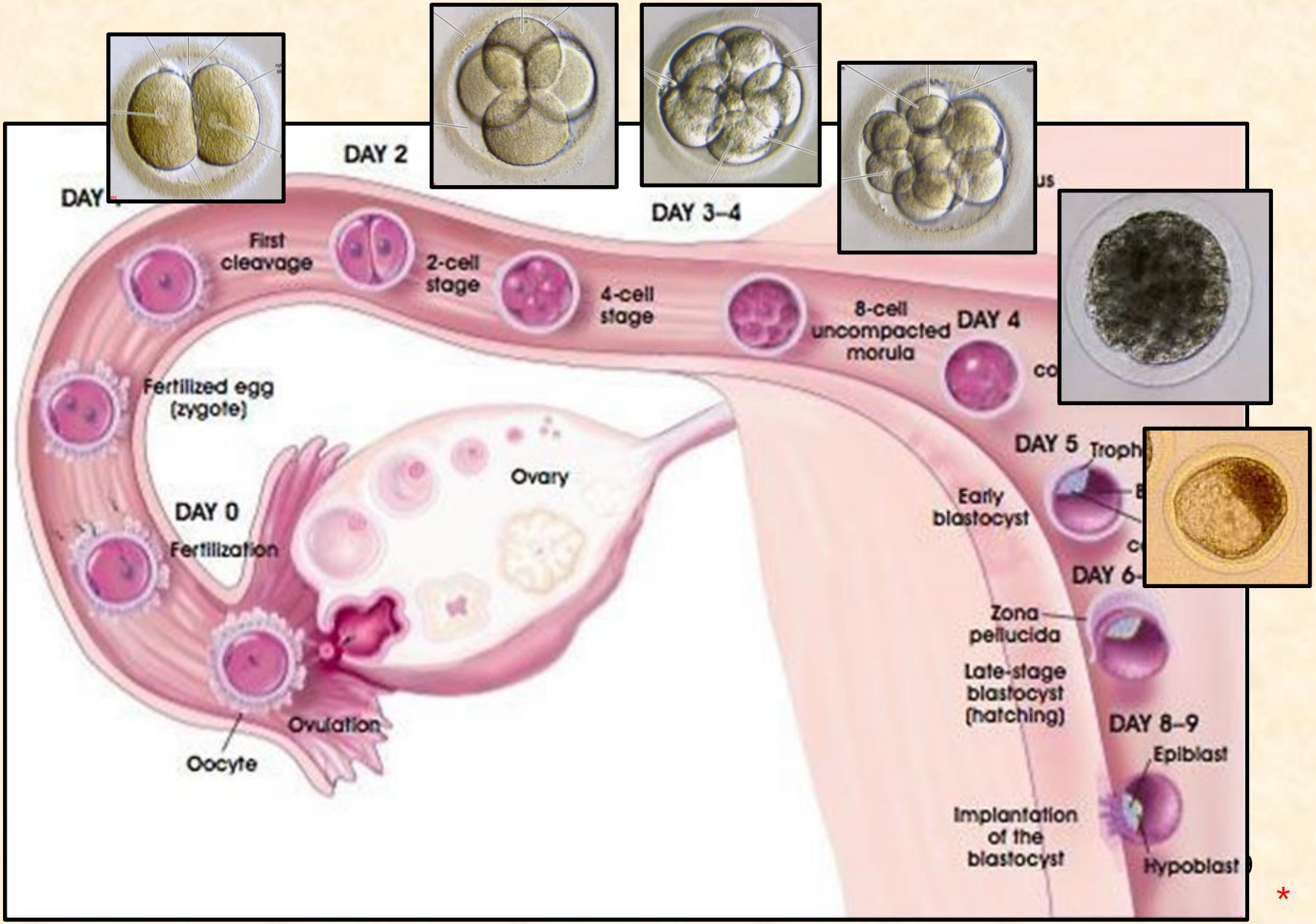
Artificial insemination gun

- Embryo flushing



Foley catheter

Embryo development stages:



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Evaluation of embryos

Embryos are evaluated according to their ***stage of development:***

Stage 1: **Unfertilized**

Stage 2: **2 to 12 cells**

Stage 3: **Early morula**

Stage 4: **Morula**

Stage 5: **Early blastocyst**

Stage 6: **Blastocyst**

Stage 7: **Expanded blastocyst**

Stage 8: **Hatched blastocyst**

Stage 9: **Expanding hatched blastocyst**

Embryos classified according to their ***quality:***

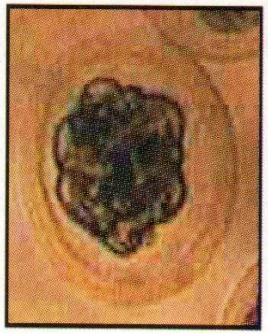
Grade 1: **Excellent or good**

Grade 2: **Fair**

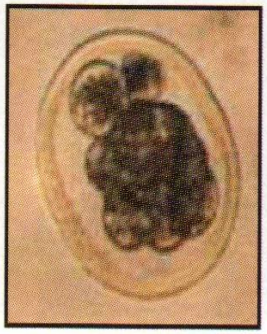
Grade 3: **Poor**

Grade 4: **Dead or degenerating**

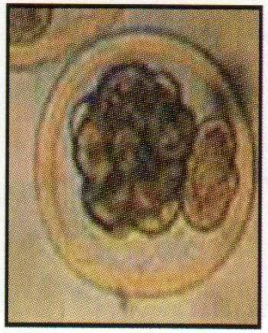
Cycle day: 6
Stage Code: 3
Quality Code:1



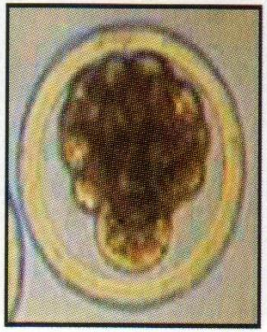
Cycle day: 6.5
Stage Code: 3
Quality Code:1



Cycle day: 6.5
Stage Code: 3
Quality Code: 2



Cycle day: 6.5
Stage Code: 3
Quality Code: 2



Cycle day: 6.5
Stage Code: 4
Quality Code: 1

Cycle day: 7
Stage Code: 4
Quality Code: 1

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Stage Code: 4
Quality Code: 1

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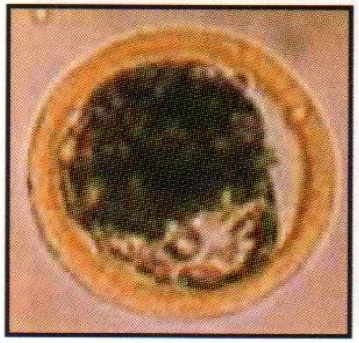
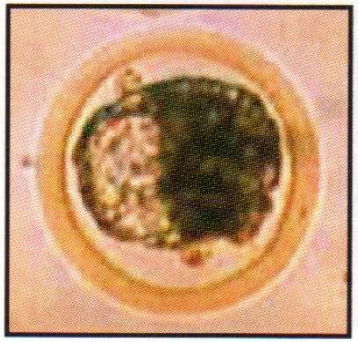
Stage Code: 4
Quality Code: 1

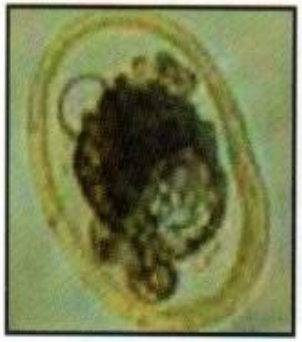


Cycle day: 7
Stage Code: 5
Quality Code:1



Cycle day: 7
Stage Code: 5
Quality Code: 1

Cycle day: 7
Stage Code: 5
Quality Code: 1

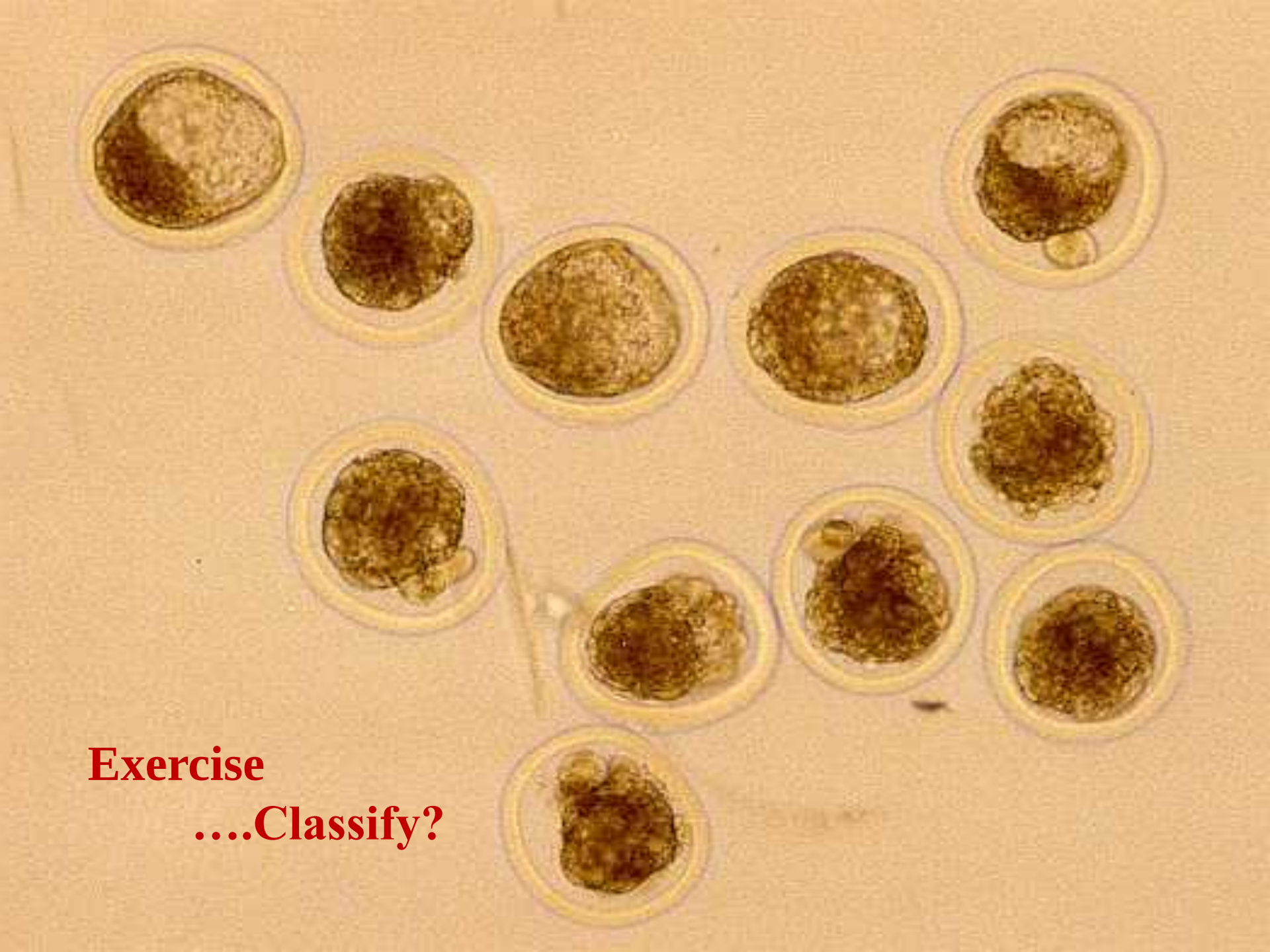


Cycle day: 7
Stage Code: 5
Quality Code: 2

Cycle day: 7
Stage Code: 5
Quality Code: 2

Cycle day: 7
Stage Code: 5
Quality Code:2

Cycle day: 7
Stage Code: 5
Quality Code: 3



Exercise

….Classify?

Embryo Transfer (ET):

- Limitations

Embryo transfer has failed to achieve the increased rates of genetic progress that had been predicted.

100 freezable embryos per donor per year

Because,

- *Not all potential donors respond positively to treatment*
- *On average about 60% of the embryos transferred result in pregnancies*

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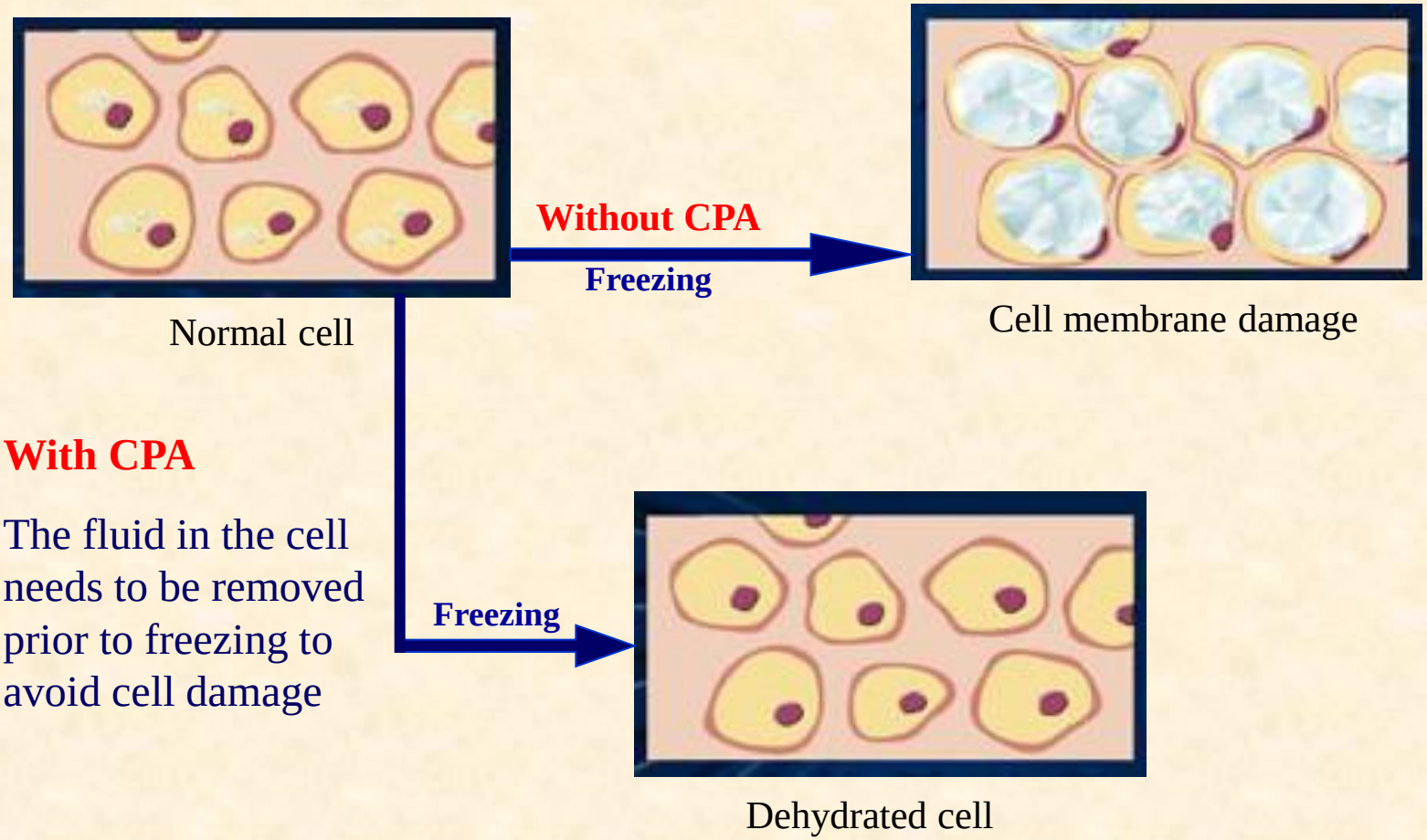
3- Cryopreservation:

- Is a process where cells or tissues are preserved by cooling to low sub-zero temperatures (-80°C or -196°C). At these low temperatures, any biological activity, including the biochemical reactions that would lead to cell death is effectively stopped.

Cryopreservation methods:

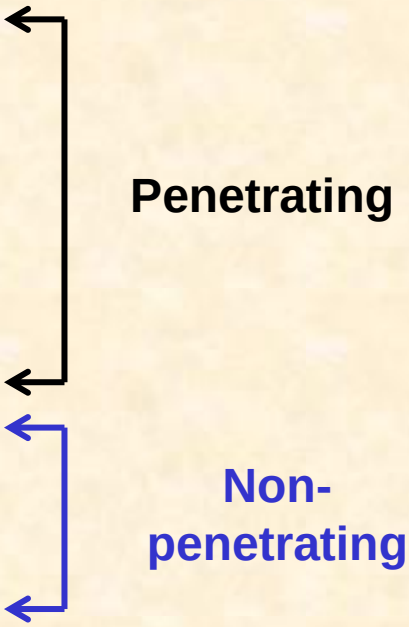
- Freezing (Slow and Rapid)

Role of Cryoprotectants :



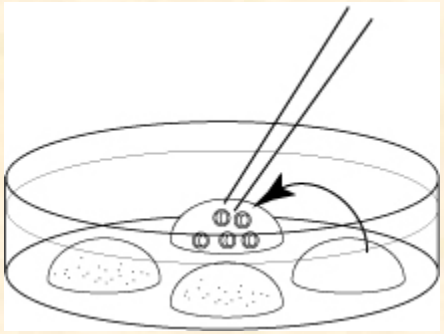
Types of Cryoprotectants :

- Glycerol
- Propanediol
- Dimethyl sulfoxde (DMSO)
- Ethylene glycol
- Sucrose
- Trehalose

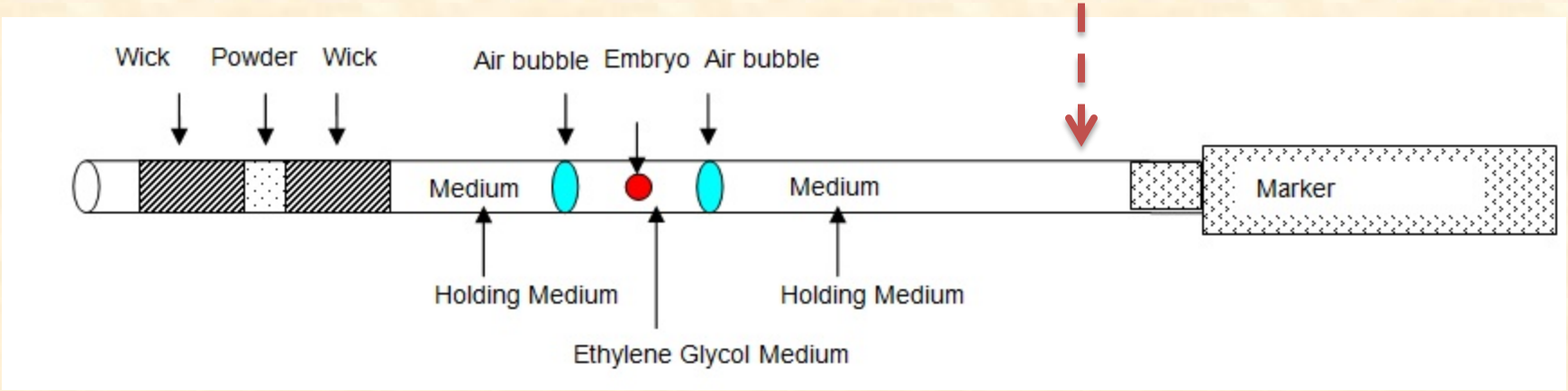


Embryo handling and freezing

- **Holding medium**
- **Freezing medium**



(Washing dish)
10 times



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