

● **LIVE** **CLASS 12th BIOLOGY**

BACKLOG **MARATHON** S E R I E S

1. Sexual Reproduction in Flowering Plants
2. Human Reproduction
3. Reproductive Health
4. Principles of Inheritance & Variation





Sexual Reproduction **in Flowering Plants**

Chapter-1

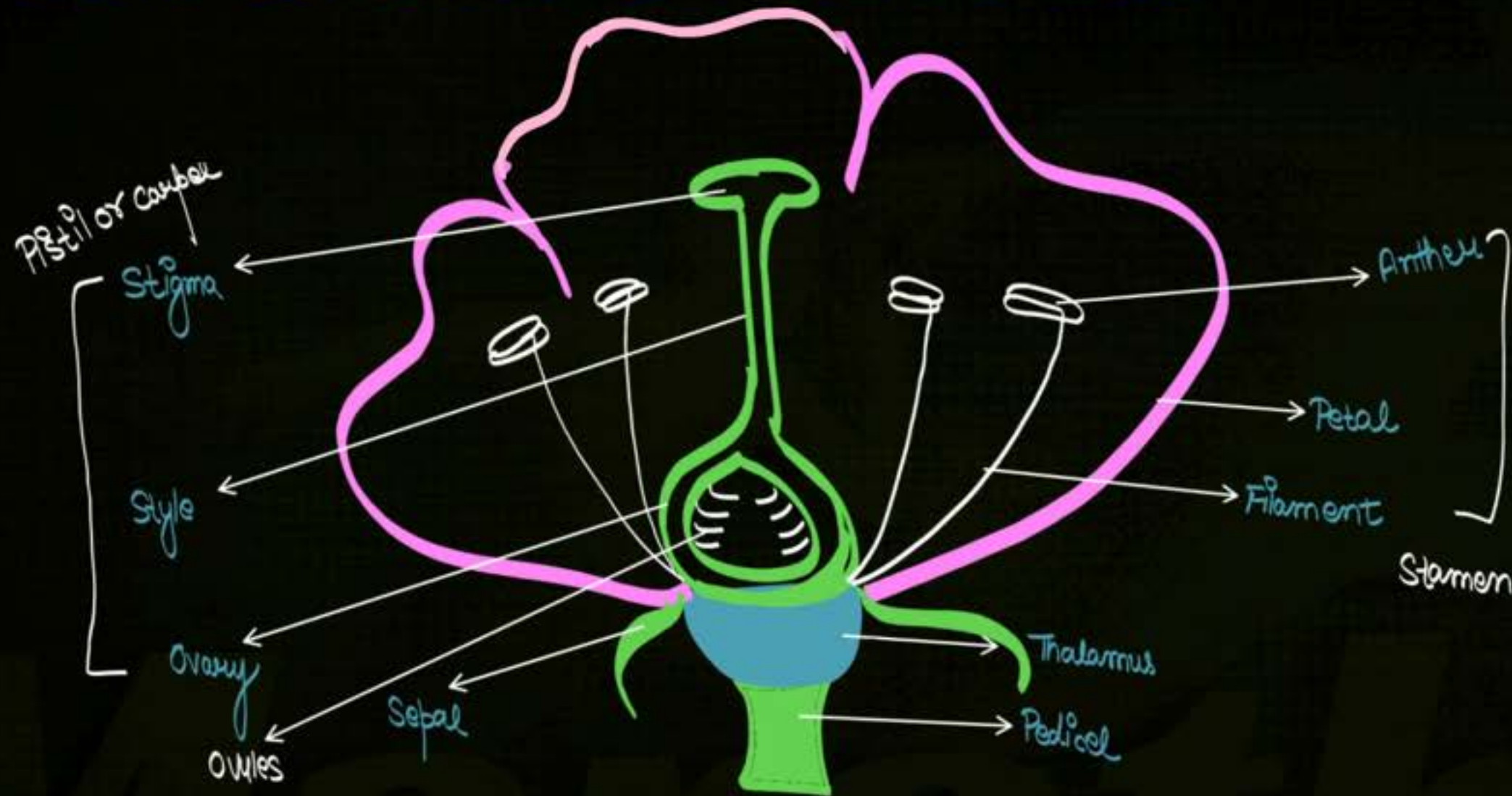
ANGIOSPERMS



Unique features of Angiosperms

- Fruit is present
 - Double Fertilization (Angiosperm)
 - Flower is a site for sexual reproduction.
- Ripened ovary ^{develops} → fruit

STRUCTURE OF FLOWER



whorl of sepals → calyx

whorl of petals → corolla

whorl of pistil or carpel → Gynoecium

whorl of stamens → Androecium

**To a biologist, flowers are morphological and embryological marvels
and site of sexual reproduction.**

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SEXUAL REPRODUCTION

Sexual reproduction involves the formation and fusion of gametes. It is a complex and slower process as compared to asexual reproduction.

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EVENTS OF SEXUAL REPRODUCTION

Pre-Fertilisation

(1) Gametogenesis
process of formation of gametes.

male gamete → microsporangogenesis
female gamete → megasporangogenesis

Fertilisation

fusion of male & female gamete
(Double fertilisation)

(2) Pollination (Transfer of gamete)

Post -Fertilisation

ovule → seed
ovary → fruit
zygote → embryo

PRE-FERTILIZATION STRUCTURES AND EVENTS :

Pre-fertilization events include gametogenesis and gamete transfer.

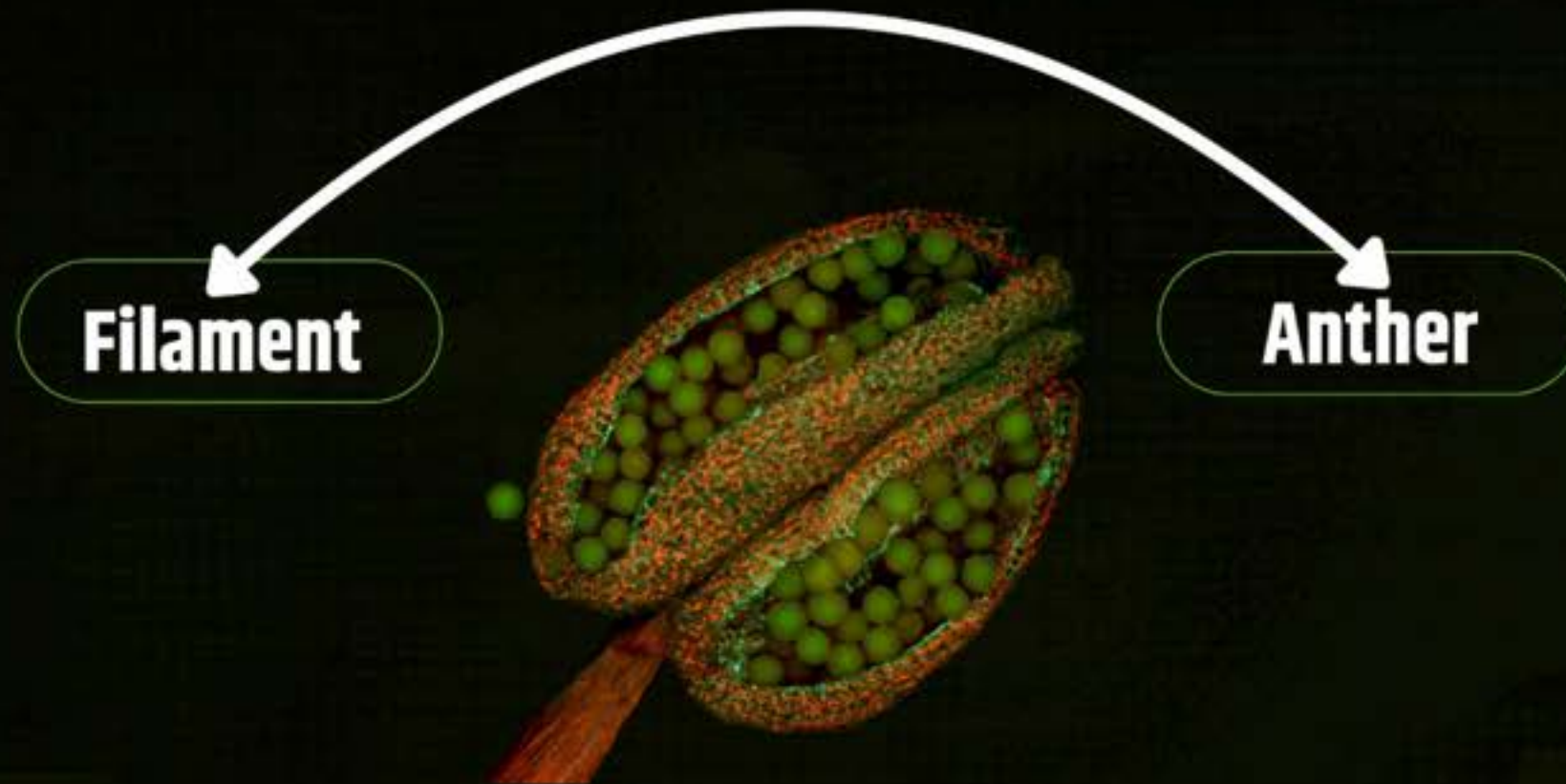
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MALE REPRODUCTIVE WHORL – ANDROECIUM

- Male reproductive organ is called androecium consists of a whorl of stamens.
- The number and length of stamens are variable in flowers of different species.

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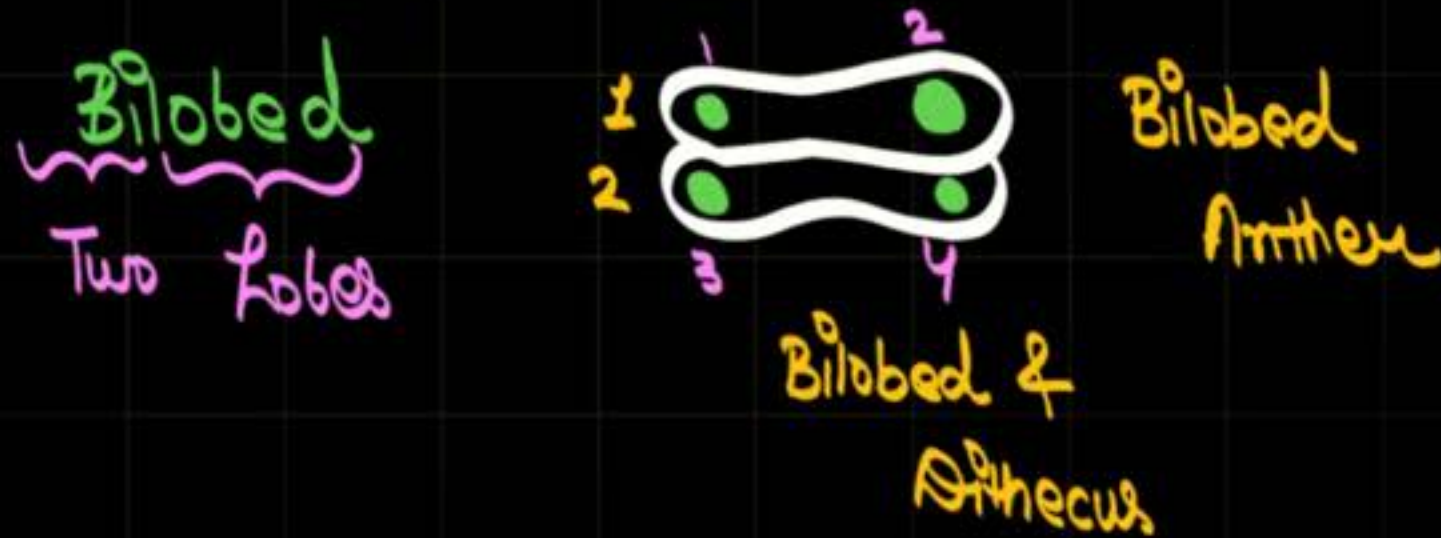
A TYPICAL STAMEN IS DIFFERENTIATED INTO TWO PARTS



STRUCTURE OF STAMEN



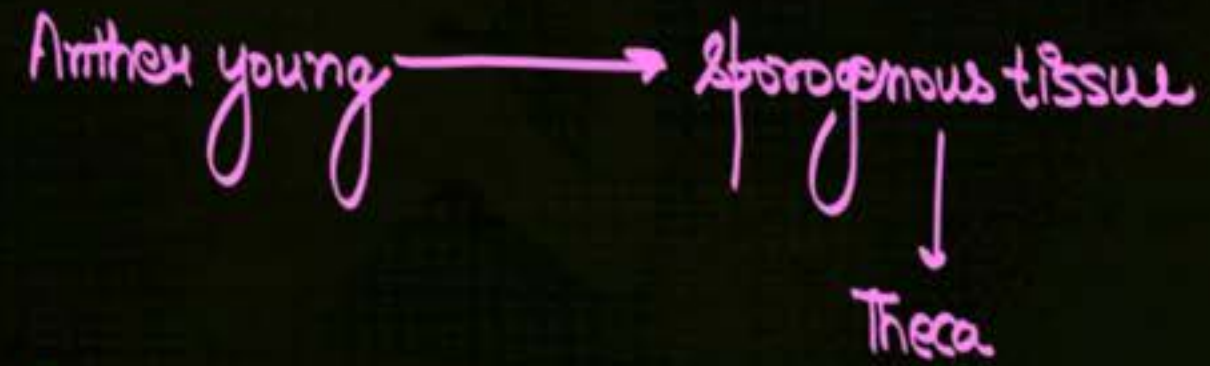
- The proximal end of filament is attached to the thalamus or the petal.
- A typical angiosperm anther is bilobed with each lobe having two theca i.e. they are dithecous.
- Often a longitudinal groove runs lengthwise separating the theca.



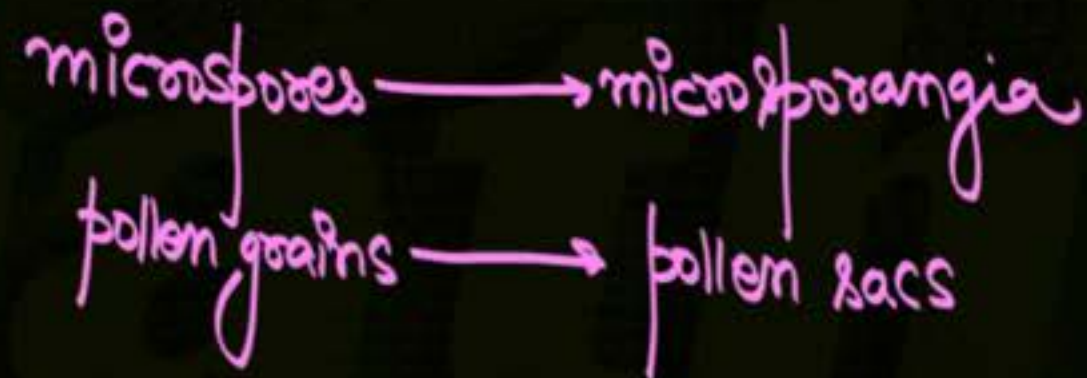


PRARAMBH 2.0

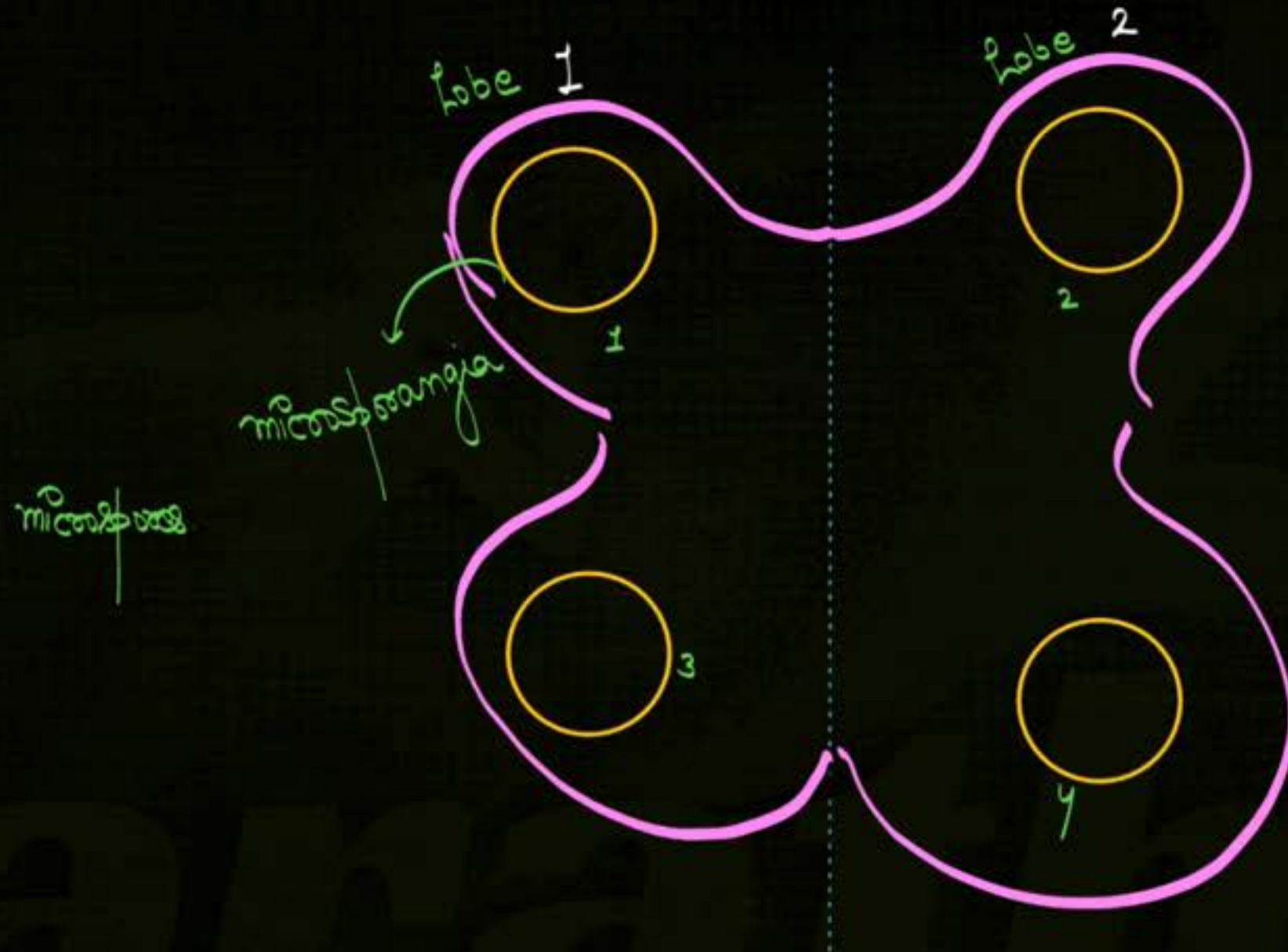
- The anther is consisting of four microsporangia located at the corners, two in each lobe.
- The microsporangia develop further and become pollen sacs, they extend longitudinally all through the length of an anther and are packed with pollen grains.



Anther mature



T.S. OF ANTHER



LAYERS

Microsporangium is generally surrounded by four different wall layers.

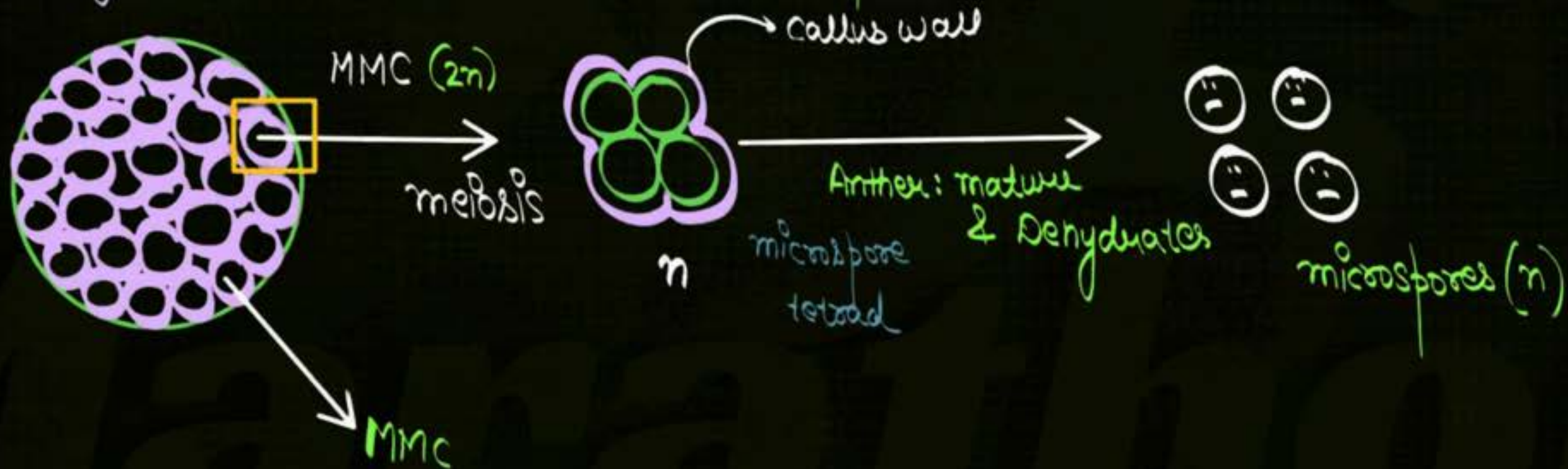
- Epidermis (Outermost)
- Endothecium
- Middle layer
- Tapetum (Innermost layer) ★ or nutritive layer (It provide nourishment to developing pollen grains)

MICROSPOROGENESIS

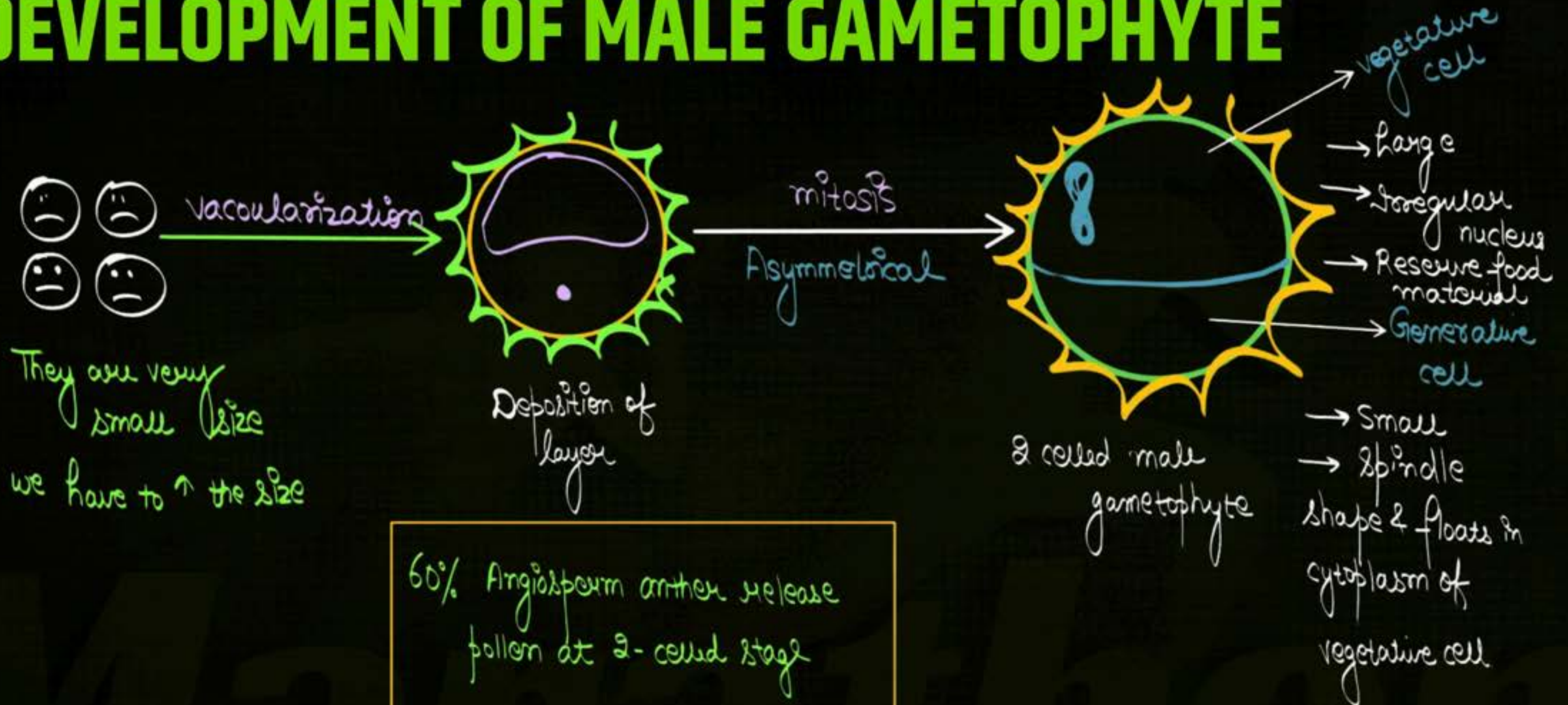
It is the process of formation of microspores

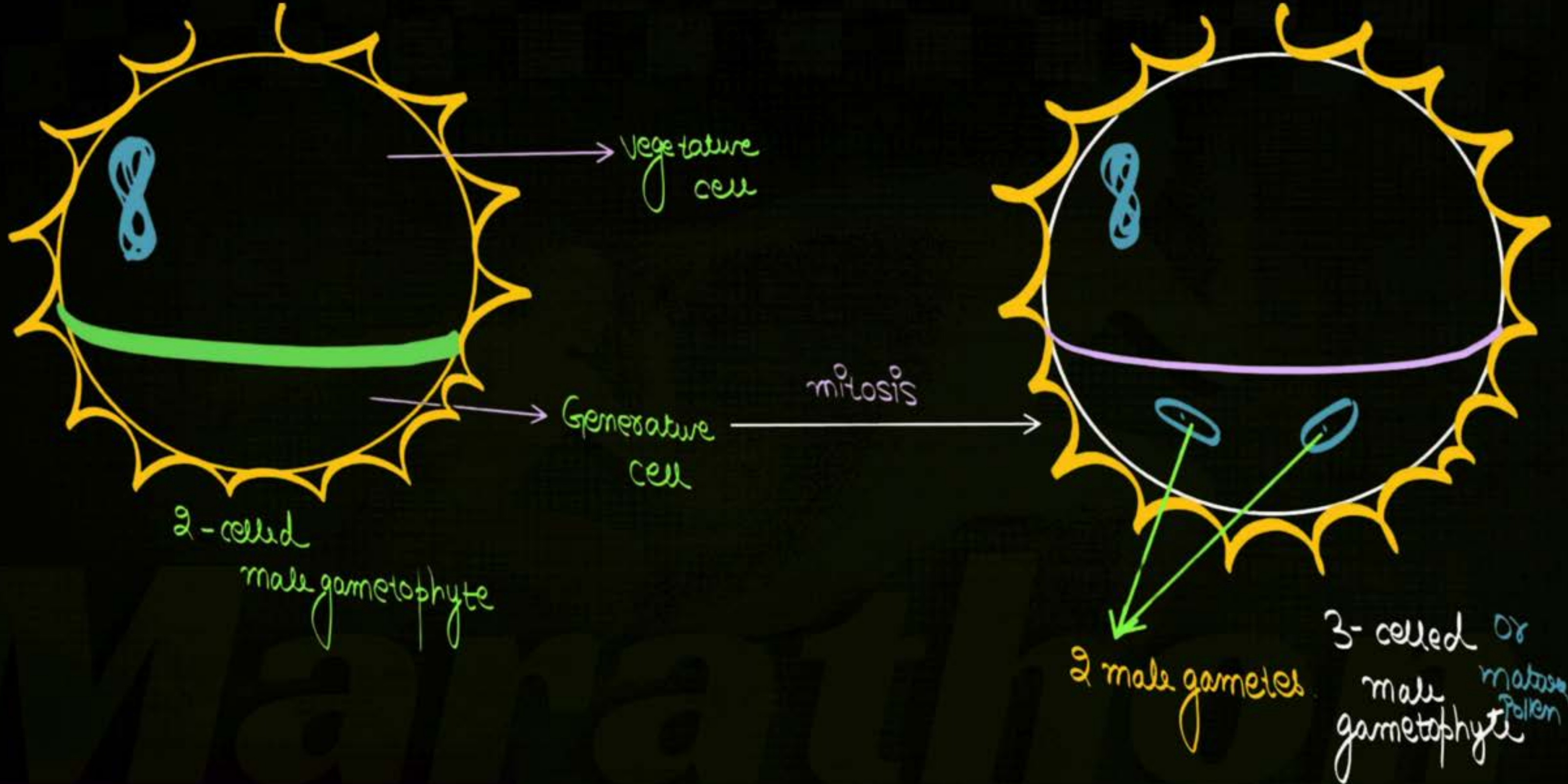
from MMC (microspore mother cell)
or PMC (Pollen mother cell)

microspores formation
Sporogenous tissue cell $\rightarrow$ MMC (microspore mother cell)



DEVELOPMENT OF MALE GAMETOPHYTE





2 celled male gametophyte → 1 Generative cell
1 vegetative cell

3 celled male gametophyte → 1 vegetative cell
2 male gametes.

NOTE

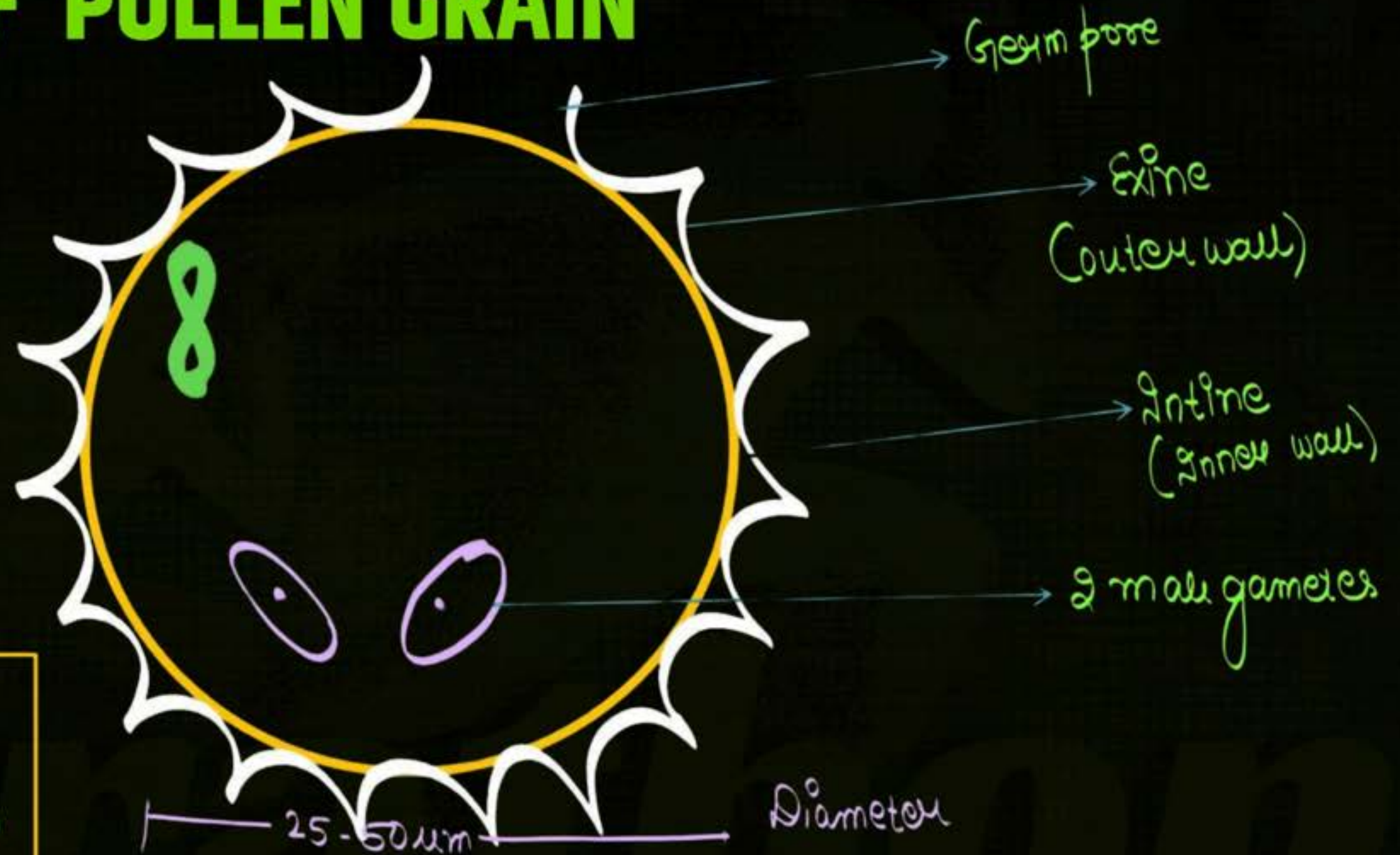
Pollen grain → It represent male gametophyte

STRUCTURE OF POLLEN GRAIN

Exine — Intine —
Sporoderm

Exine: Thick, Discontinuous
Sporopollenin

Intine: Continuous, made up of
cellulose & pectin





Sporopollenin: most resistant organic matter known.

Physical: ↑ Temperature
↑ Pressure

Chemical: Strong acid
Strong alkali

Enzyme

AERO-ALLERGENS

Pollen grains of many species which are present in the air cause allergy and bronchial afflictions – are called "aero allergens" e.g. Chenopodium, Parthenium (carrot grass)





In some people allergic pollens cause chronic respiratory disorders - asthma, bronchitis etc.

Parthenium that came into India as a contaminant with imported wheat has become ubiquitous in occurrence and cause pollen allergy.

Common

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POLLEN TABLETS & SYRUPS

Pollen grains are nutrient-rich and are increasingly used as food supplements. Many pollen-based products (like tablets and syrups) are widely available, especially in Western countries. Pollen consumption is believed to enhance performance in athletes and racehorses.



VIABILITY OF POLLEN GRAINS

In some cereals such as rice and wheat, pollen grains lose viability within 30 minutes of their release, and in some members of rosaceae, leguminoseae and solanaceae, they maintain viability for months. The period for which pollen grains remain viable is highly variable and to some extent depends on the prevailing temperature and humidity.



Factors

→ Reserve Food material

→ Temperature

→ Humidity.

viable pollen: produce pollen tube

Cryopreservation:

to prolong pollen
viability

★ Stored at -196°C liquid Nitrogen

Technique: Cryopreservation

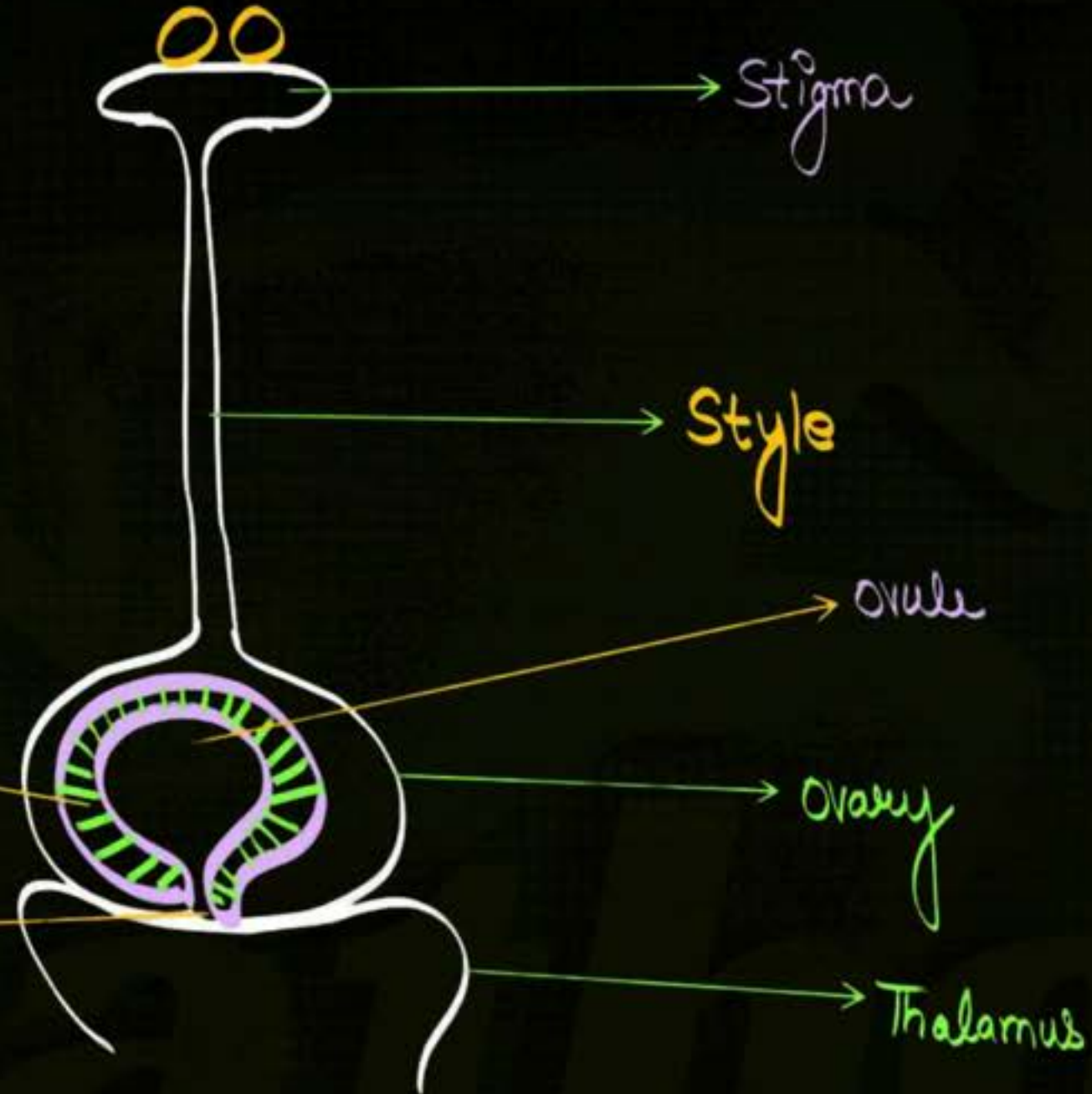
THE PISTIL or Carpel

Gynoecium: If gynoecium consist
whole of carpel or pistil
or pistil

monocarpellary

locule or
chamber

Placenta
(nourishment)



If gynoecium consist
more than one carpel
multicarpellary

Multicarpellary (multiple carpels)

If carpels are 
fused together

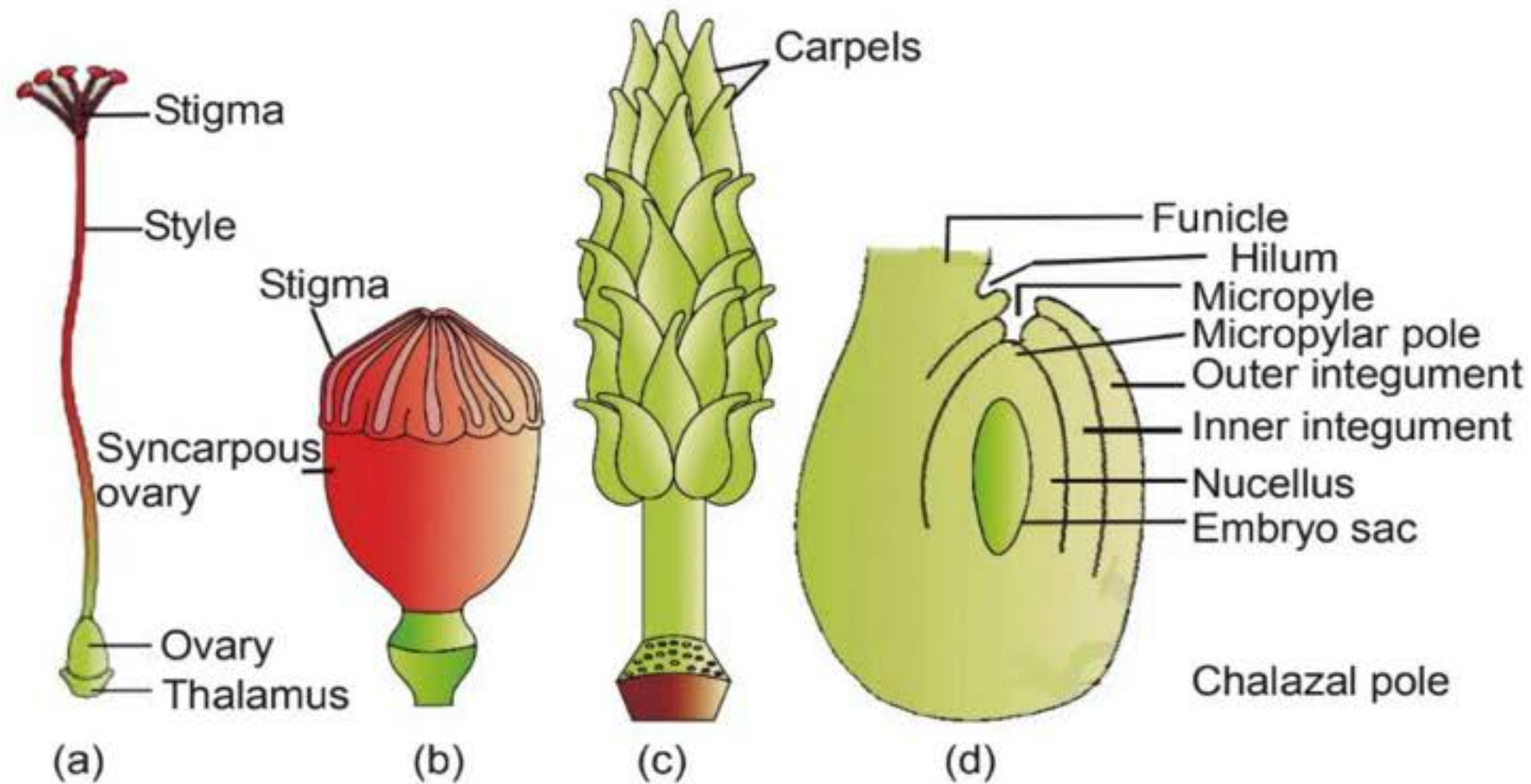
Syncarpous

ex:- china rose & papaver (poppy)

If carpels are 
free

Apocarpous

ex:- Michelia

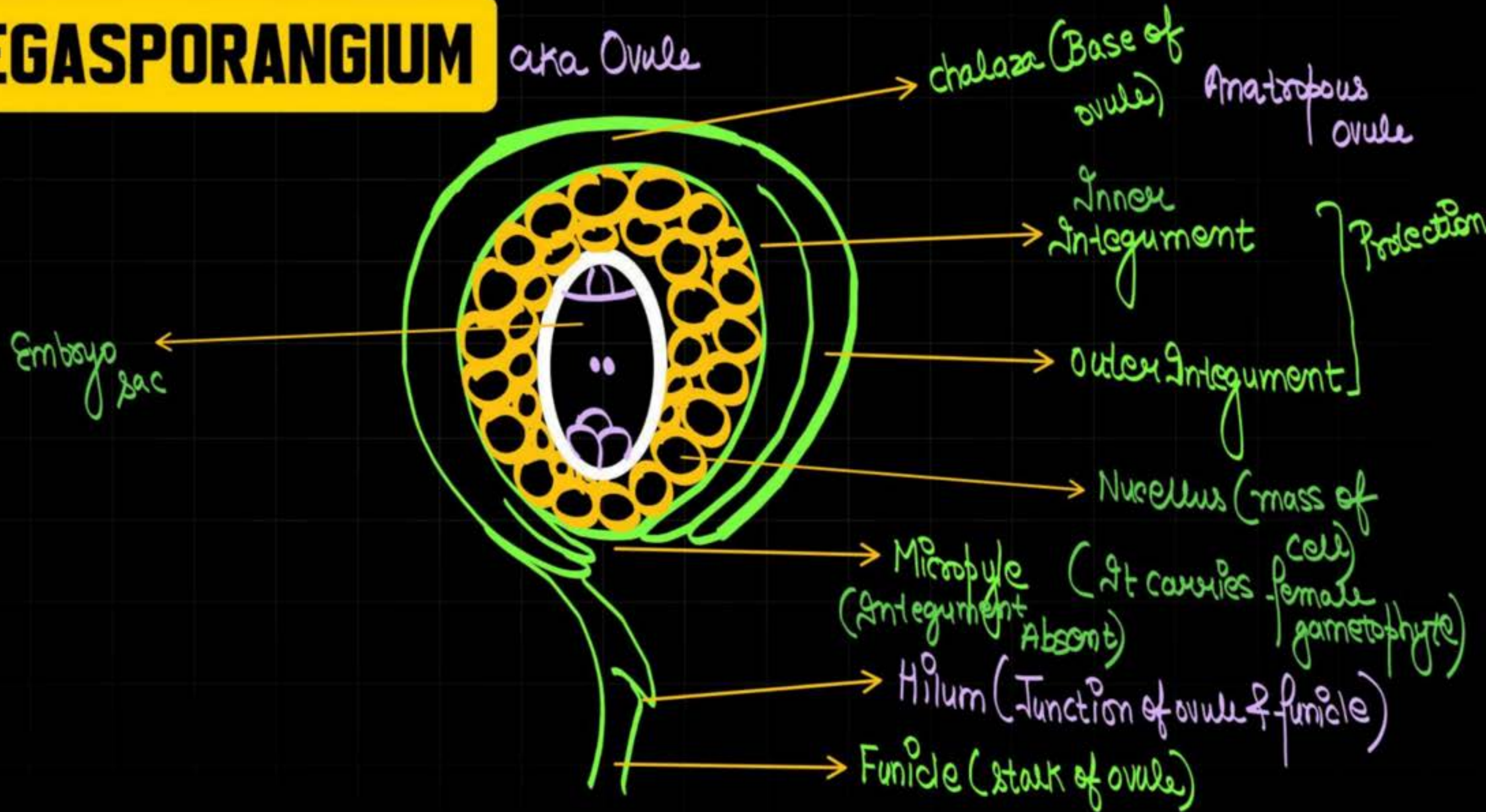


(a) A dissected flower of *Hibiscus* showing pistil (other floral parts have been removed);
 (b) Multicarpellary, syncarpous gynoecium (pistils) of *Papaver*; (c) A multicarpellary,
 apocarpous gynoecium of *Michelia*; (d) A diagrammatic view of a typical anatropous ovule



MEGASPORANGIUM

aka Ovule



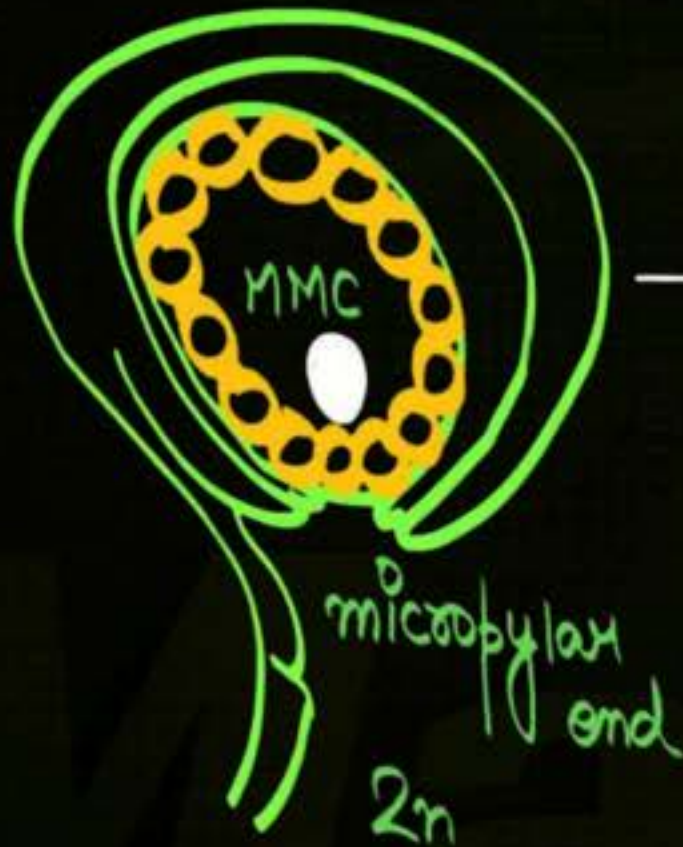


MEGASPOROGENESIS

It is the process of formation of megaspores from MMC (megaspore mother cell)

megaspores

formation

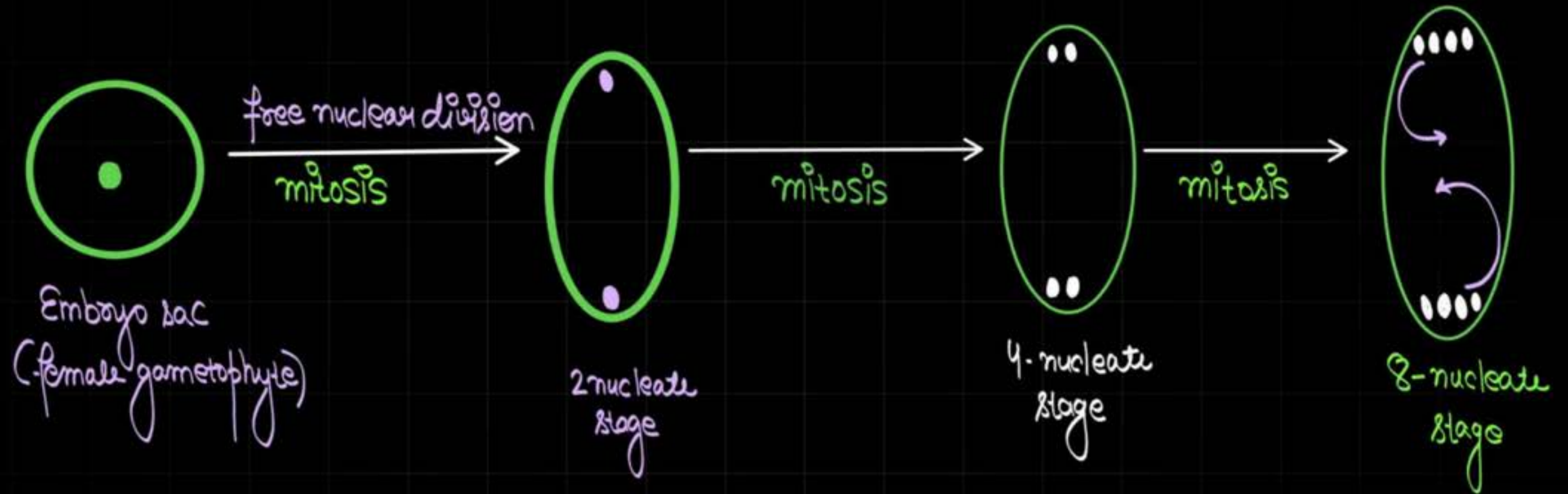


Meiosis
(Reduction Division)



only one functional megaspore
megaspores towards chalazal end
towards microphyll end degenerate

functional megaspore →
Embryo sac (female gametophyte)

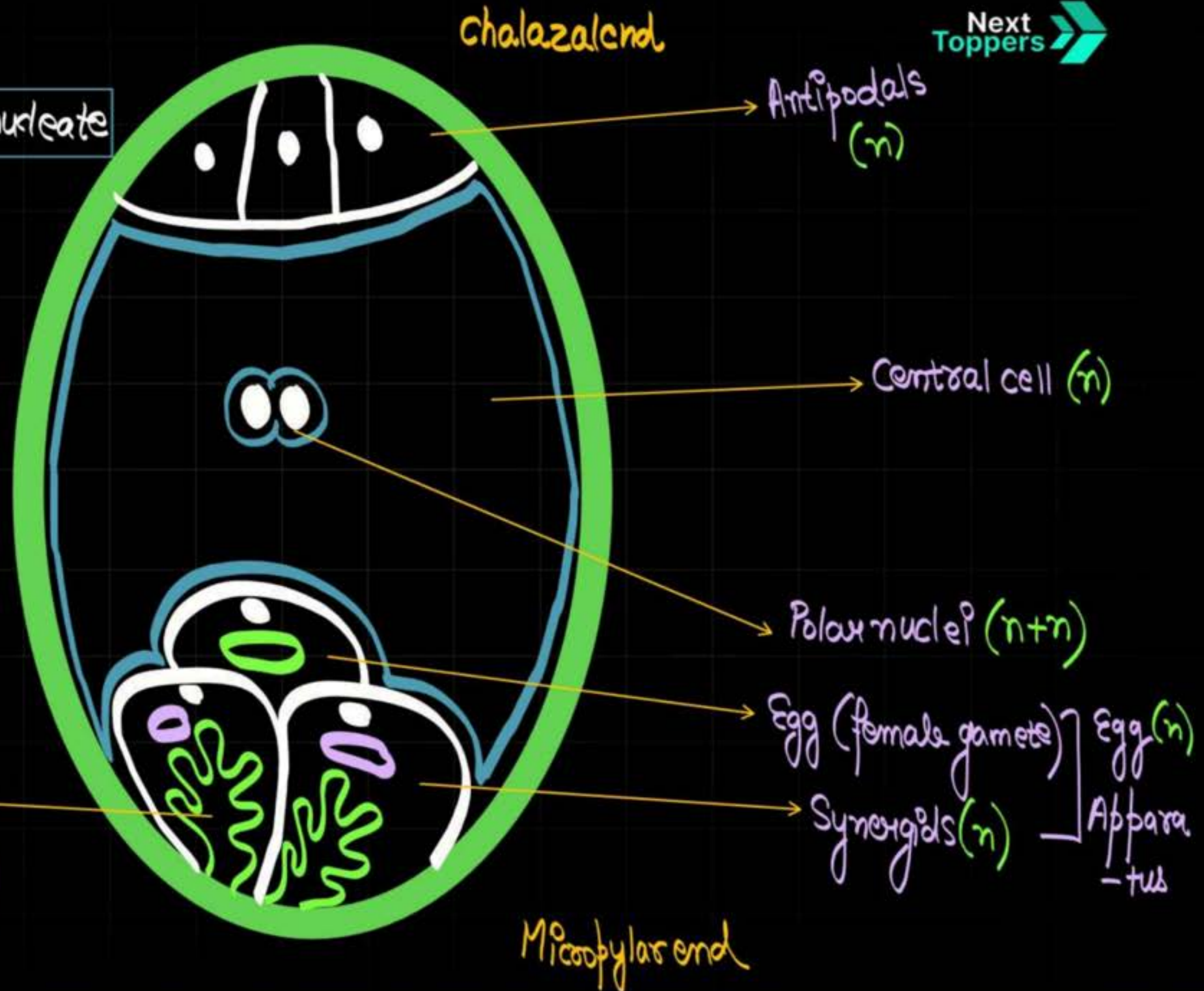


Mature Embryo sac : 7 celled - 8 nucleate

Monosporic Development:
Single megaspore involved in
- formation of Embryo sac

secrete chemical that guide
pollen tube in synergids

Filiform Apparatus
(finger like projections)



POLLINATION

Transfer of pollen grain from Anther to the stigma

Pollination {
 → Self pollination (Autogamy)
 → Cross pollination (Xenogamy)



TYPES OF POLLINATION

AUTOGAMY:

(Self pollination)

Transfer of pollen grain from Anther to the stigma of same flower
(Bisexual flower)

GEITONOLOGY:

Transfer of pollen grain from anther to the stigma of Different flower but same plant

XENOLOGY:

Cross pollination

Transfer of pollen grains from anther to the stigma of Different flower, different plant but same species.

Geitonogamy

Functionally $\longrightarrow$ similar to cross pollination (need pollinating agent)

Genetically $\longrightarrow$ similar to self pollination



ADAPTATIONS FOR SELF POLLINATION :

Inbreeding devices

(i) Monocliny (Bisexuality) : Flowers are Bisexual

(ii) Homogamy :- Both sex organs mature at same time

(iii) Cleistogamy :- Commelina, Viola (common pansy), Oxalis

(Inbreeding device)

1. cleistogamous : They don't open at all (ensure self pollination)

2. chasmogamous : These flower can open (ensure cross pollination)

(Outbreeding device)

Advantage of self pollination → Assured seed set

Disadvantage of self pollination → Less Genetic Variability

OUTBREEDING DEVICES

ensure cross pollination

Dicliny (Unisexuality) → Flowers are Unisexual

1. Pistillate flower (only pistils)
2. Staminate flower (only stamens)

Dichogamy → Both sex organs don't mature at same time

Heterostyly (morphological barrier) Difference in length of stamens or pistil

Self sterility or self-incompatibility (Genetic Barrier) → prevent the fertilization of ovum by self pollen by inhibiting pollen grain germination & pollen tube formation.

Advantage: ↑ Genetic Variability

Monoecious

One home

Pistillate flower
Staminate flower

Two Different flower but
same plant

Autogamy: X

Geitonogamy: ✓

Dioecious

Two home

Two different flower but different plant.

Autogamy: X

Geitonogamy: X

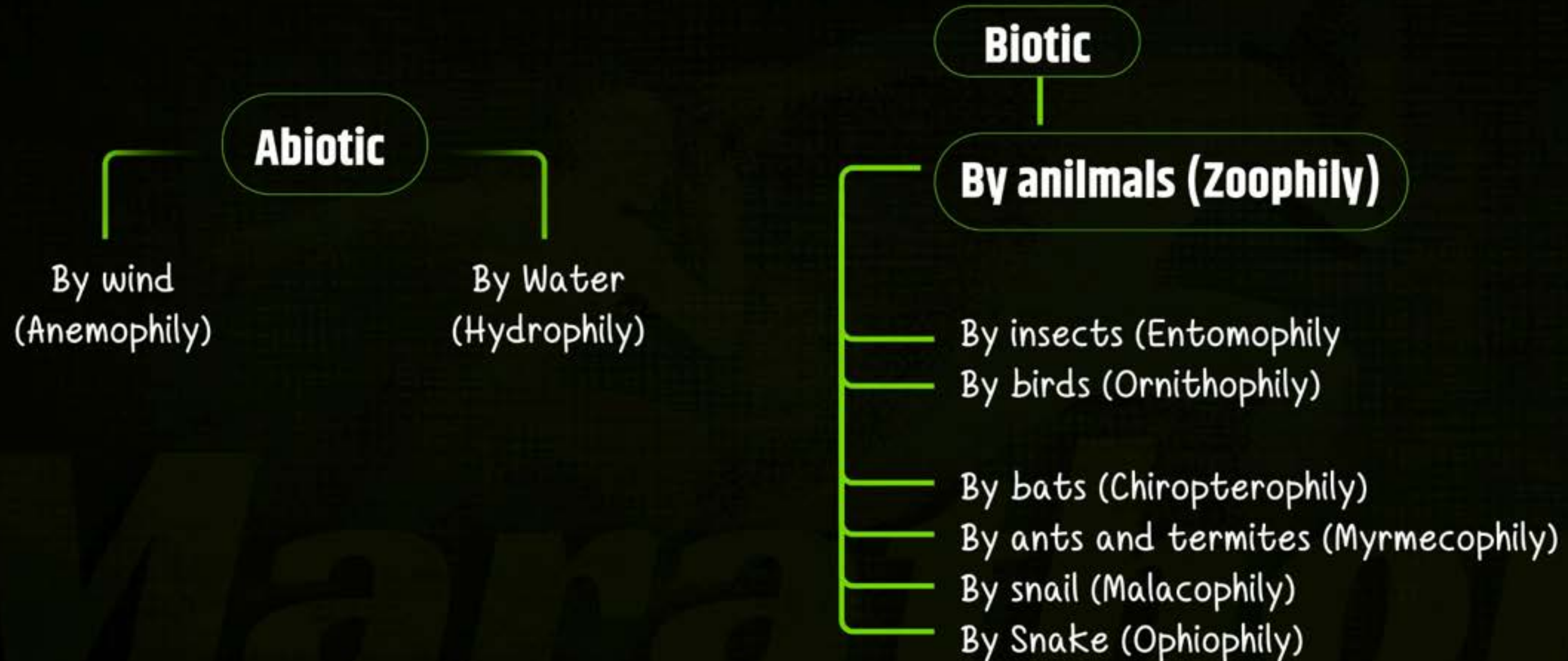


POLLINATING AGENTS

- Plants use two abiotic (wind and water) and one biotic (animals) agents to achieve pollination.
- Majority of plants use biotic agents for pollination.

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AGENT OF POLLINATION





ANEMOPHILY:

wind pollination

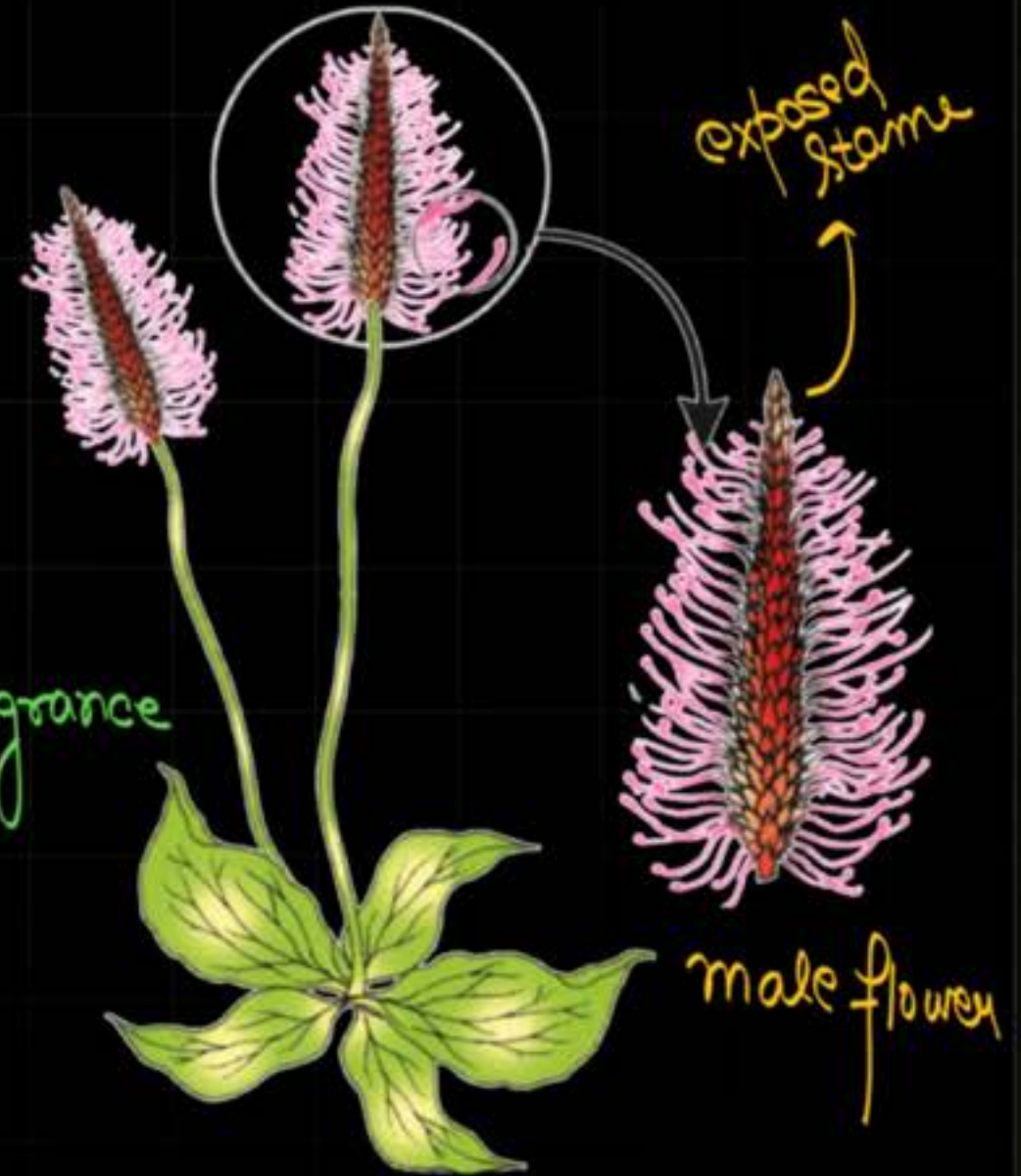
Flower → Anemophilous flowers

NOTE

Transfer of pollen from anther to the stigma is a chance factor to compensate the losses pollen grains are produce in enormous amount in wind & water pollination

Adaptations:

- pollen grains are dry & non-sticky
- Flowers are small, Unattractive, ^{no} fragrance, no nectar.
- well exposed stamens.
- Reduced calyx & corolla



→ Anther: Versatile

→ Stigma: Feathery stigma (trap pollen grains from wind)

eg: wind pollination is common in grass

→ Date palm

→ Coconut

→ Sugarcane

Maize plant

Tossels → Male Reproductive flower

Silk → Female Reproductive flower



↓
Stigma
(trap the
pollen grain
from the wind)



HYDROPHILY:

(water pollination)

rare in Angiosperm

common

Algae / Bryophytes / Pteridophytes

Flower → Hydrophilous flower.

Water pollination

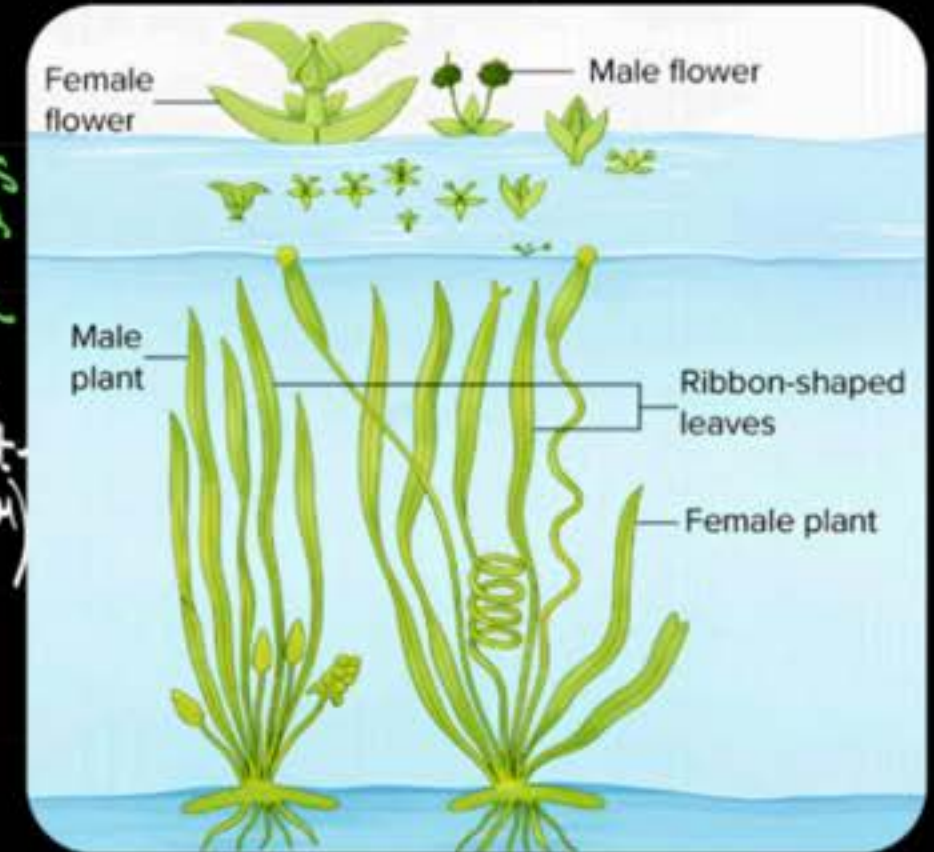
Epiphydrophily

pollination takes place on the surface of water
eg:- Vallisneria (freshwater)

Hypohydrophily

pollination takes place inside the water

eg:- marine seagrass - or
zostera, Hydrilla
(fresh water - ex)



Adaptation

- long & ribbon like
- Unwetttable, mucilaginous sheath
(most of water pollinated species)

eg: Lotus, water hyacinth, waterlily
Eichhornia
wind or insect pollination

ENTOMOPHILY:

Insect pollination

Flower : Entomophilous flowers.

Adaptations

- Large flowers
- Attractive flowers (Bright colour petals)
- Fragrance (attract visitors)
- Nectar (Reward)
- Sticky pollen grains

Beetles & flies → flower
produce
foul odour

→ Reward can be safe space to lay eggs

eg:- Amorpha pharous, moth & yucca plant
(6ft height)

pollination
takes
place.

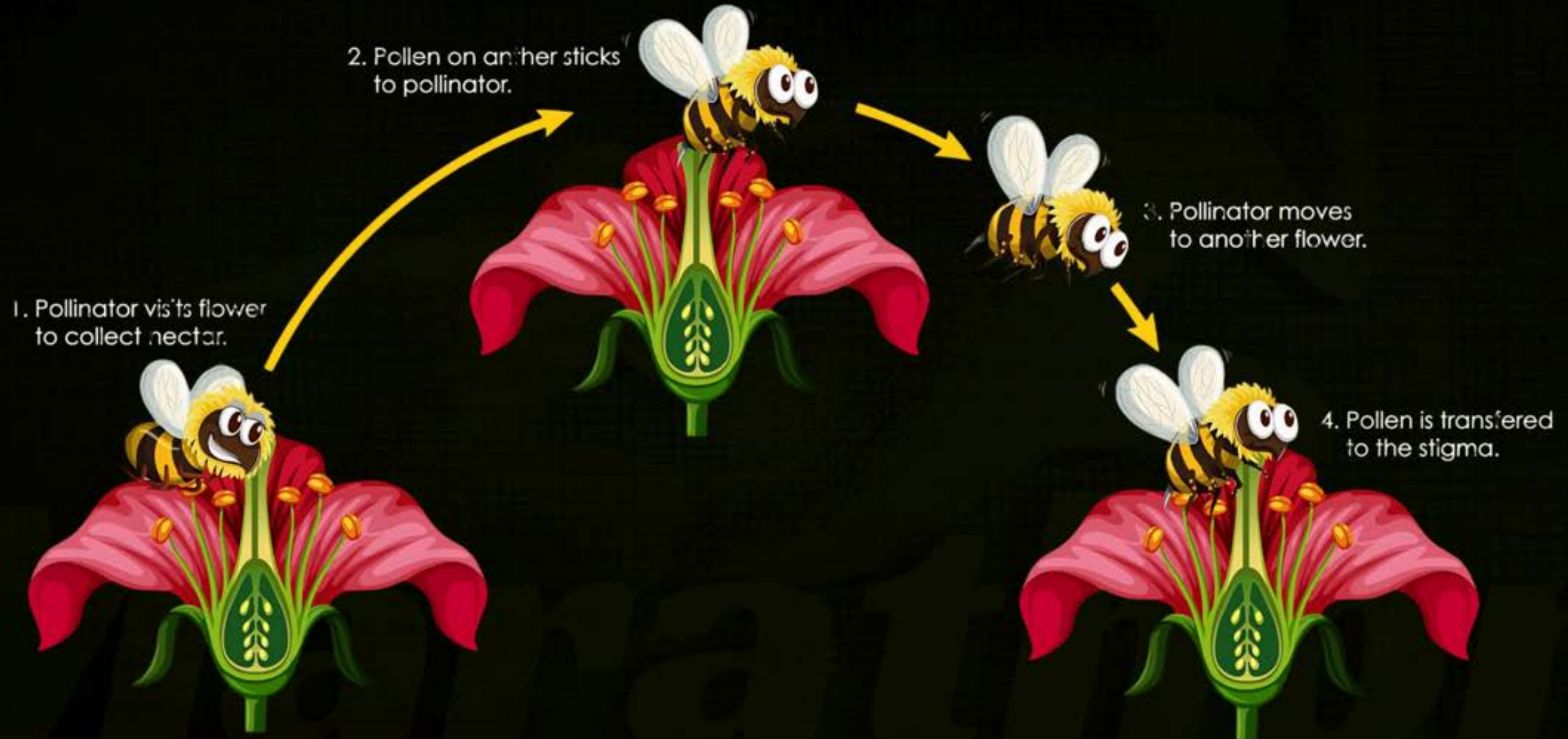
safe space (ovary loculi)
Provide to lay
eggs

moth & yucca plant



Amorphophallus (height - 6ft)

HOW INSECT POLLINATION TAKES PLACE ??



Larger Animals (zoophily)

- Arboreal (Tree-dwelling)
- Lemur (Primates)
- Rodents
- Lizards (Gecko & lizard)

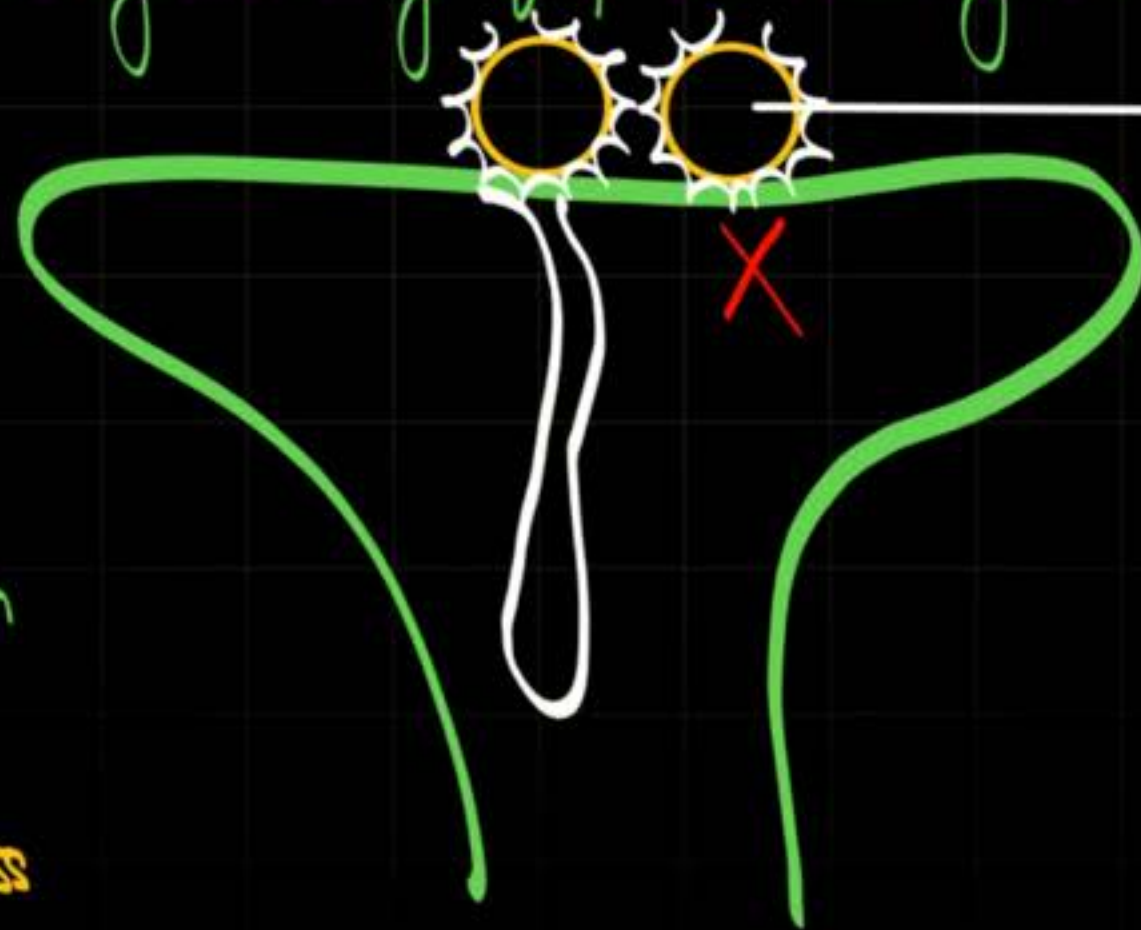
POLLEN - PISTIL INTERACTION :-

All the events including landing of pollen on stigma, entry of pollen tube inside ovule

Pistil recognize pollen
due to continuous chemical

Dialogue (interaction) between
pollen & pistil

→ It is dynamic process



Incompatible or
wrong type

(foreign species or self pollen)

by inhibiting pollen germination
& pollen tube

ARTIFICIAL HYBRIDISATION

Crop Improvement program



Disease
Resistant



High yield

Hybrid

ARTIFICIAL HYBRIDISATION

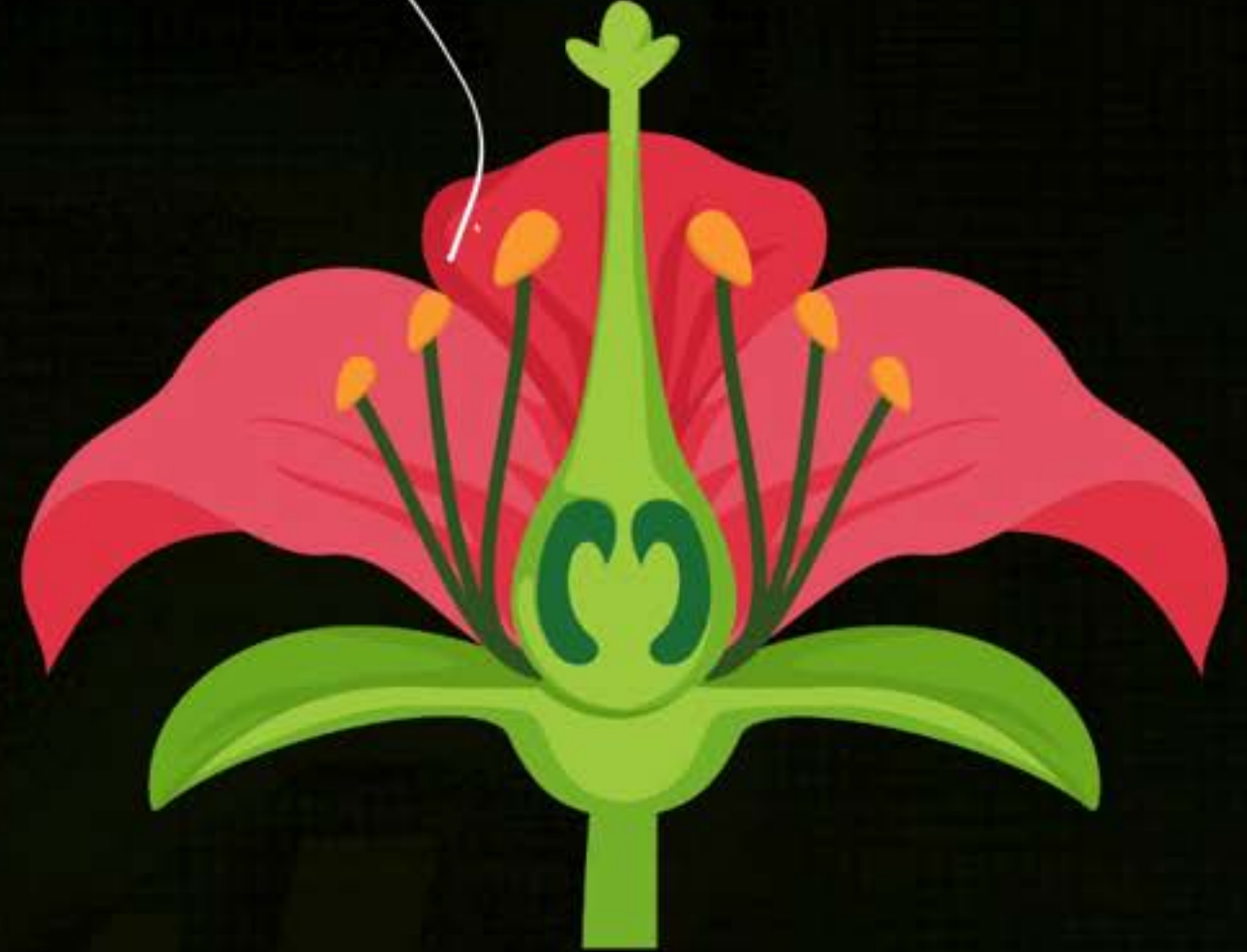
- Removal of anthers from the flower bud before the anther dehisces using a pair of forceps is necessary. This step is referred to as emasculatation.
- Emasculated flowers have to be covered with a bag of suitable size, generally made up of butter paper, to prevent contamination of its stigma with unwanted pollen. This process is called bagging.

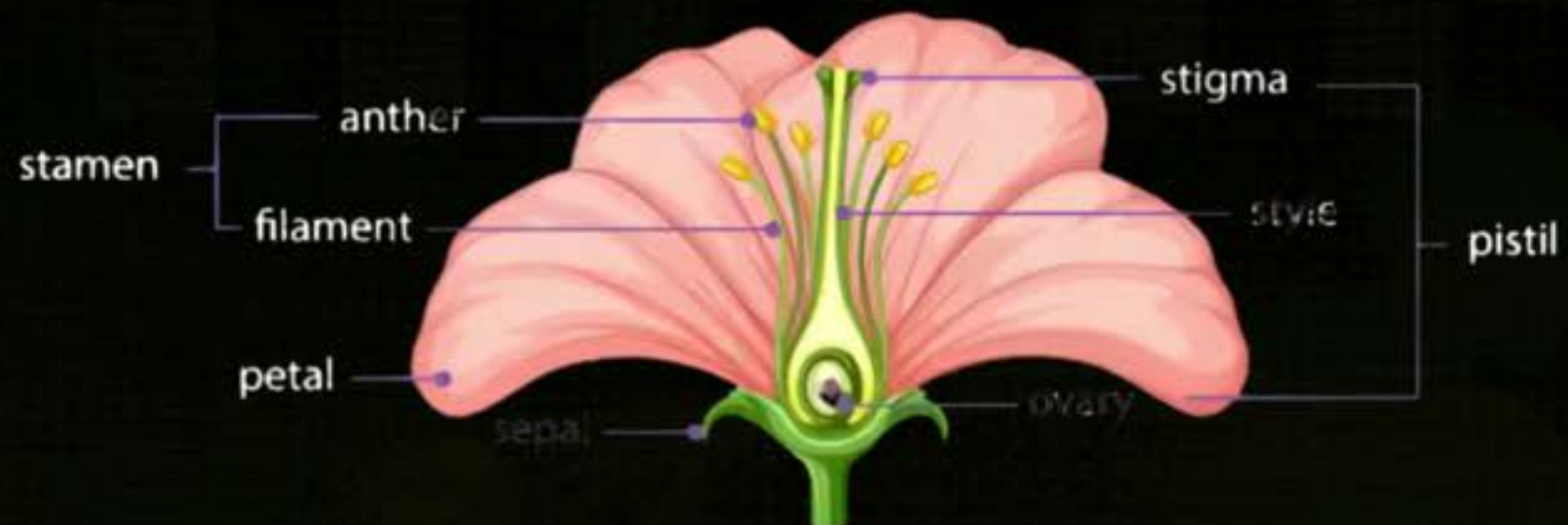
① Emasculation

② Bagging

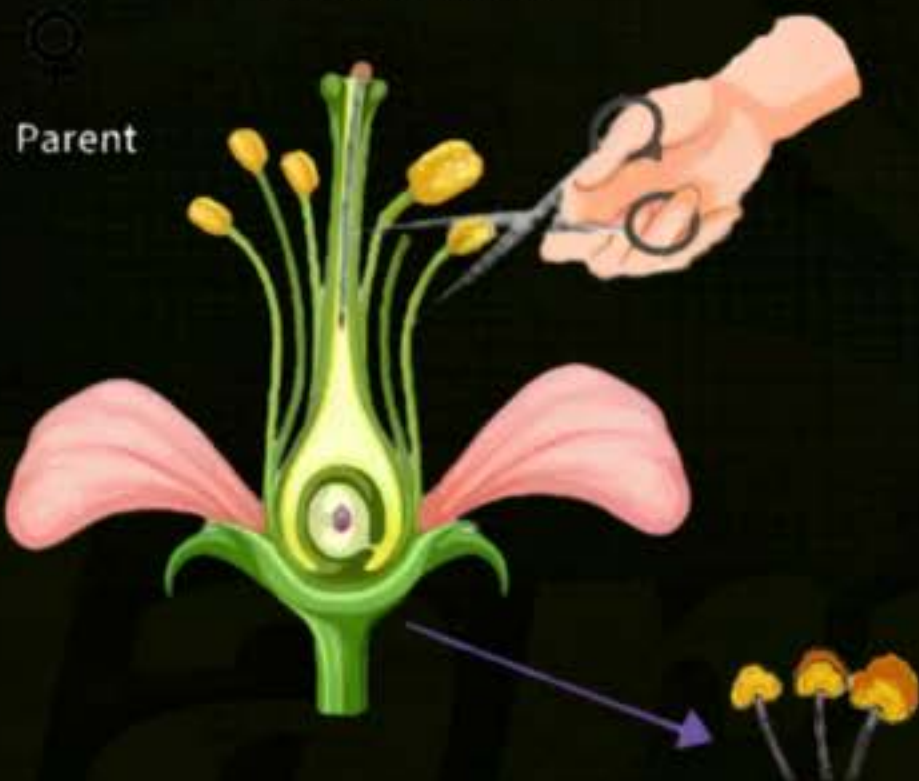


Bisexual flower





Removal of Anthers
(Emasculation)



Transfer of Pollen
(Pollination)

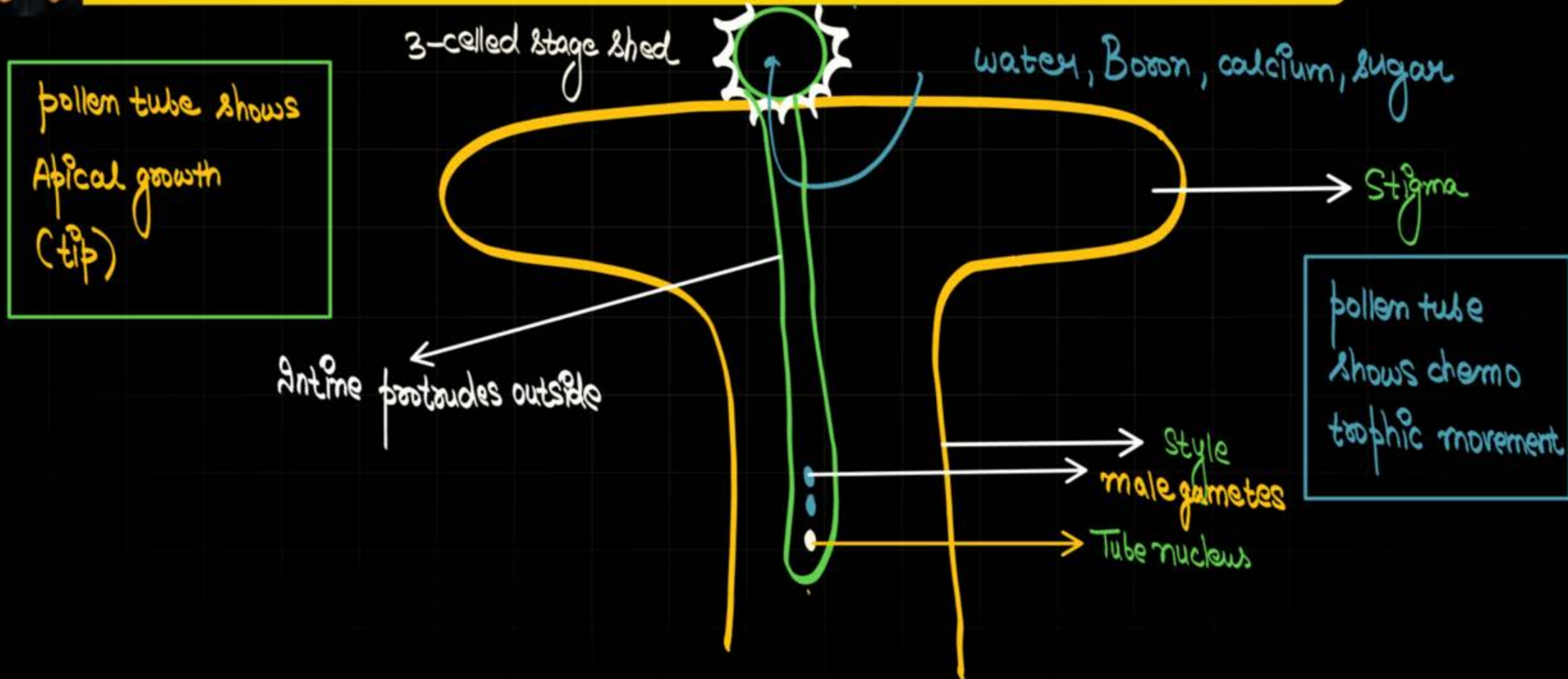


FERTILIZATION

- Germination of pollen on stigma
- Entry of pollen tube Inside Ovule
- Entry of pollen tube Inside Embryo sac
- Fusion of gametes

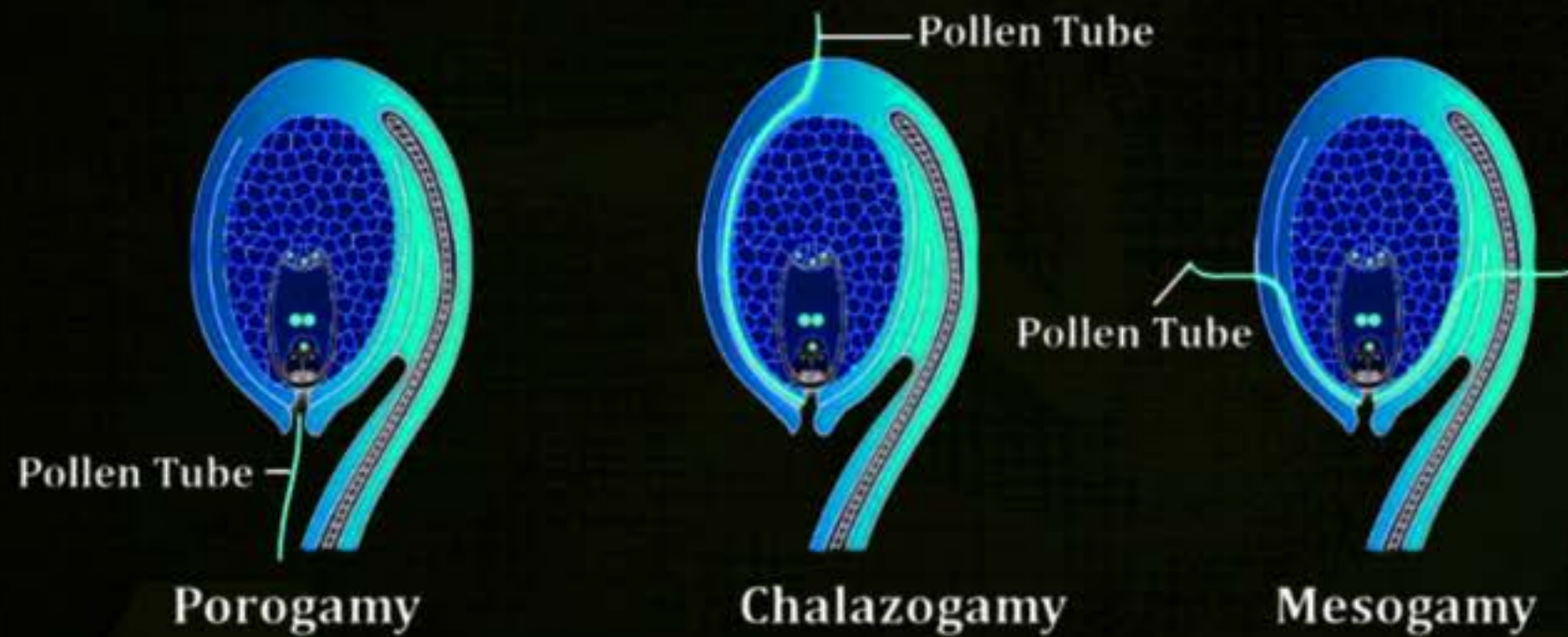


GERMINATION OF POLLEN GRAINS ON STIGMA :-



ENTRY OF POLLEN TUBE INTO OVULE

- A mature ovule in which embryo sac has also matured, has three paths for the entry of pollen tube:-



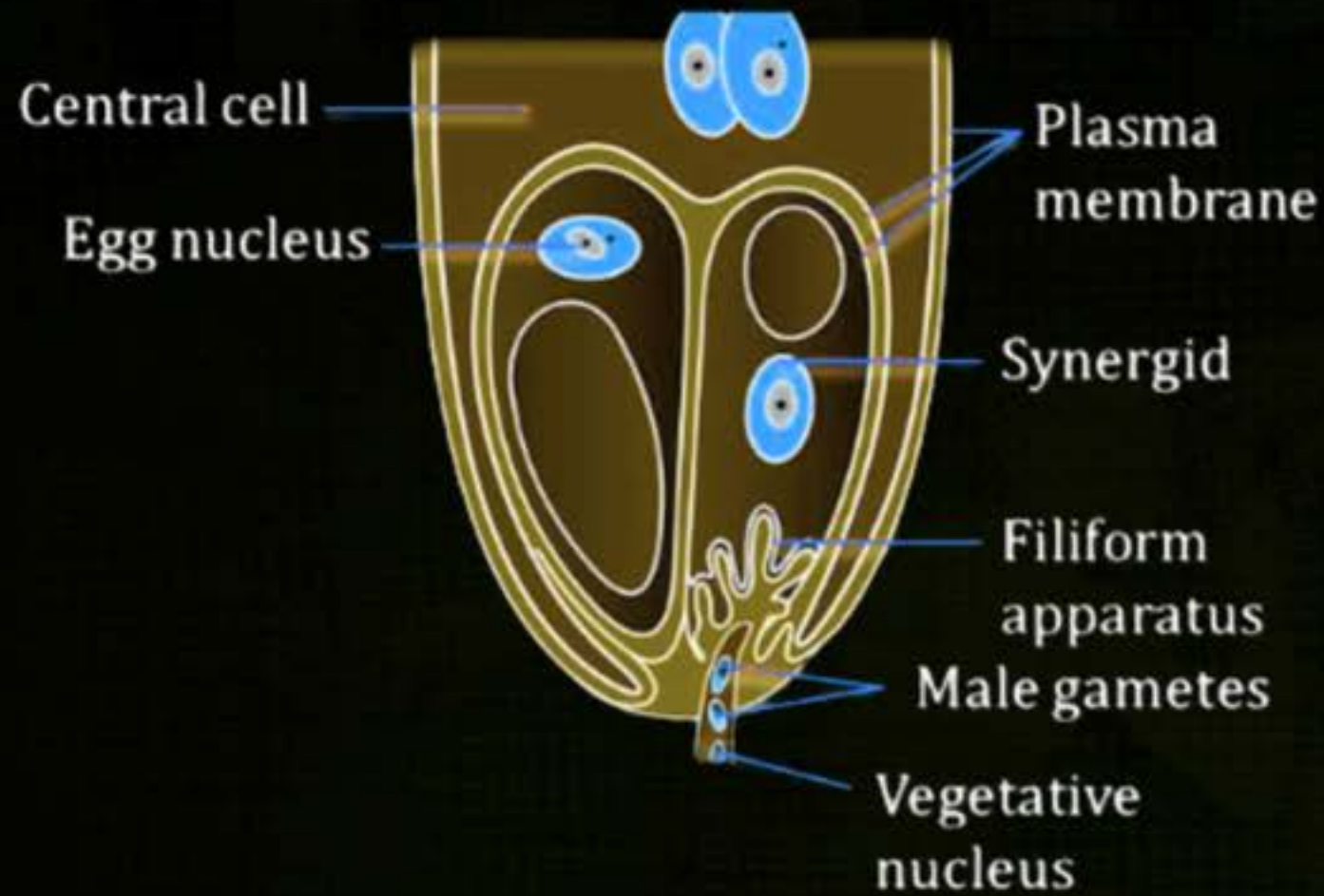
Various methods of entry of pollen tube into the ovule

ENTRY OF POLLEN TUBE INTO EMBRYOSAC :-

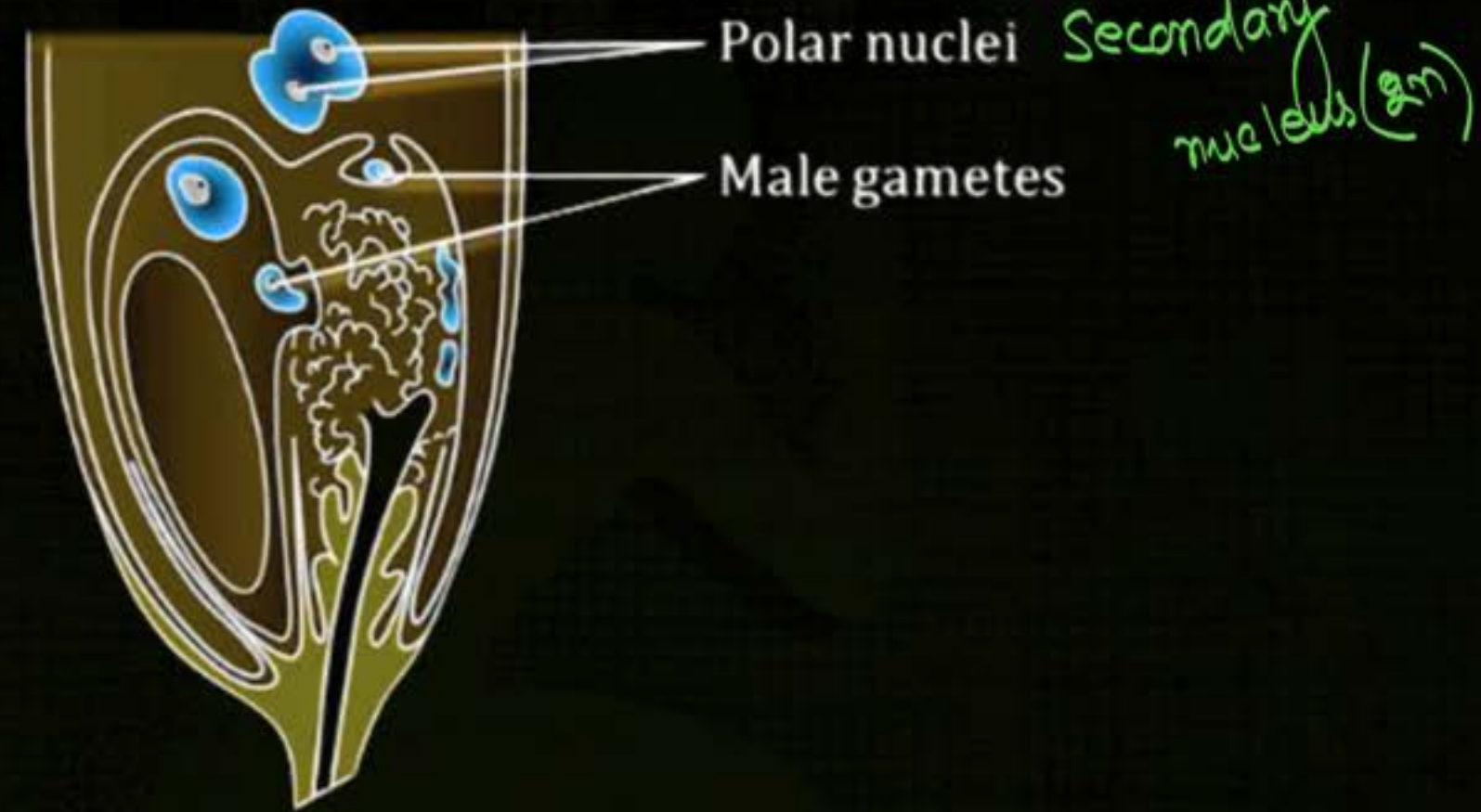
pollen tube enters through one of synergids inside embryo sac

Pollen tube bursts due endosmosis $\xrightarrow{\text{release}}$ all the content inside
(2 male + Tubernucleus)
Degenerating Synergids

Synergid + Tubernucleus start Degenerating.



**Enlarged view of an egg apparatus
Showing entry of pollen tube
Into a synergid**



**Discharge of male gametes into a synergid and
the movements of the sperms (male gametes),
one into the egg and the other into the central cell**

FUSION OF GAMETES

1 male gamete + 1 egg cell $\xrightarrow{\text{Syngamy}}$ Zygote ($2n$)

1 male gamete + Secondary nucleus $\xrightarrow{\text{Triple fusion}}$ Triploid structure ($3n$)

Syngamy + Triple fusion

Double fertilization $\longrightarrow$ Discovered by Nawaschin

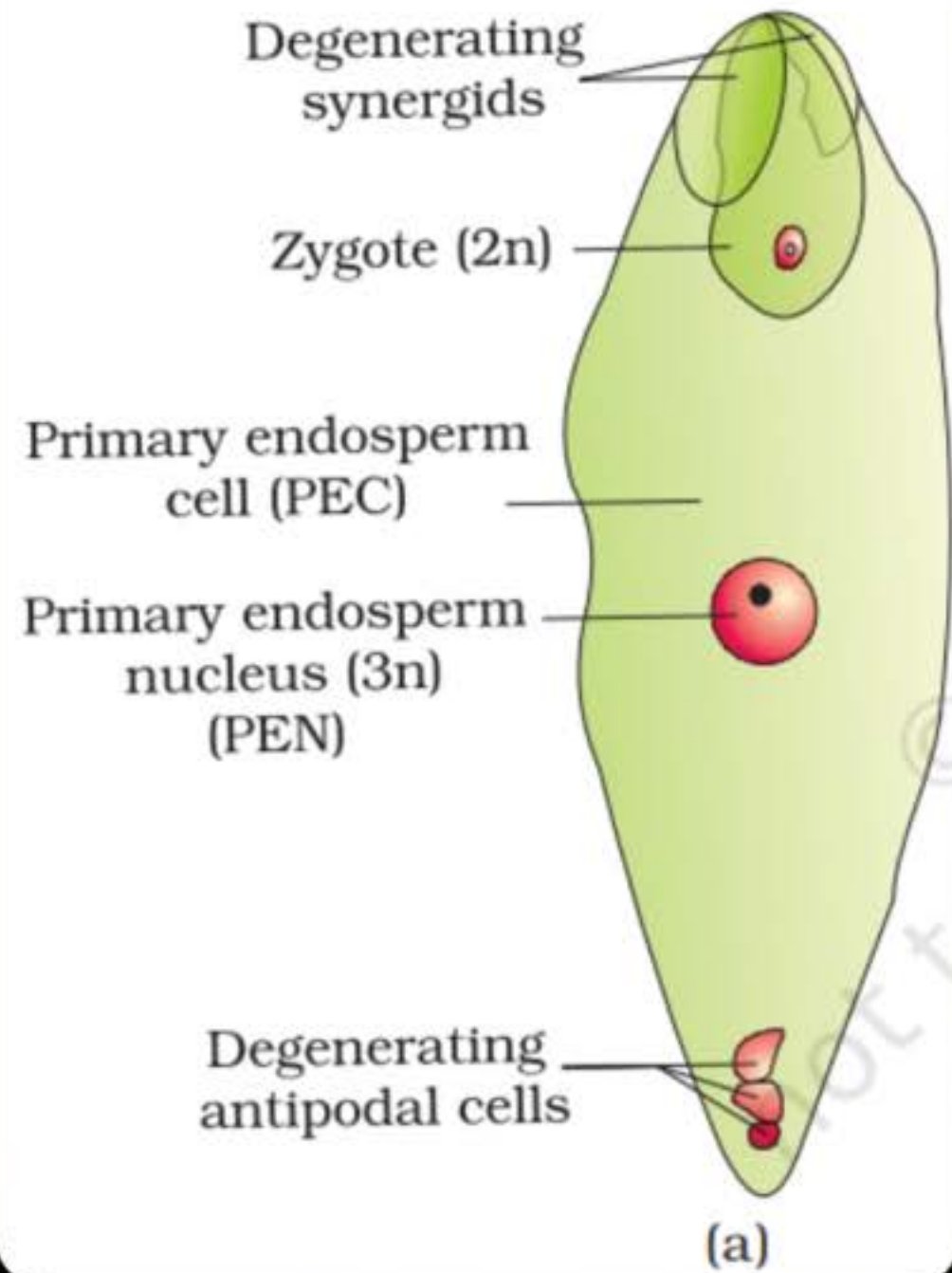


Zygote $\xrightarrow{\text{develop}}$ embryo

Triploid structure $\xrightarrow{\text{develop}}$ PEN (Primary endosperm nucleus)
(3n)

Central cell $\xrightarrow{\text{develop}}$ PEC (Primary Endosperm cell) $\xrightarrow{\text{develop}}$ Endosperm
(provide nourishment to developing embryo)

Antipodal & Synergids $\rightarrow$ Degenerates.



POST- FERTILISATION : STRUCTURES AND EVENTS



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graph TD; A[POST- FERTILISATION : STRUCTURES AND EVENTS] --- B[Development of Endosperm]; A --- C[Embryogenesis]
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Development of Endosperm

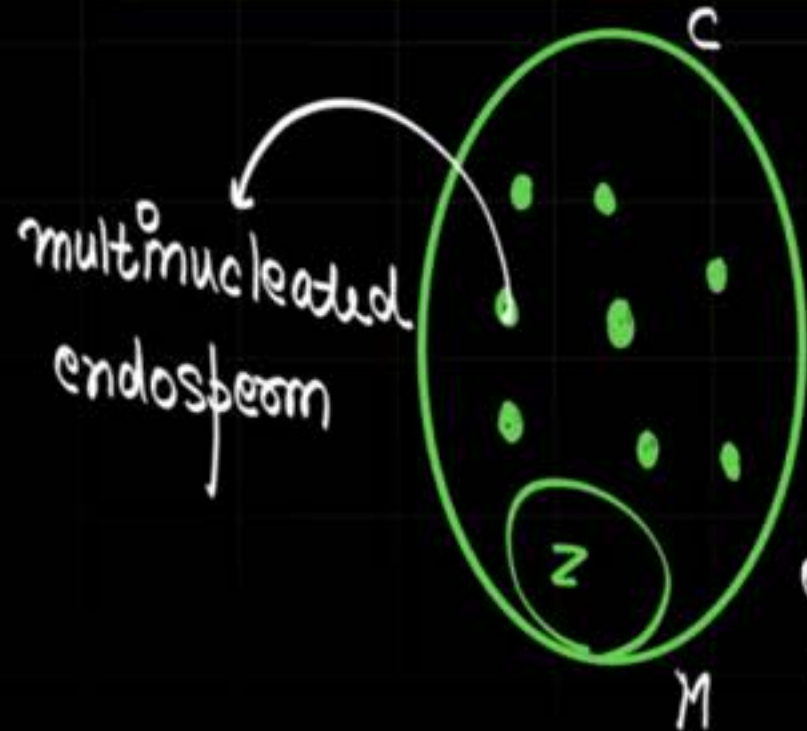
Embryogenesis

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ENDOSPERM DEVELOPMENT

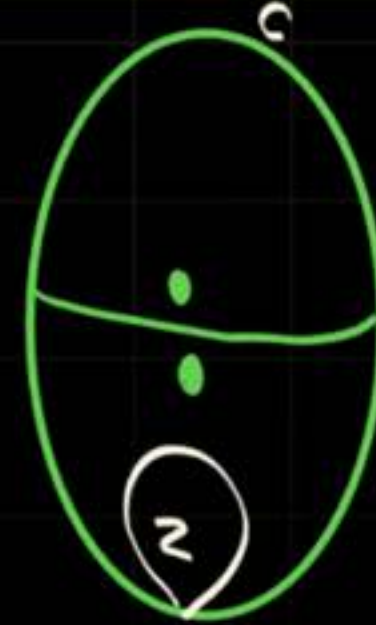
Nuclear Endosperm
OR
Free Nuclear Endosperm

Cellular
Endosperm



Karyokinesis
is not followed
by cytokinesis

eg:- Coconut water, white kernel → M cellular endosperm



eg:- Datura & Petunia

Karyokinesis is
followed by cytokinesis

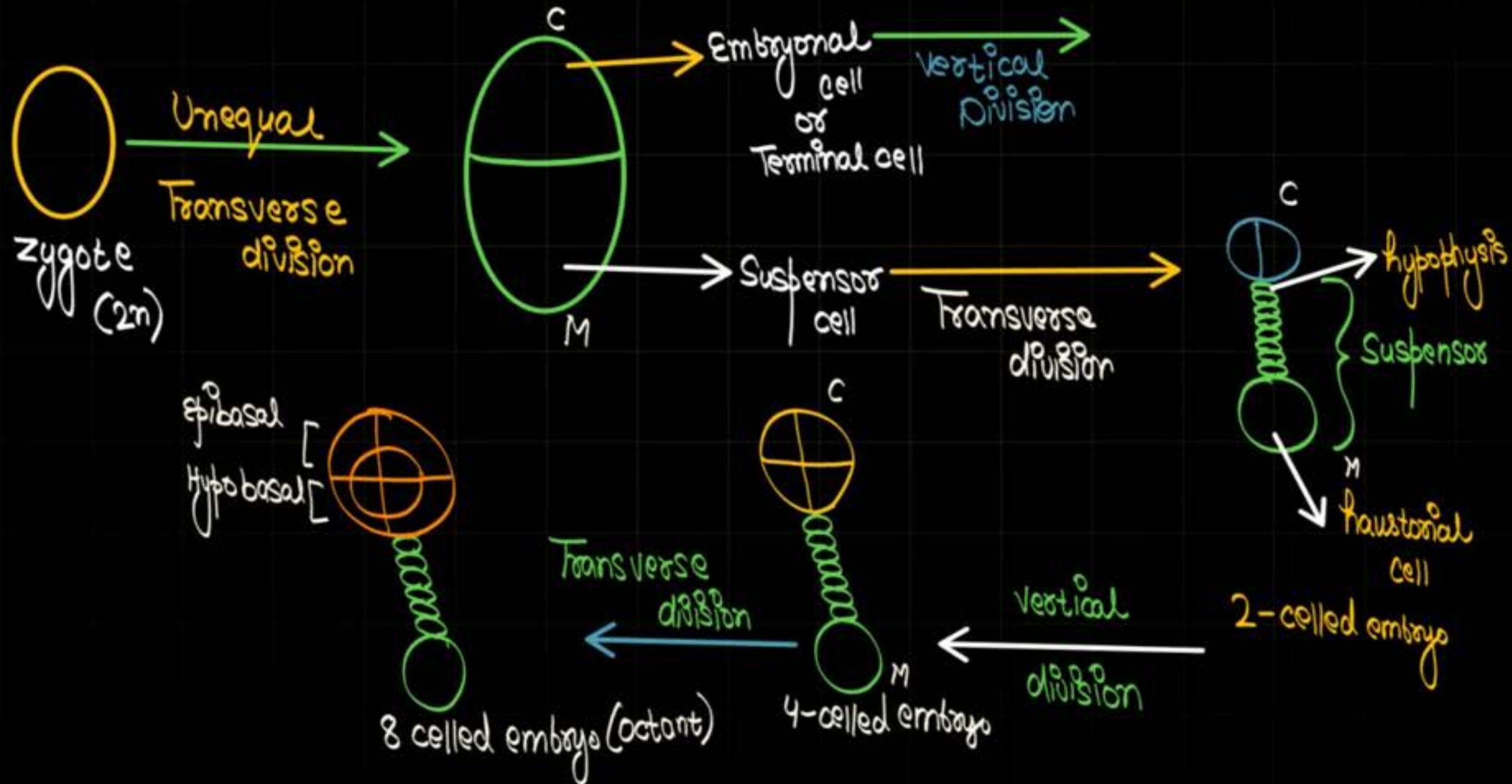
- Endosperm may either be completely consumed by the developing embryo (e.g., pea, groundnut, beans) before seed maturation or it may persist in the mature seed (e.g. castor and coconut)

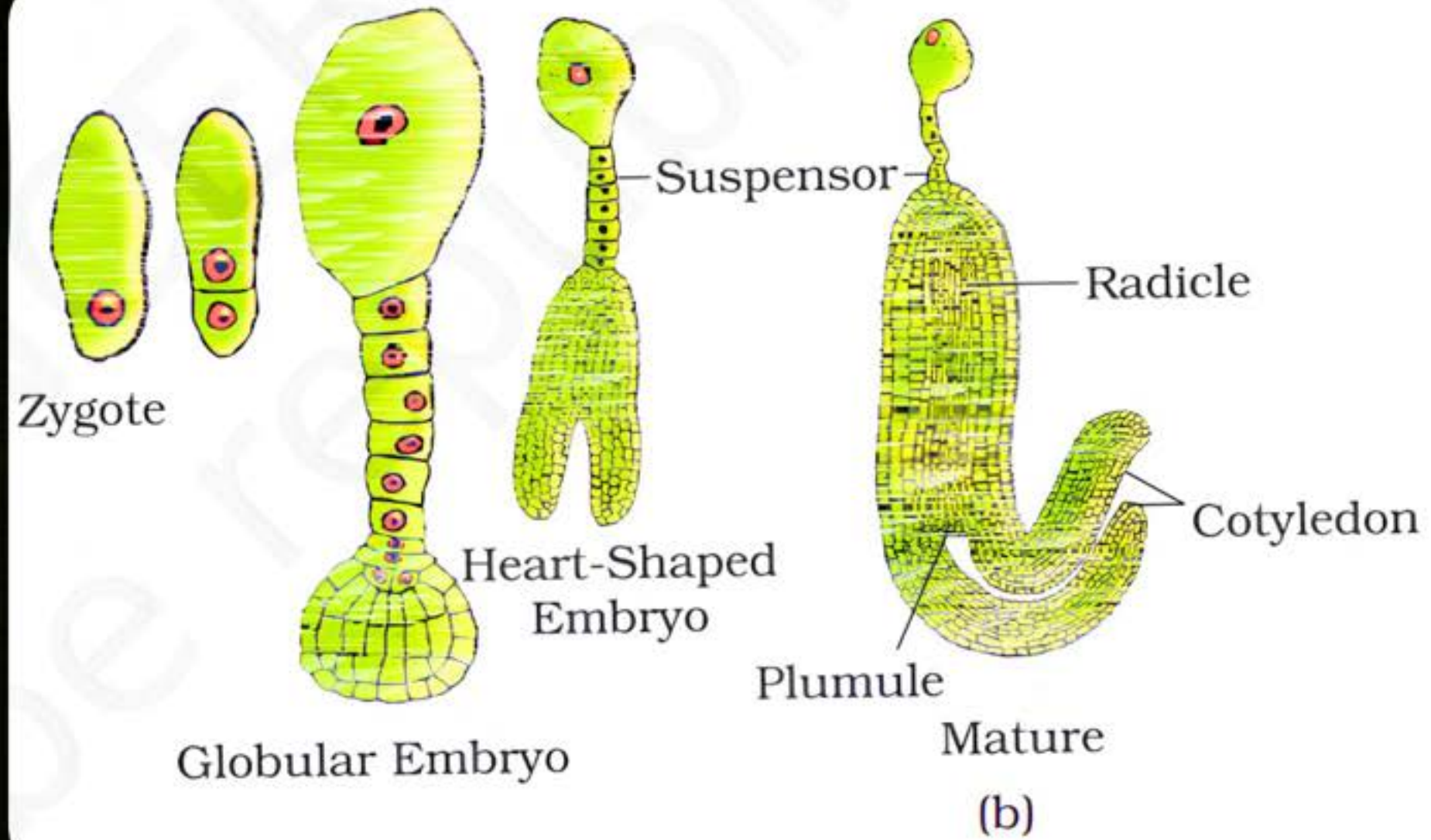
EMBRYOGENESIS

- The process of development of embryo from the zygote is called embryogenesis or embryogeny.

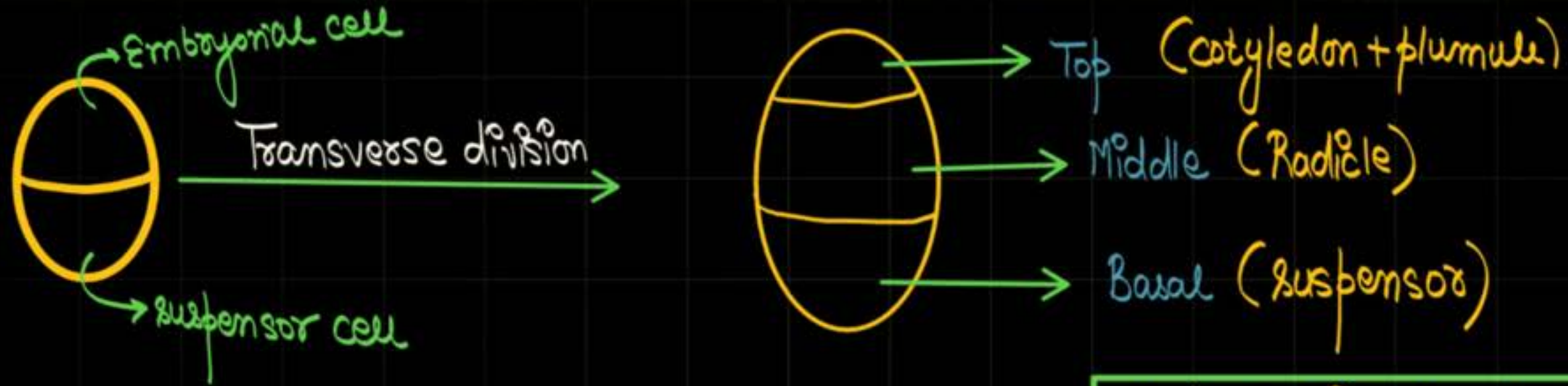
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DICOT EMBRYOGENESIS





MONOCOT EMBRYOGENESIS



Suspensor is not well
Developed in monocot
embryo

upto globular
embryo all
stages are same



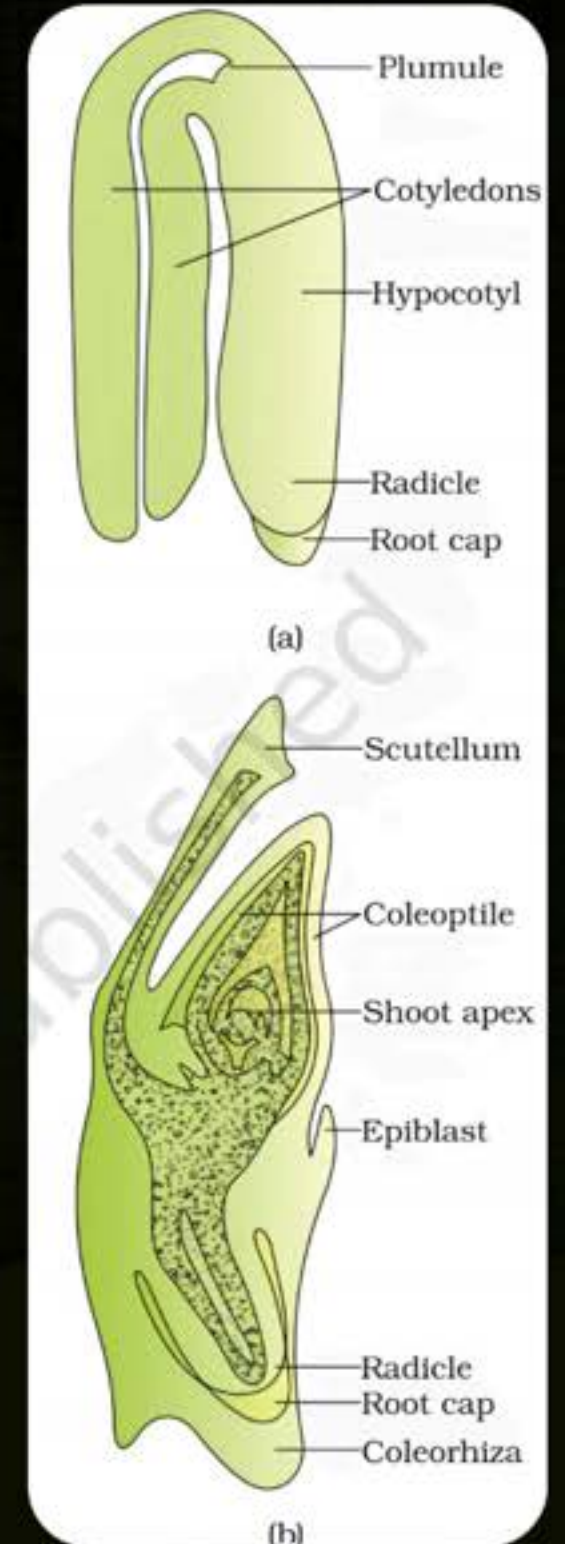
Epicotyl : Terminates with plumule + shoot tip

Hypocotyl : terminates with radicle + root tip

Embryonal Axis: Elongated stalk connecting both cotyledons

In grass family cotyledon → Scutellum

Epiblast → Reduced cotyledon (grass)



epicotyl : Upper coleoptile + shoot apex

hypocotyl : Radicle + Root cap + Coleorhiza
(undifferentiated sheath)

ANGIOSPERMIC SEED

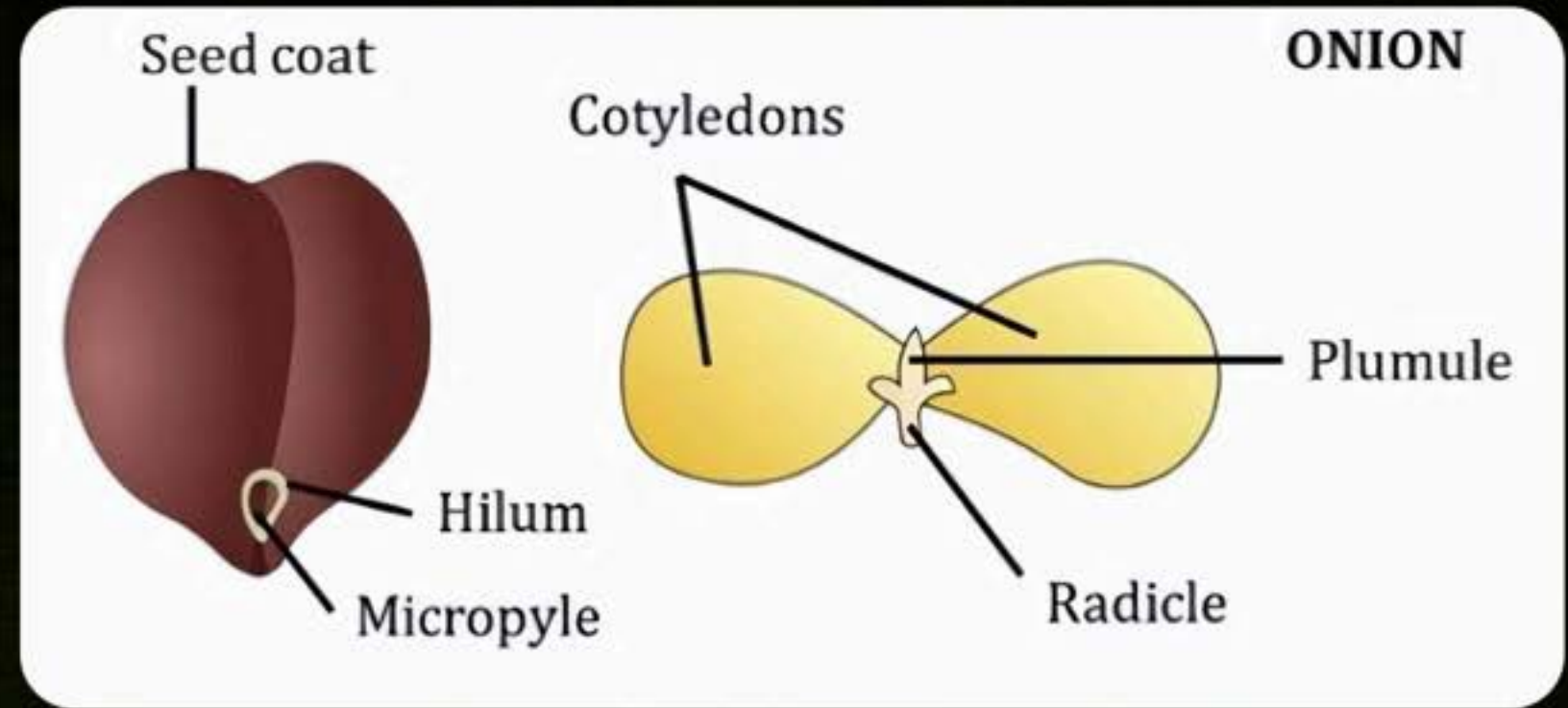
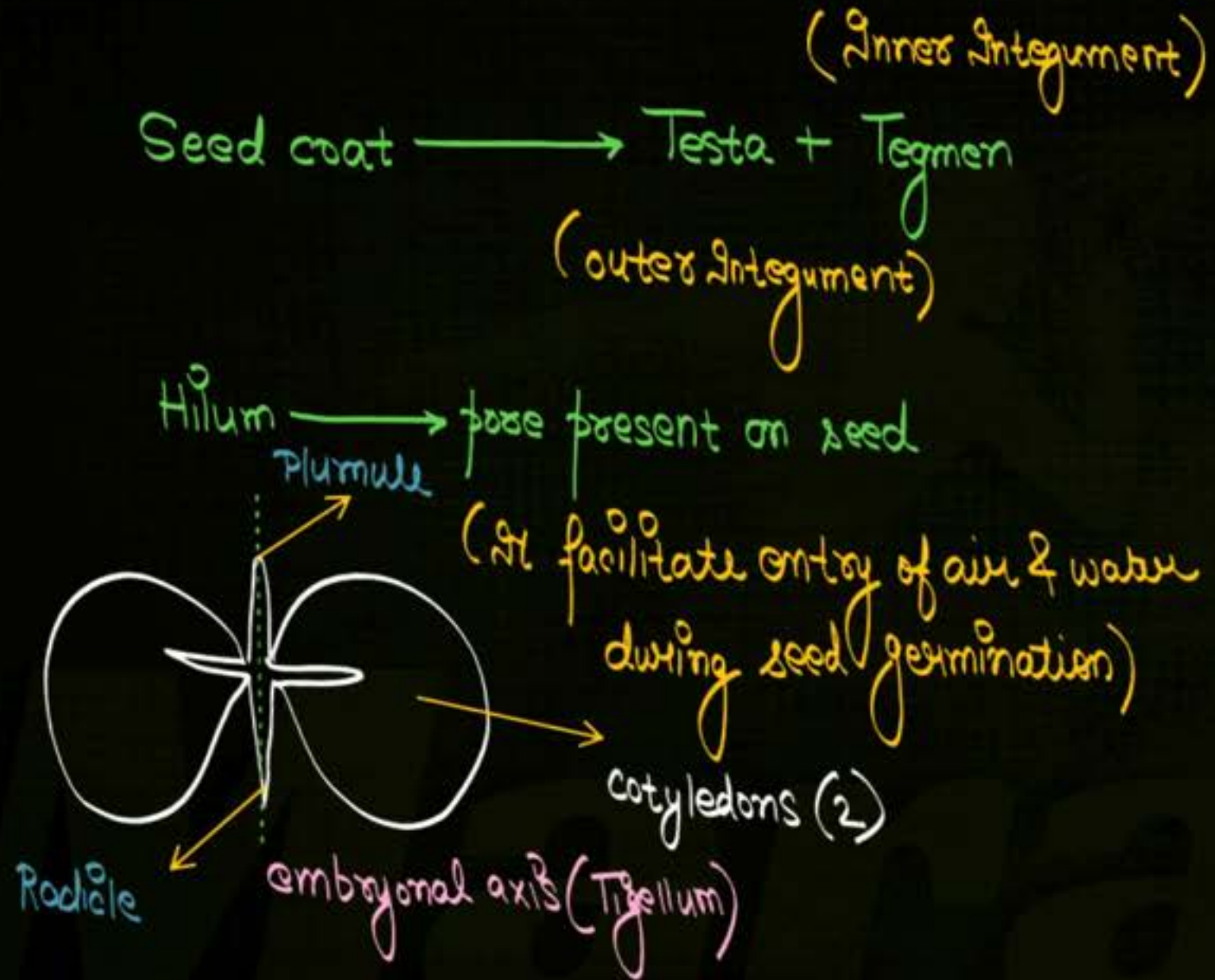
- Fertilized ovule is known as seed.

Ripened ovule → seed

Seed {
→ Dicot seed
→ monocot seed

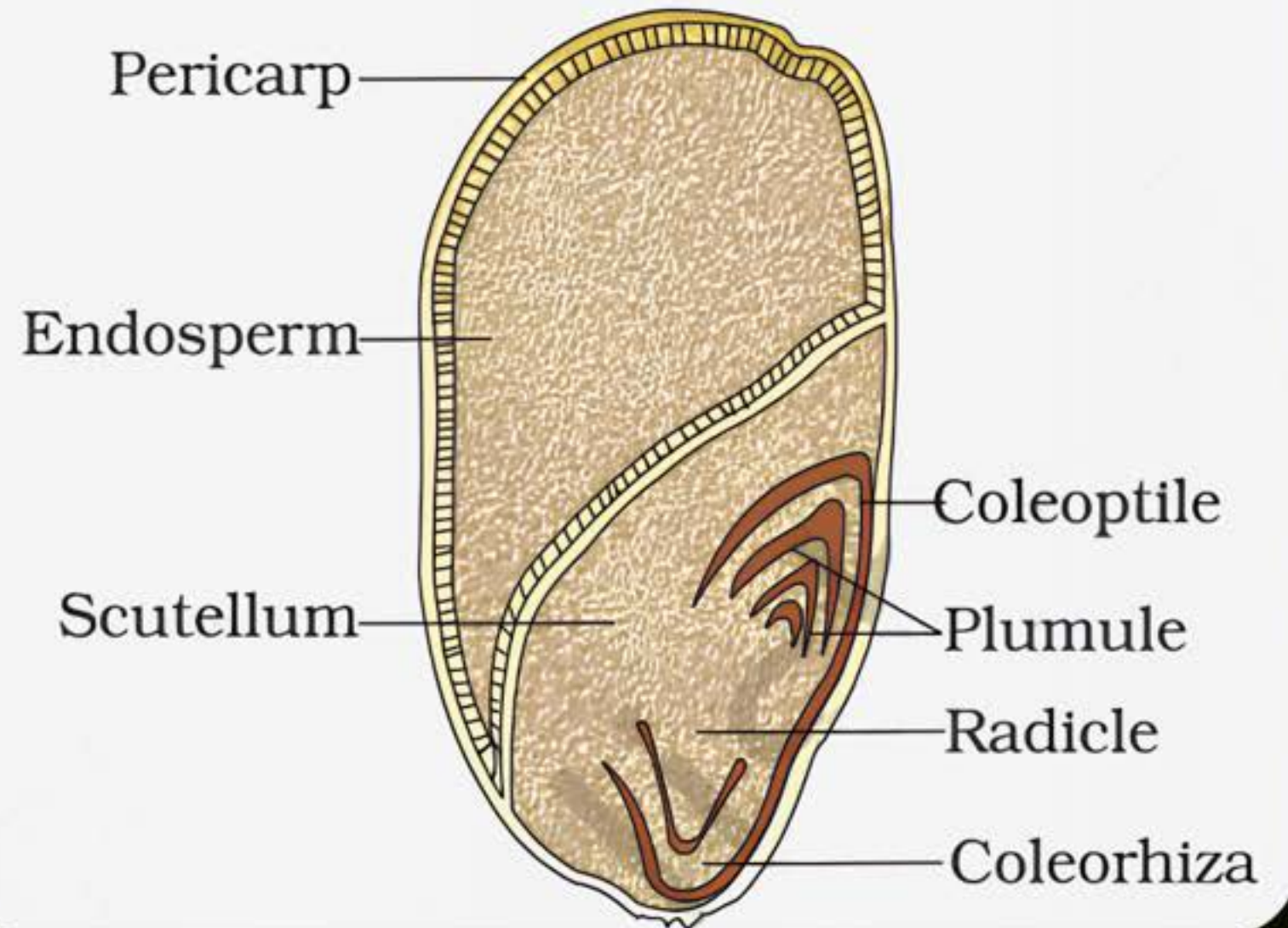
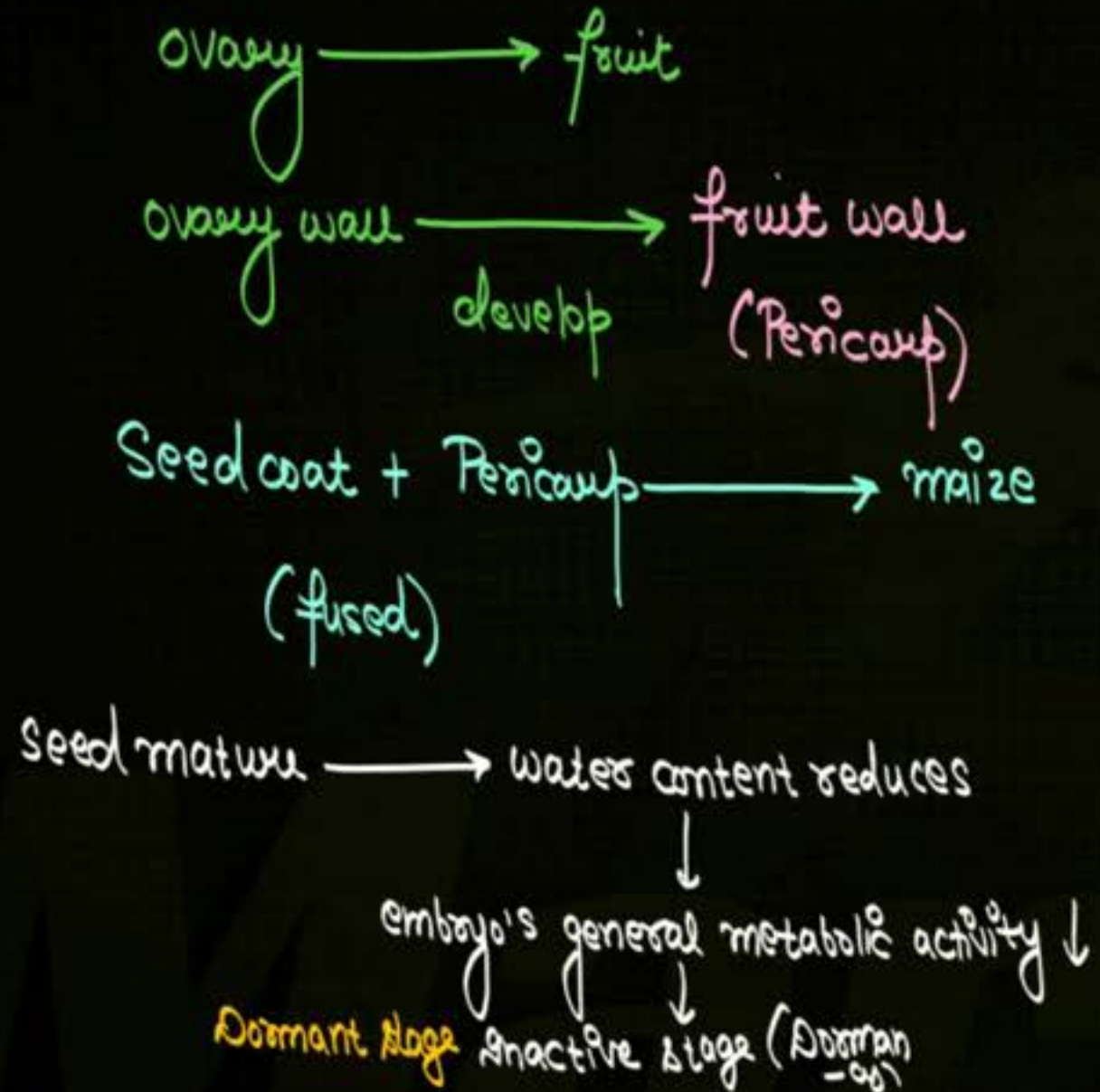
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DICOT SEED



MONOCOT SEED

maize (corn)



NON ENDOSPERMIC OR EX-ALBUNOUOUS SEED OR NON ALBUMINOUS SEEDS:

e.g. gram, pea, bean, ground nut. But in castor, seeds are endospermic.

Dicot seed

dicot seed

Endosperm is completely consumed by developing embryo

Endosperm is not completely consumed

monocot seed :- pothos (money plant) & Vallisneria

ENDOSPERMIC OR ALBUMINOUS SEEDS

Examples : Most of monocot seeds e.g. wheat, rice, coconut, barley and maize etc.

- In some seeds such as black pepper and beet, remnants of nucellus are also persistent. This residual, persistent nucellus is the perisperm.

Seed viability

Ability of seed to germinate

Factors affecting seed viability

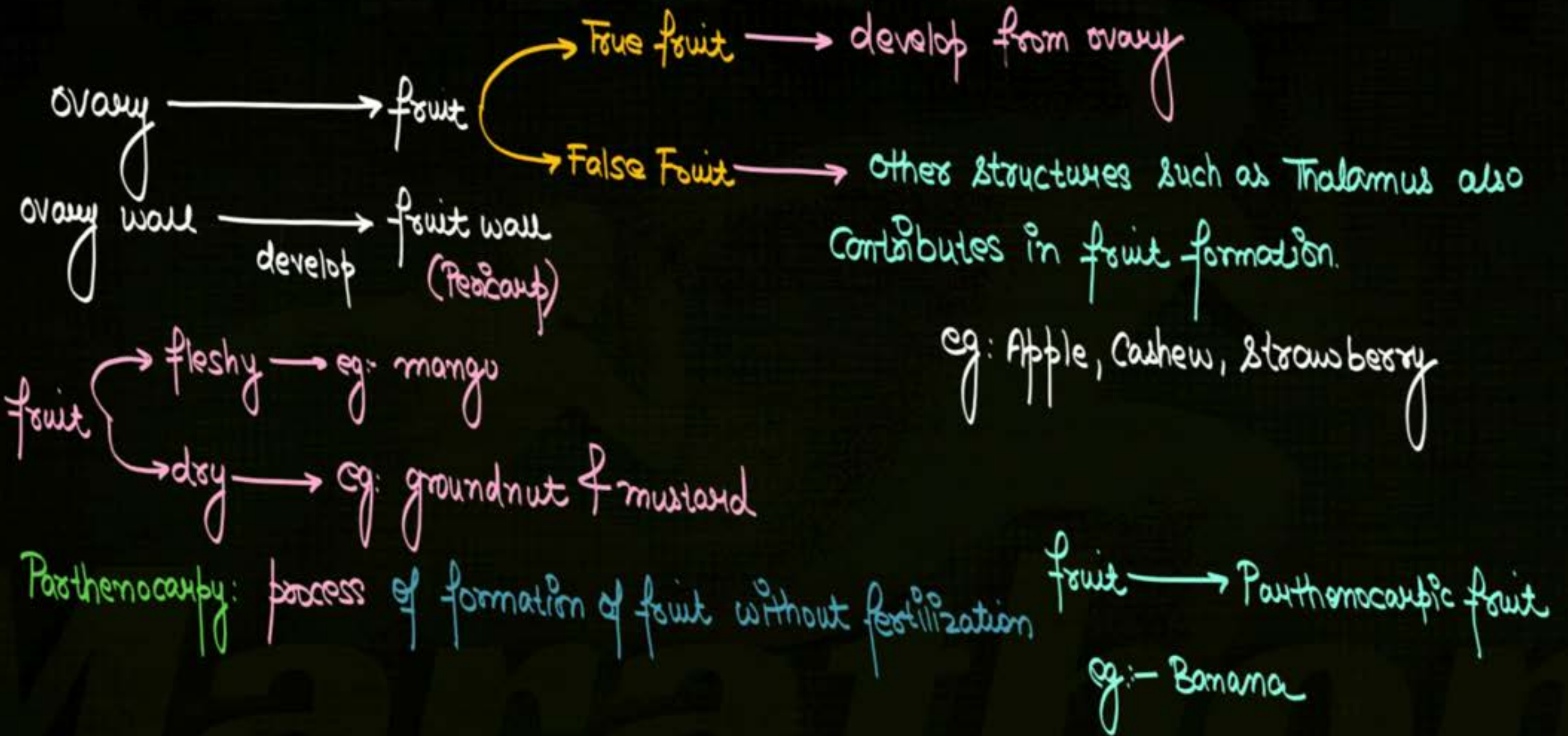
- Temperature
- Reserve food material
- Humidity
- Water

ex:- *Lupinus arcticus* → 10,000 years
excavated from
Arctic Tundra

② *Phoenix Dactylifera* → 2,000 years
(Date palm)

IMPOTANCE OF SEED

- Better Dispersal
- Genetic Variation (It is a product of sexual Reproduction)
- Protection of next generation
- Agriculture



APOMIXIS AND POLYEMBRYONY

Apomixis: Formation of seed without fertilization # to maintain offspring superiority.

→ It is a type of Asexual Reproduction that mimics sexual reproduction

In some species
of Asteraceae &
grass.



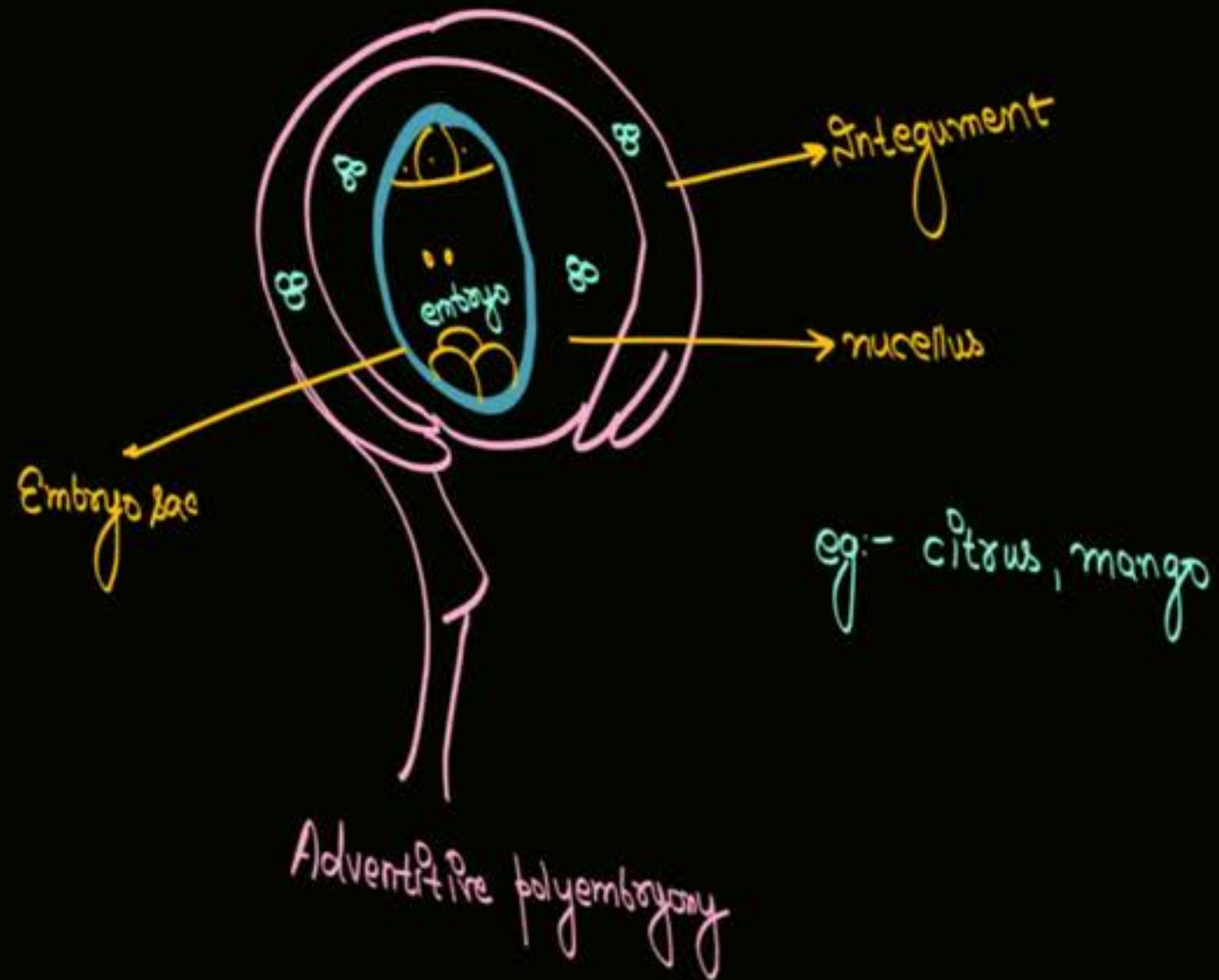
Diploid embryo sac
all structures are Diploid

eg: Apple & pear

egg ($2n$) → Zygote ($2n$) → embryo ($2n$)

Polyembryony

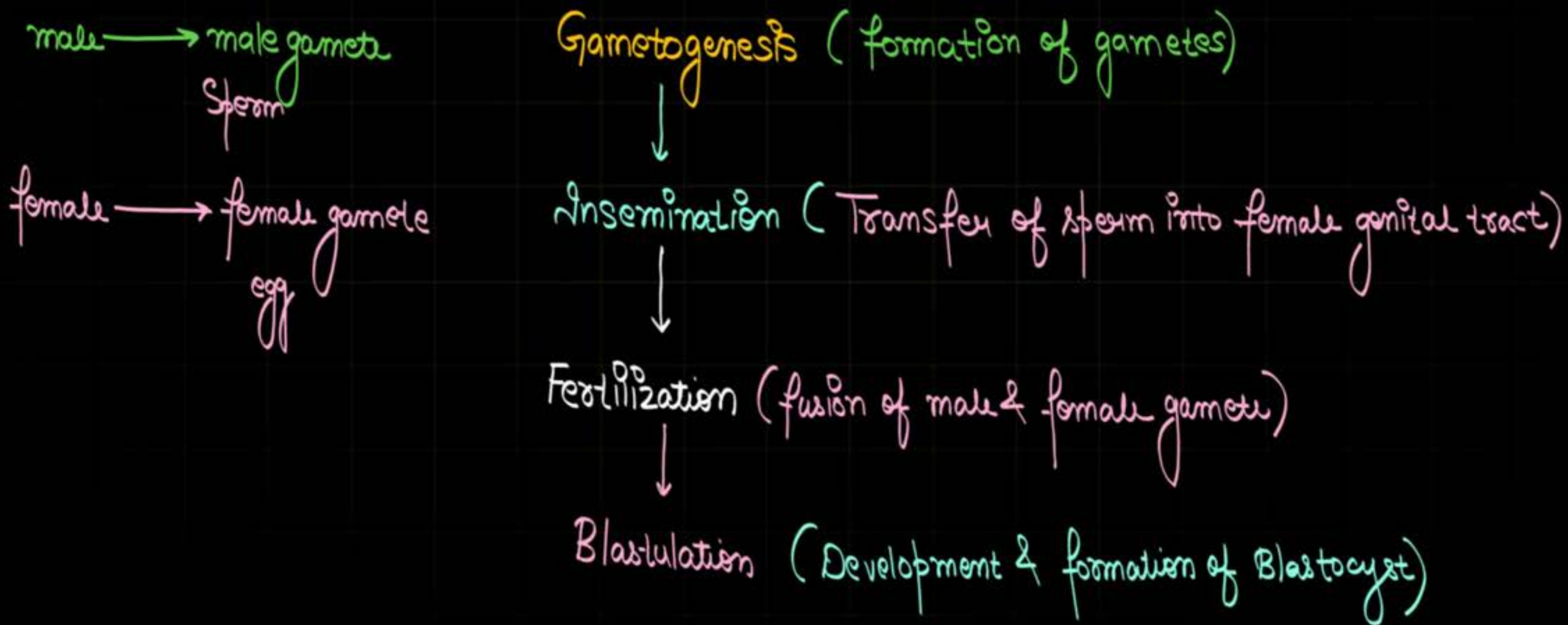
many embryo's



Human Reproduction

Chapter-2

REPRODUCTIVE EVENTS

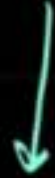


Implantation (Attachment of Blastocyst to the Uterine wall)



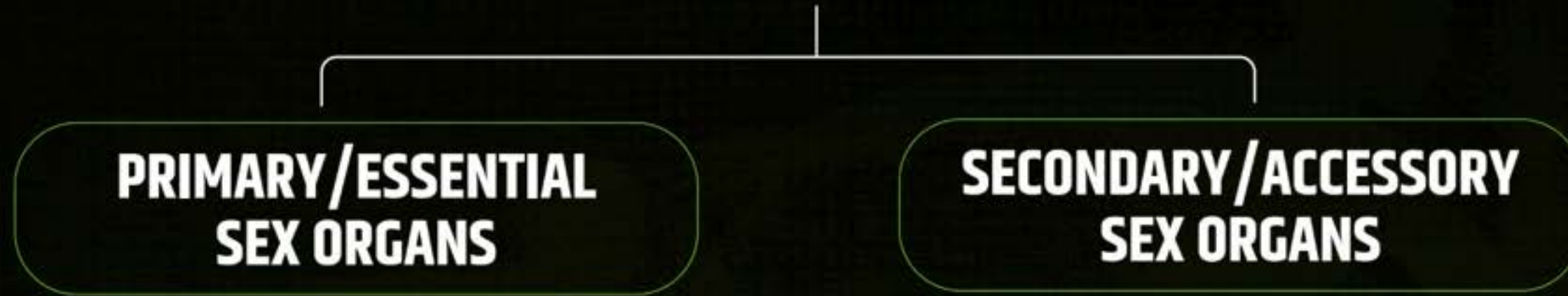
Gestation period → 9 months
Human

Gestation (further development of Embryo)



Parturition (Delivery of Baby)

THE REPRODUCTIVE ORGANS / SEX ORGANS



male gametes + Release sex hormones

male → Testis

female → Ovary

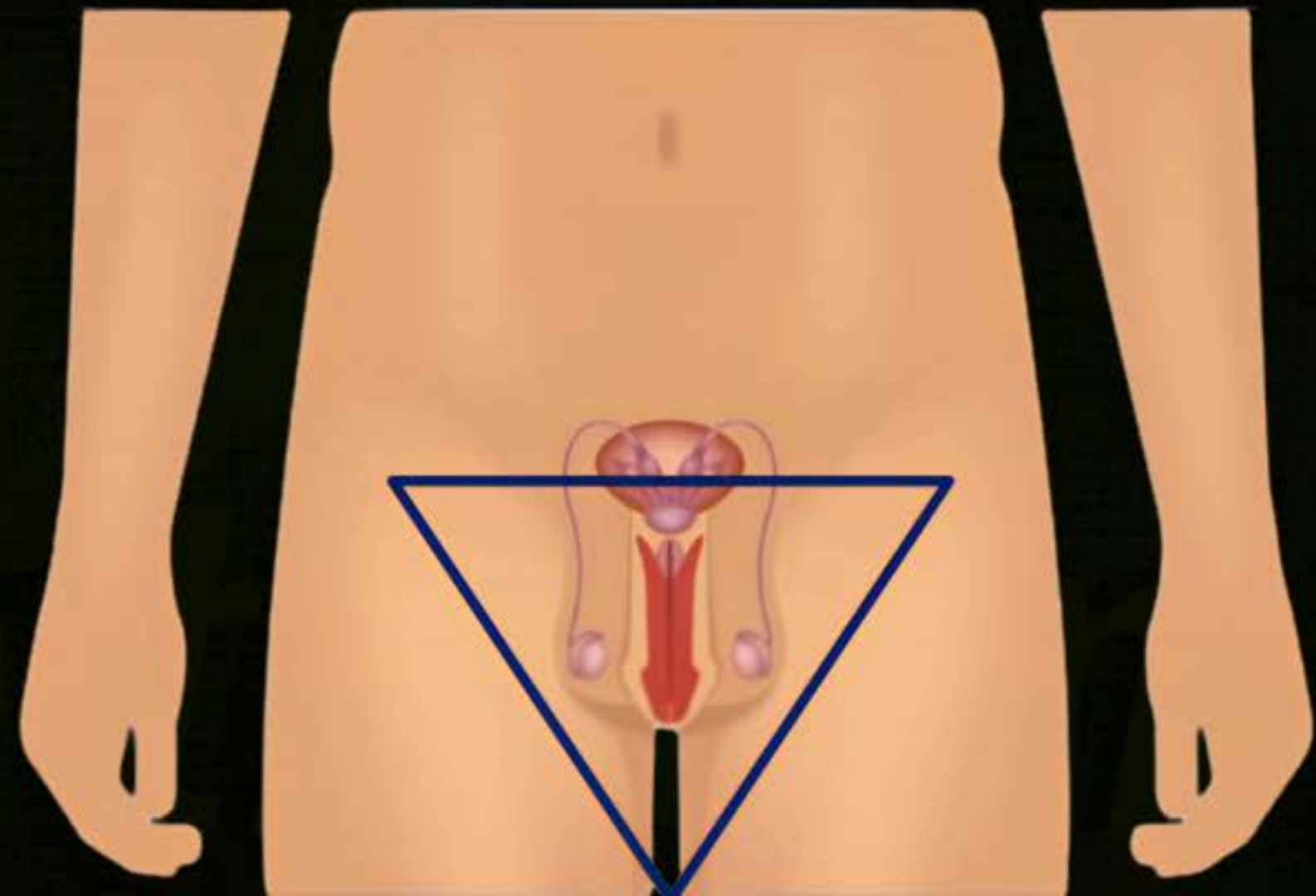
male { Duct
Glands

Female { Ducts
External genitalia

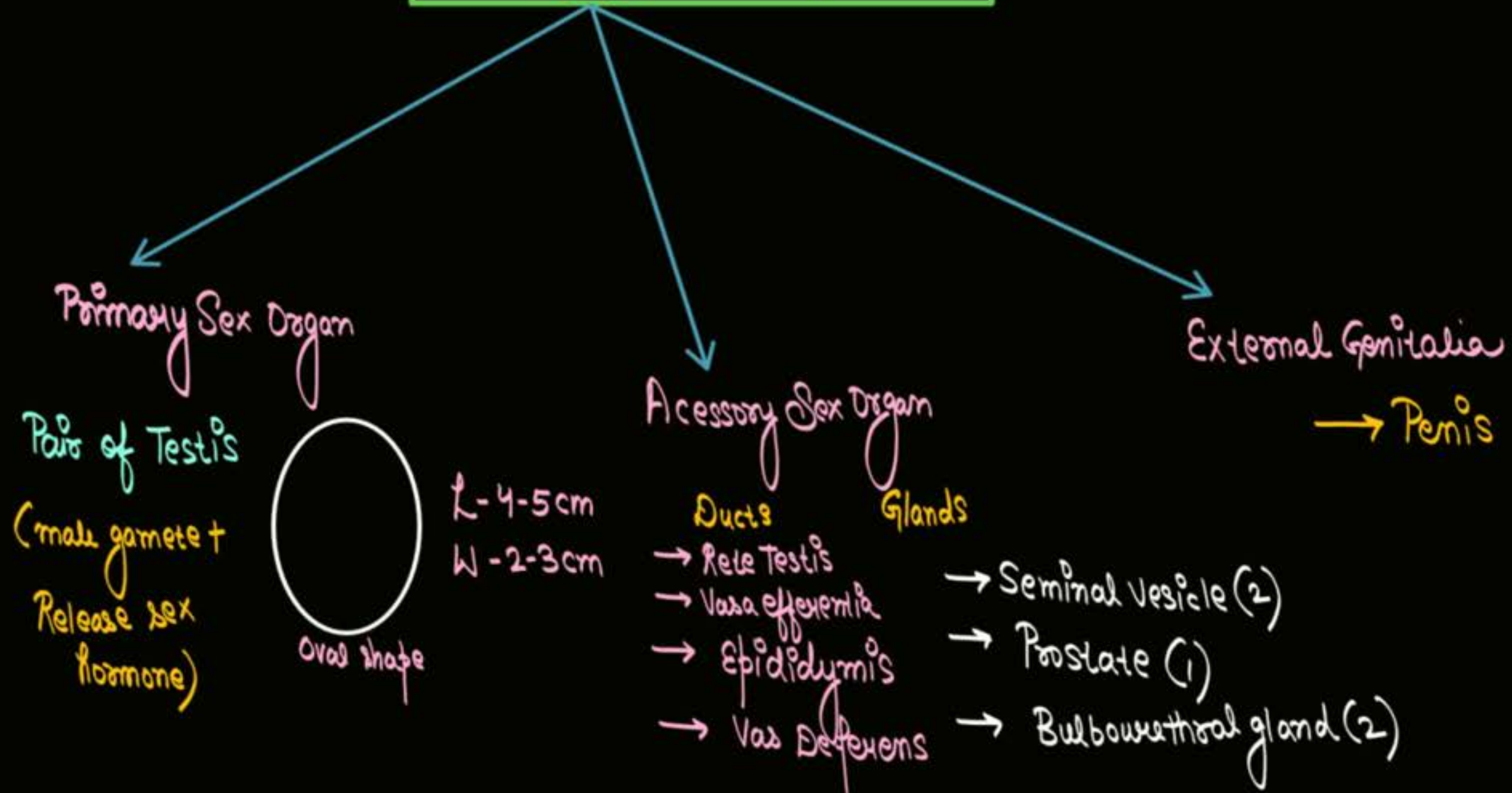
THE MALE REPRODUCTIVE SYSTEM

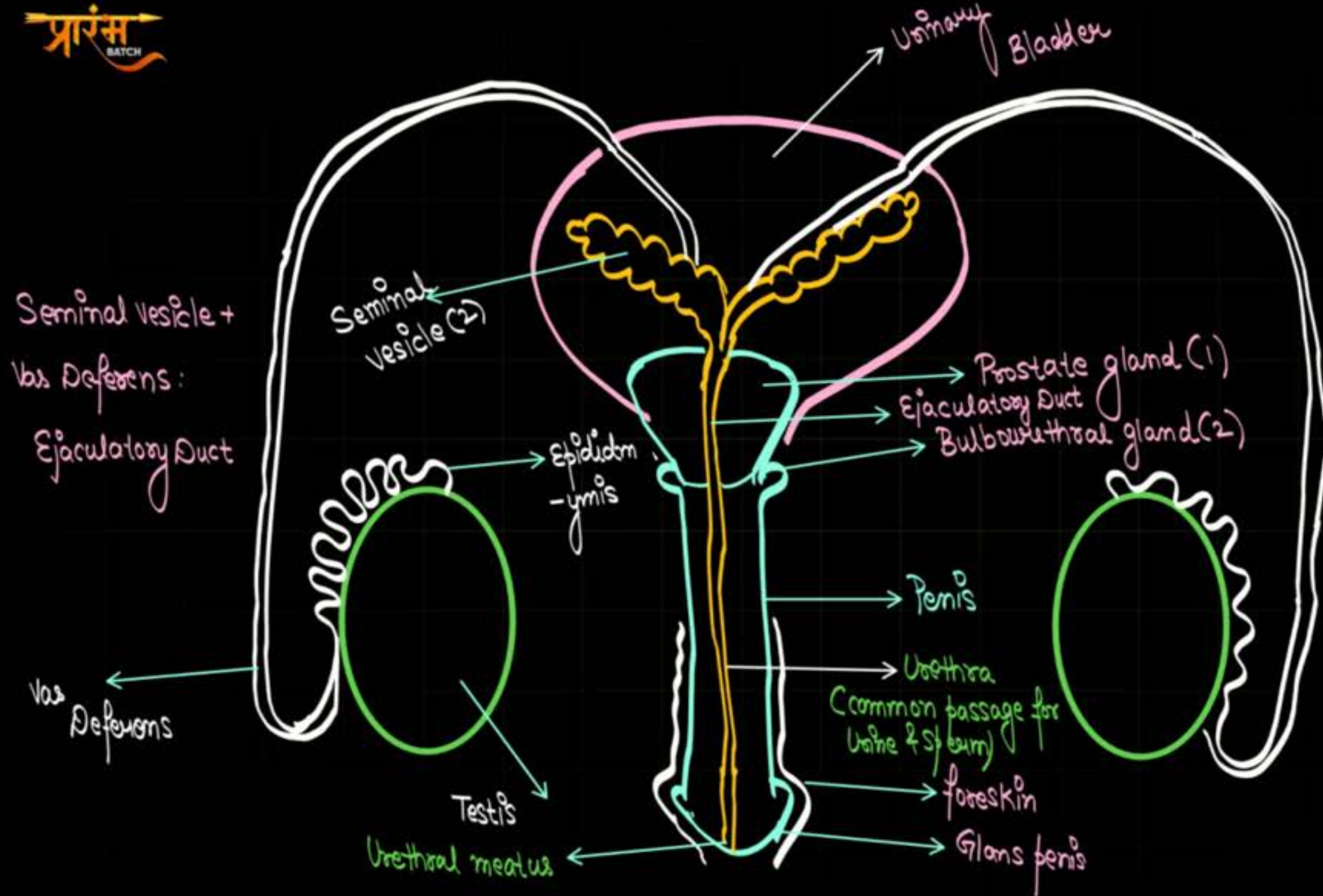
LOCATION:

Pelvis Region
Pelvic cavity



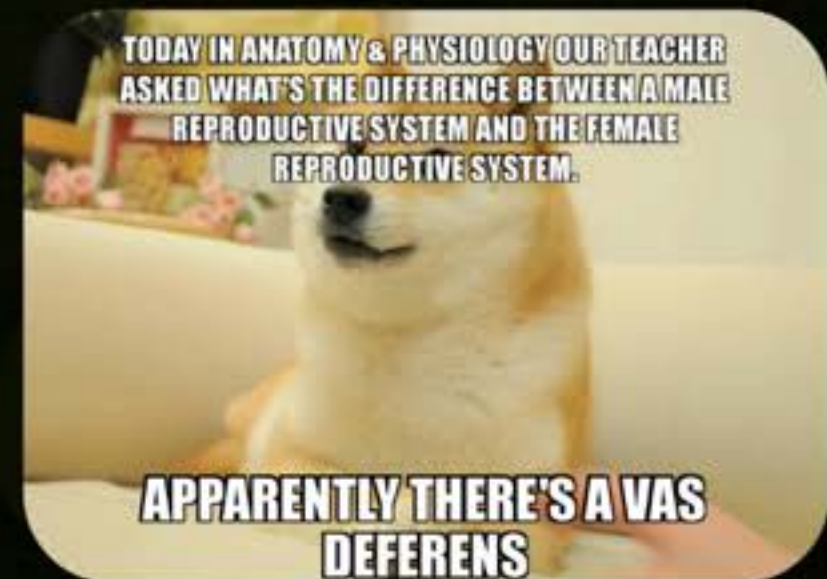
Male Reproductive System





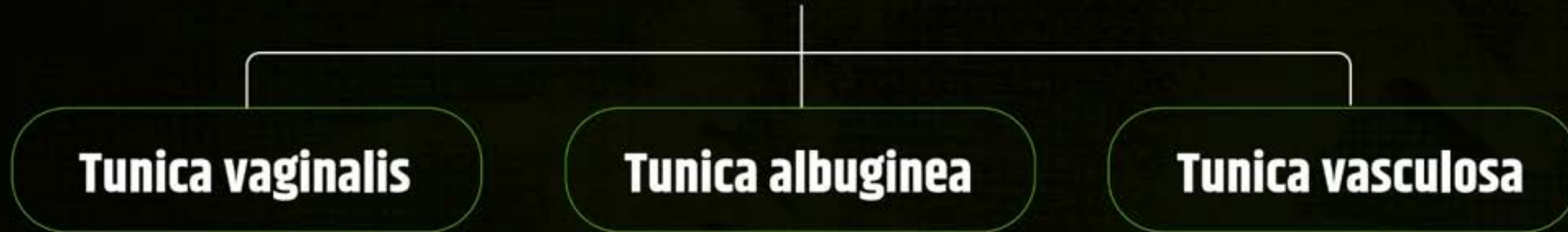


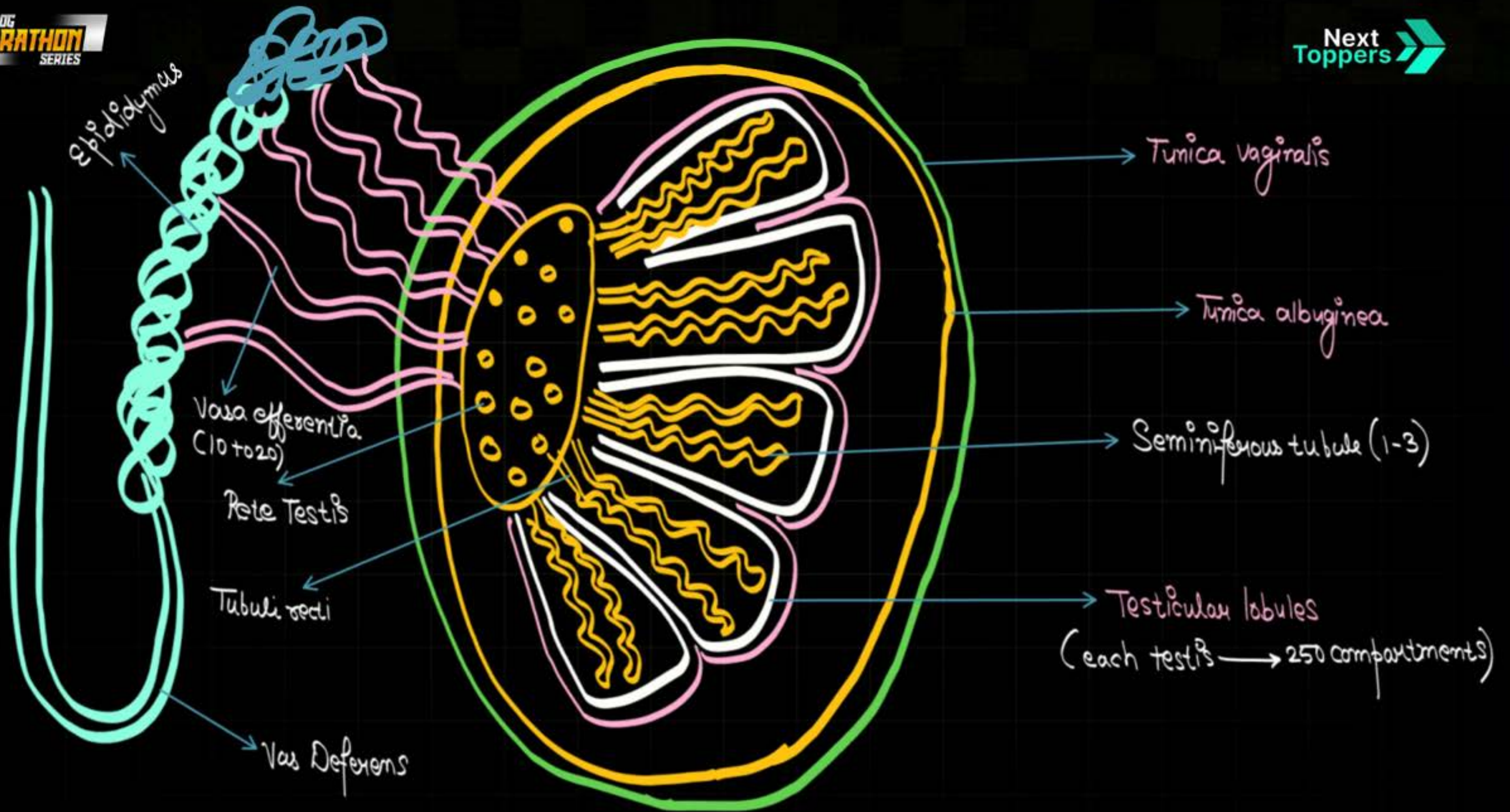
- Both testes are located in a small bag like structure situated below & out side the abdominal cavity called as scrotum or scrotal sac. The temperature of scrotum is $2 - 2.5^{\circ}\text{C}$ lesser than body temperature, necessary for spermatogenesis.



INTERNAL STRUCTURE OF TESTIS

Testis is covered by dense covering which consist of three coats.





- Seminiferous tubules join together to form straight tubules or tubuli recti
- network of tubules called as rete testis.
- Rete testis fuse to form 10 to 20 efferent ductule called as vasa efferentia

GLANDS

1. Seminal vesicle (2): 60-70% rich in fructose, alkaline

2. Prostate Gland (1): Rich in calcium

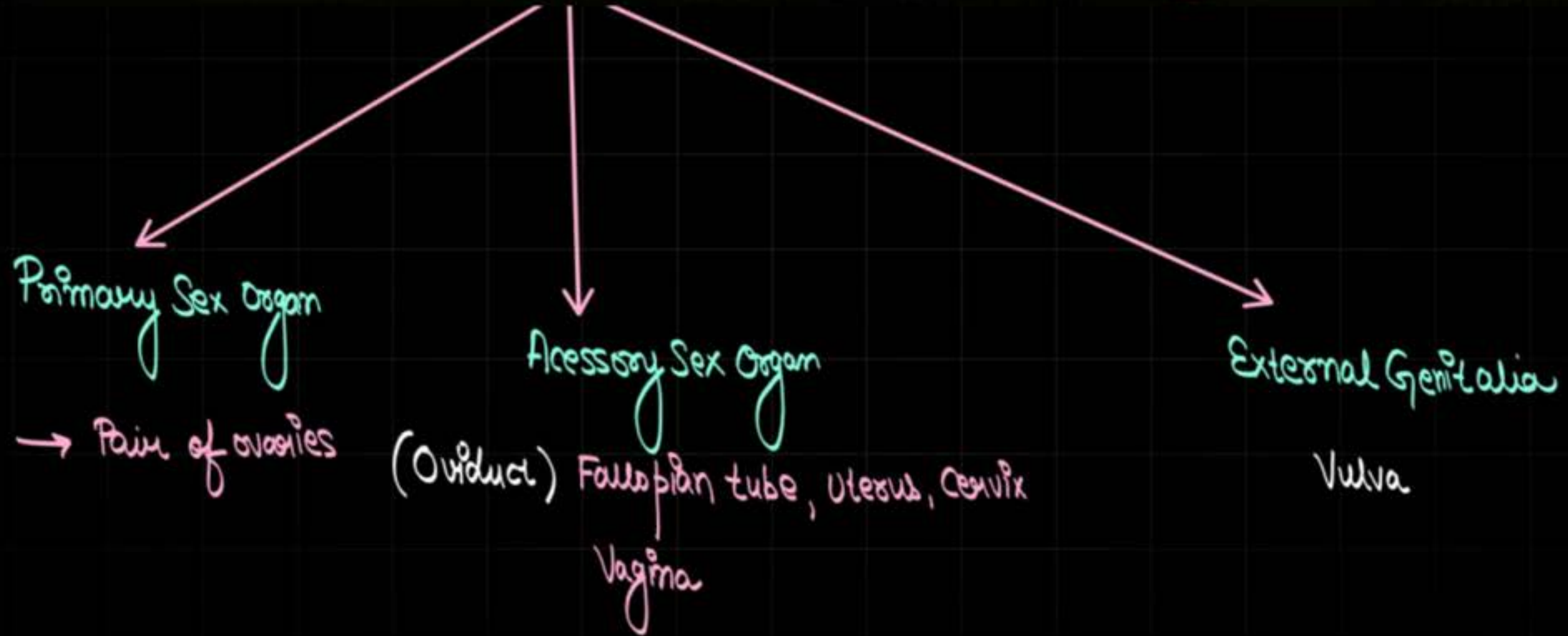
3. Bulbourethral Gland or Cowper's Gland (2): Lubrication of penis.

Seminal plasma: Rich in fructose, calcium, some enzymes

Seminal plasma +
Spermatozoa
(Sperm) →
Semen



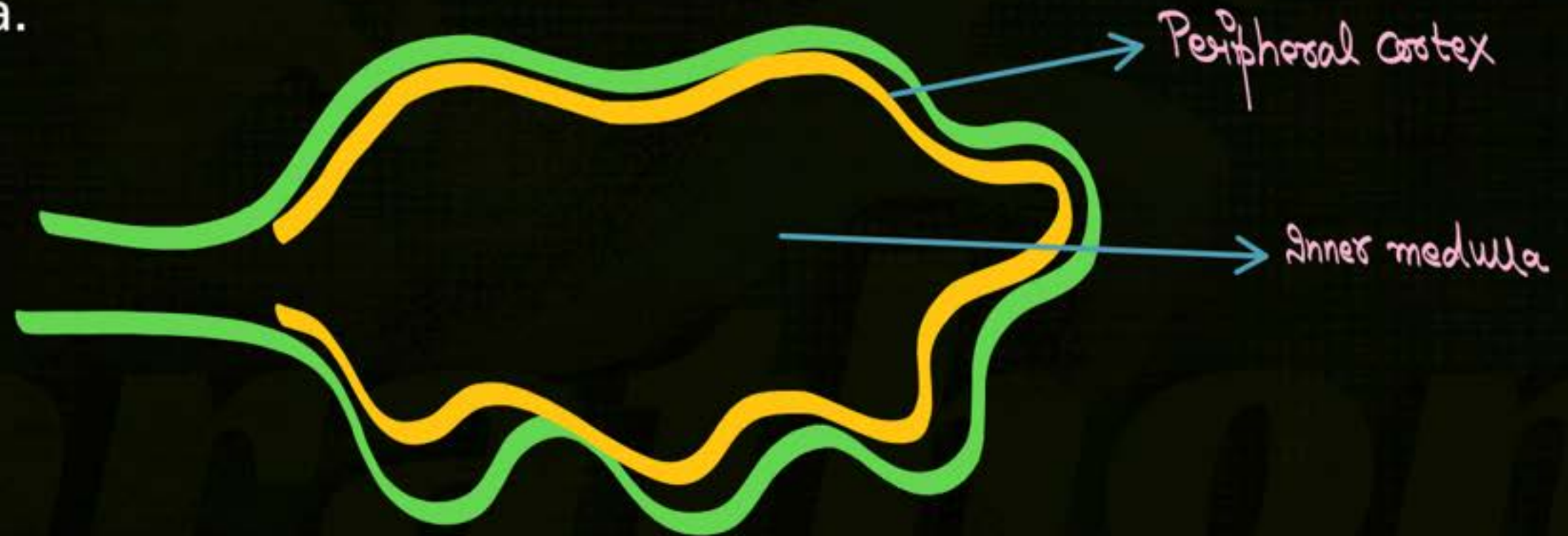
FEMALE REPRODUCTIVE SYSTEM





OVARY

- Each ovary is about 2 to 4 cm in length
- Connected to the pelvic wall and uterus by ligaments.
- Each ovary is covered by a thin epithelium which encloses the ovarian stroma. The stroma is divided into two zones – a peripheral cortex and an inner medulla.



FALLOPIAN TUBE

- Each fallopian tube is about 10-12 cm long

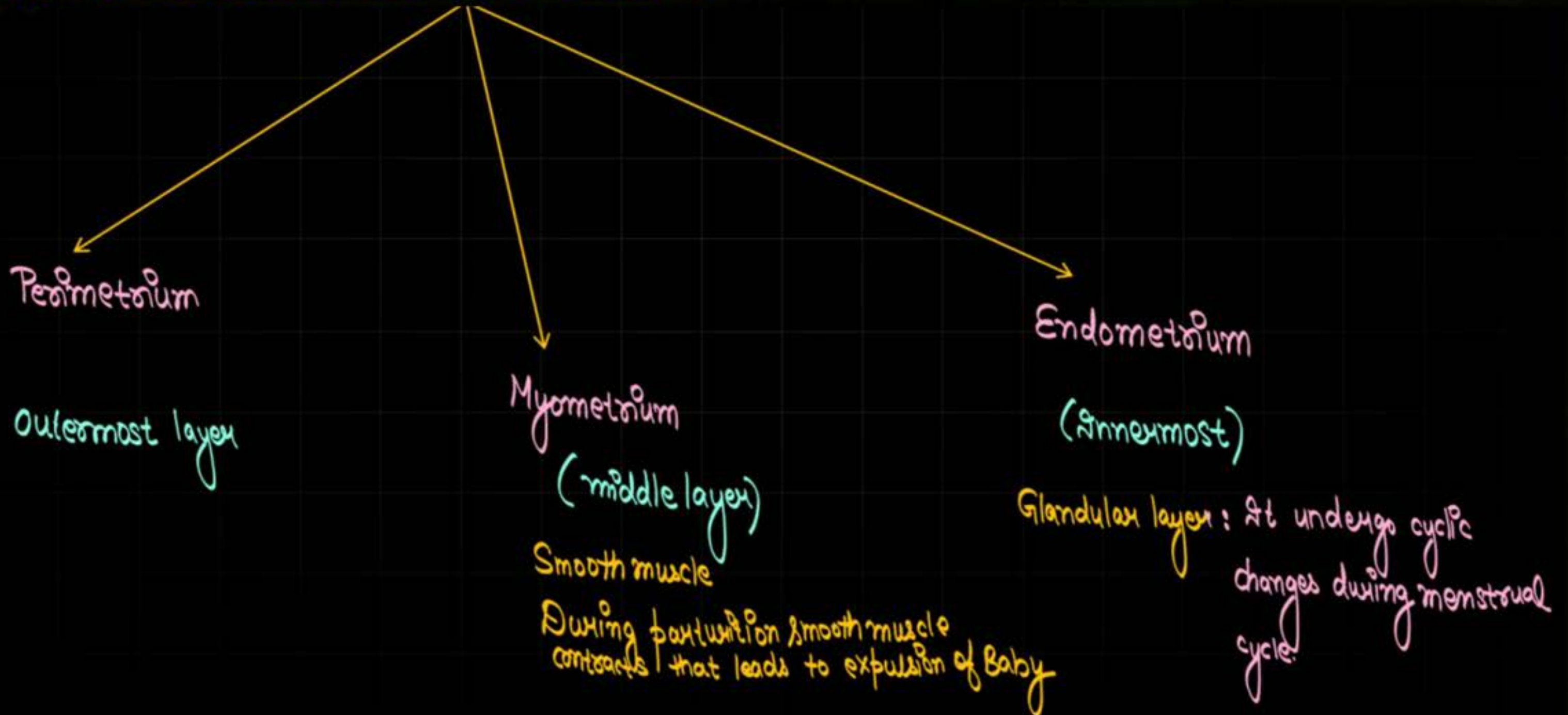
Marathon

UTERUS

- The uterus is single and it is also called womb.
- shape - **inverted pear**
- It is supported by ligaments attached to the pelvic wall.
- The uterus opens into vagina through a narrow cervix.
- The cavity of the cervix is called **cervical canal** which alongwith vagina forms the **birth canal**.



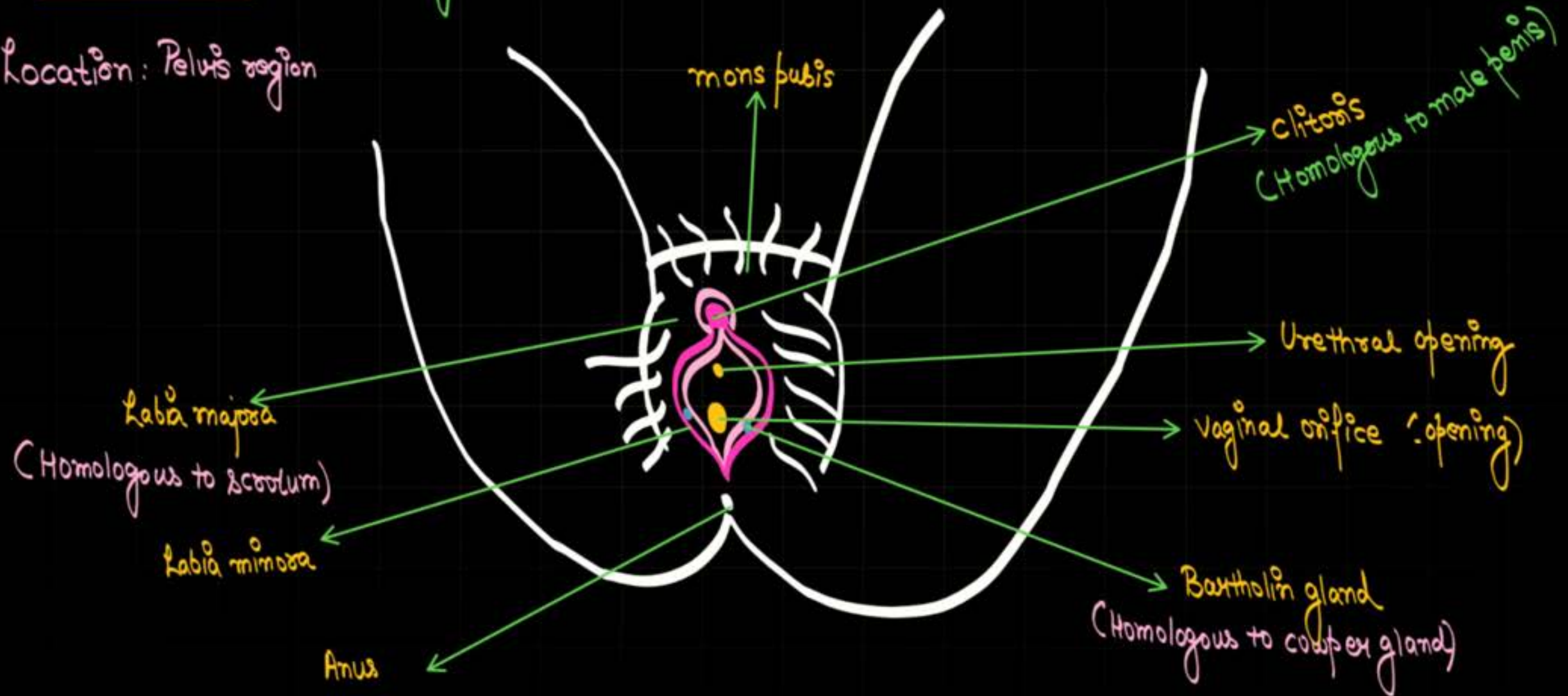
HISTOLOGY OF UTERUS



VULVA

External genitalia in females

Location: Pelvis region



Mons Pubis: cushion of fatty tissue, covered by pubic hair

Labia majora folds of fleshy tissue that extend from mons pubis & surrounds vaginal opening

Labia minora thin folds of tissue inside Labia majora

Clitoris tiny finger like structure, homologous to male penis

Bartholin's gland Homologous to Cowper's gland
function: lubrication of vulva

Hymen Mucous membrane that covers vaginal orifice

NOTE:

- The hymen is often torn during the first coitus (intercourse). However, it can also be broken by a sudden fall or jolt, insertion of a vaginal tampon, active participation in some sports like horseback riding, cycling, etc. In some women the hymen persists even after coitus. In fact, the presence or absence of hymen is not a reliable indicator of virginity or sexual experience.

MAMMARY GLAND (BREAST)

paired structure

→ It consists of glandular tissue & variable amount of fat

→ glandular tissue is divided into 15-20 mammary lobes

Lactiferous Duct

(milk is sucked out)
Nipple

Mammary Ampulla

Mammary duct

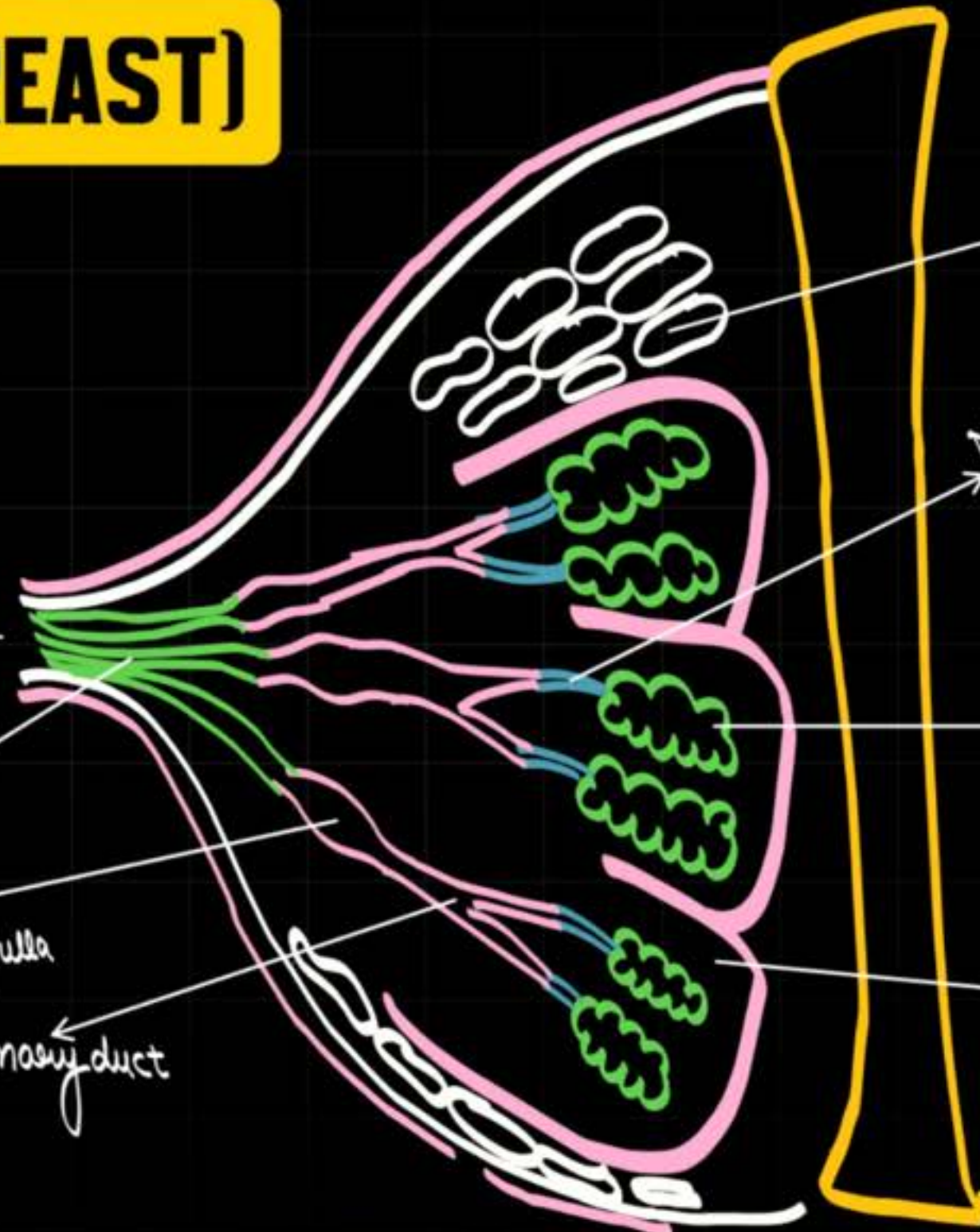
fat

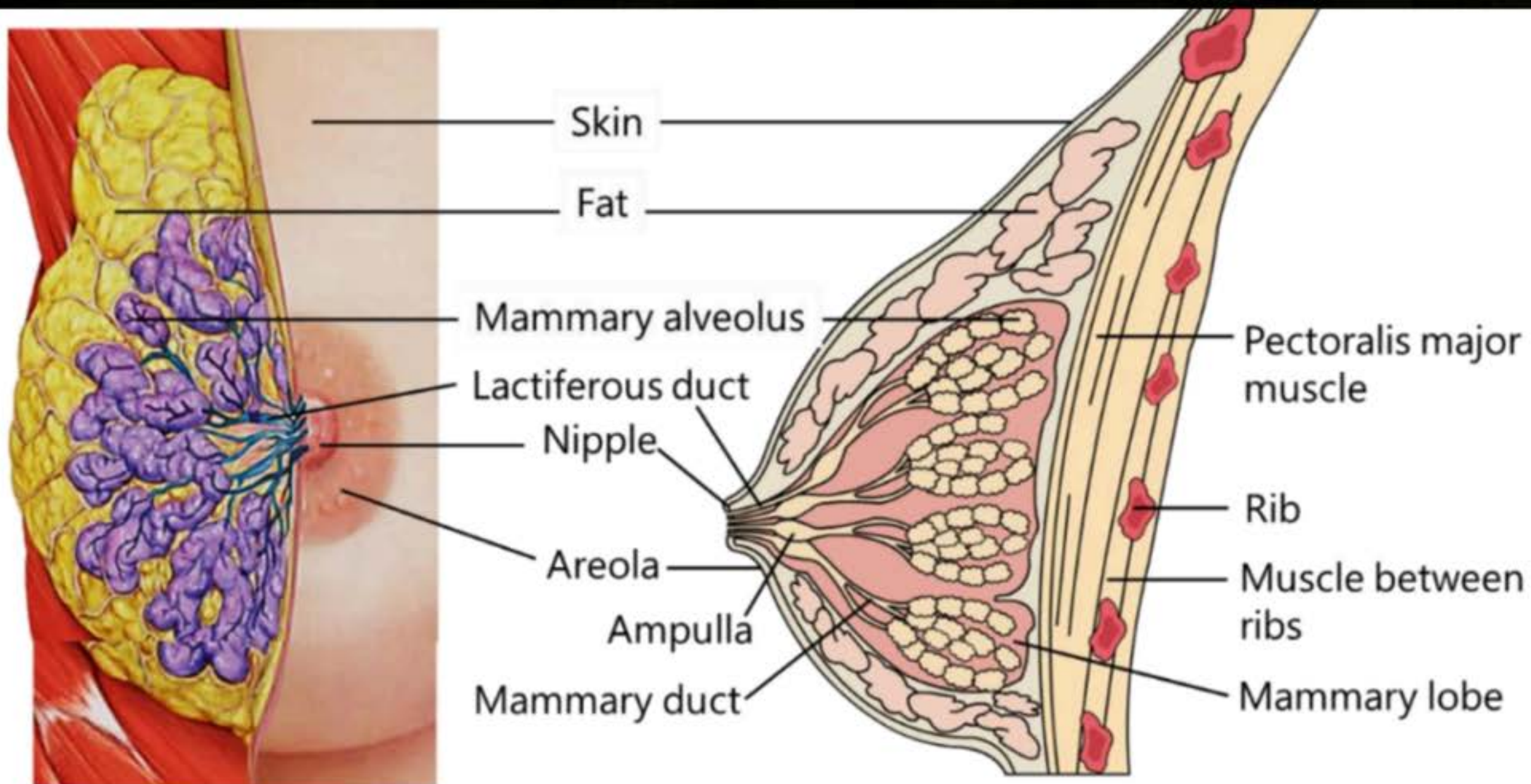
Mammary Tubules

Alveolar cells secrete milk & stored in lumen

Alveoli

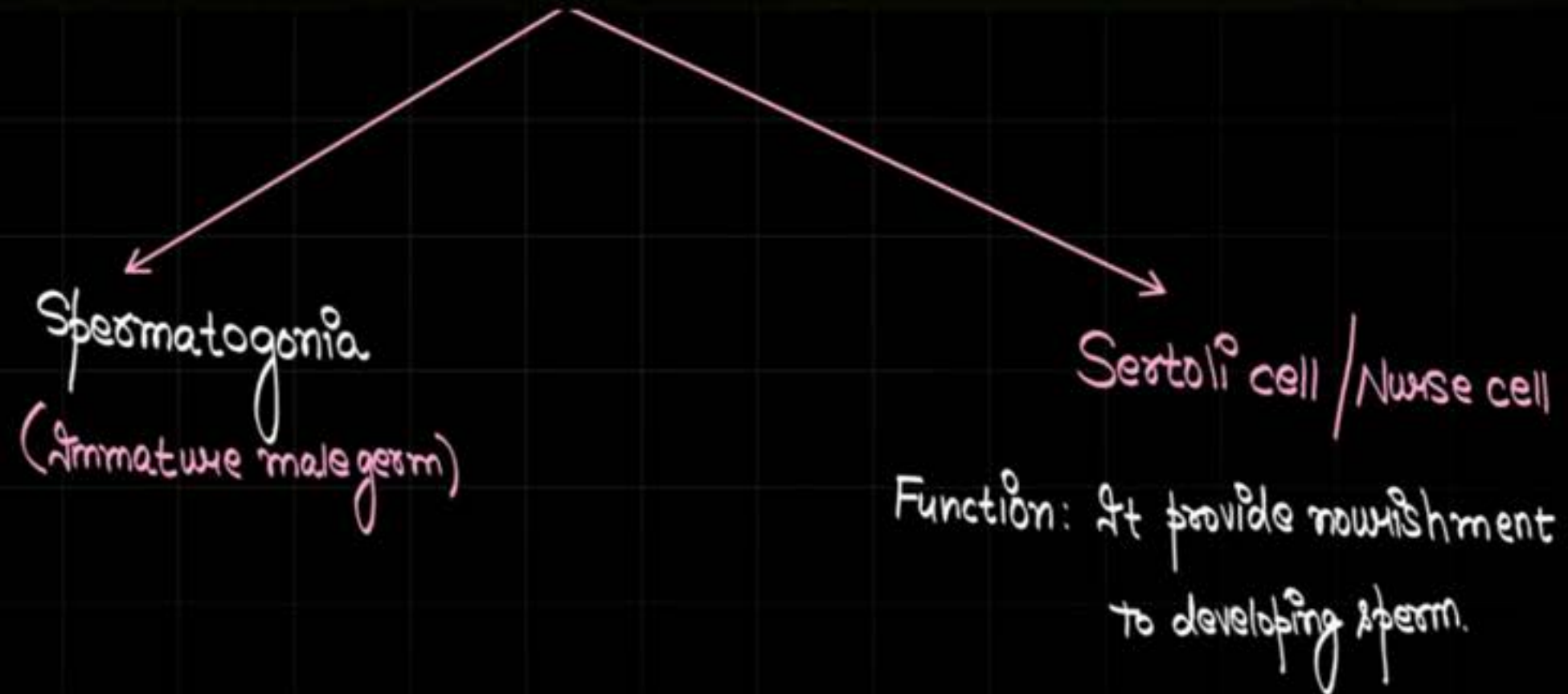
Mammary lobes (15-20)

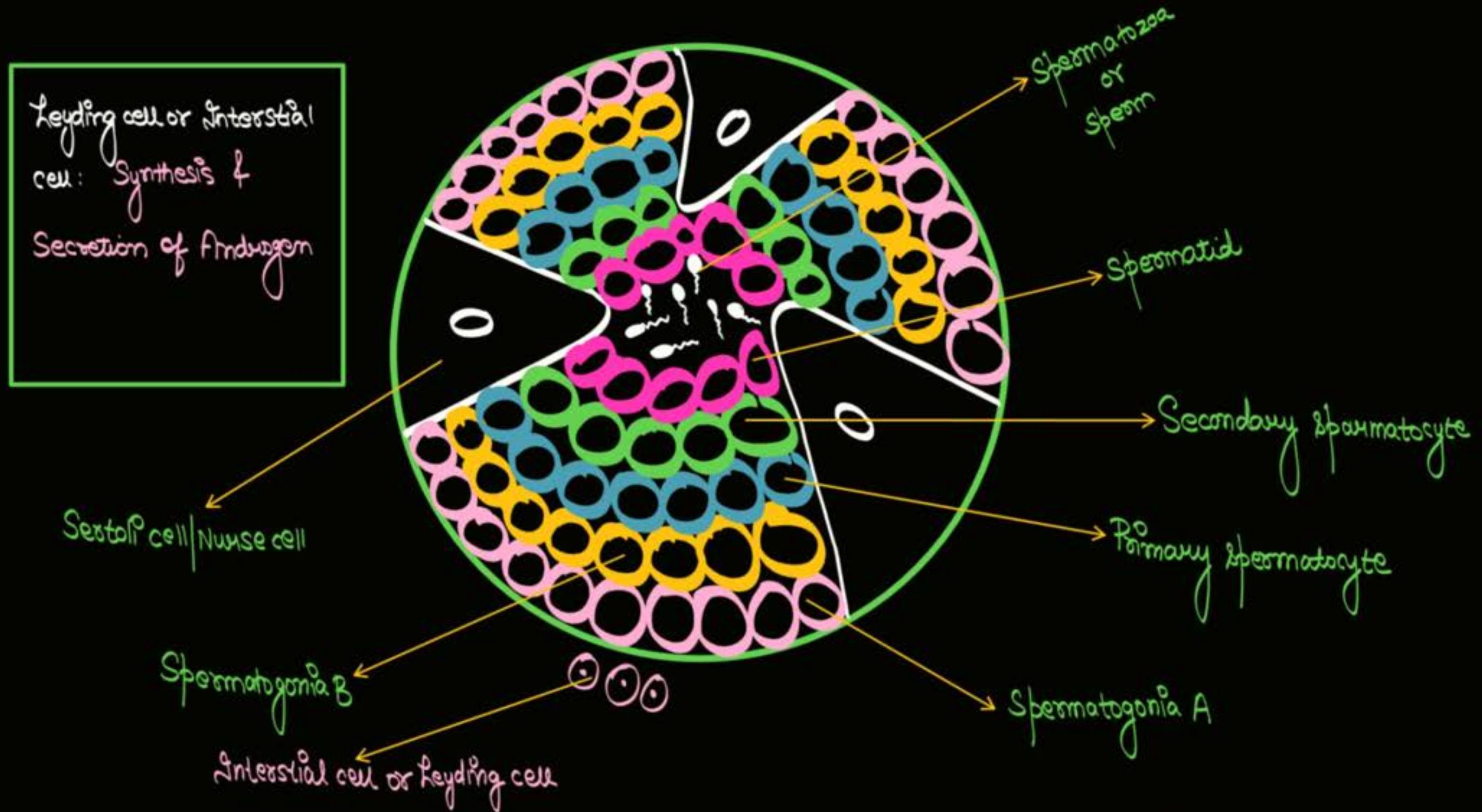




HISTOLOGY OF SEMINIFEROUS TUBULES:

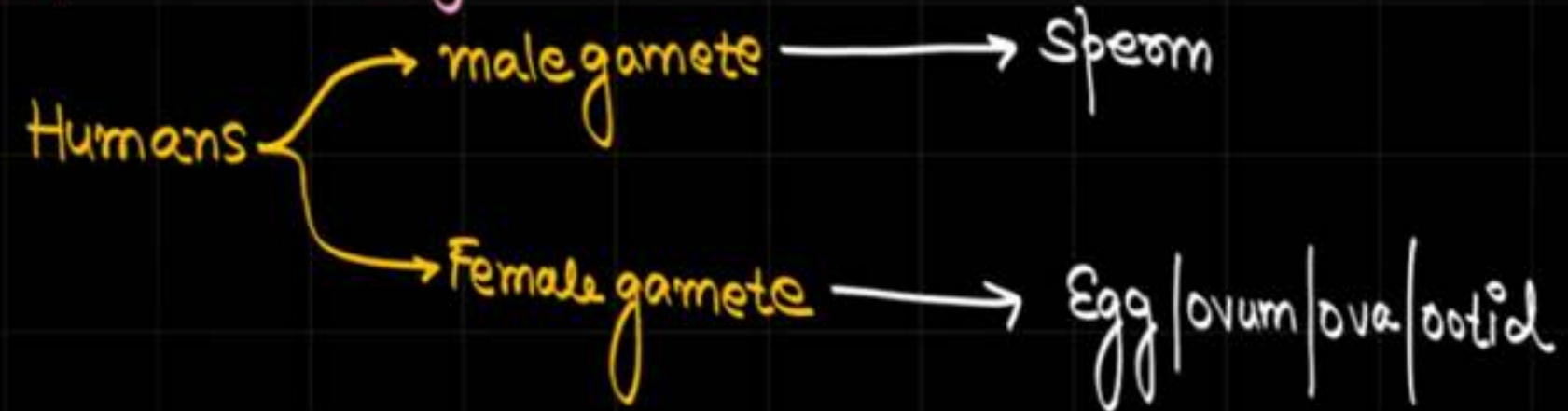
- Each seminiferous tubule is lined on its inside by two types of cells





GAMETOGENESIS

It is process of formation of gamete



Spermatogenesis: It is process of formation of sperm (male gamete)

Oogenesis: It is the process of formation of egg/ovum/ova/ootid

Gametogenesis is divided in three stages:

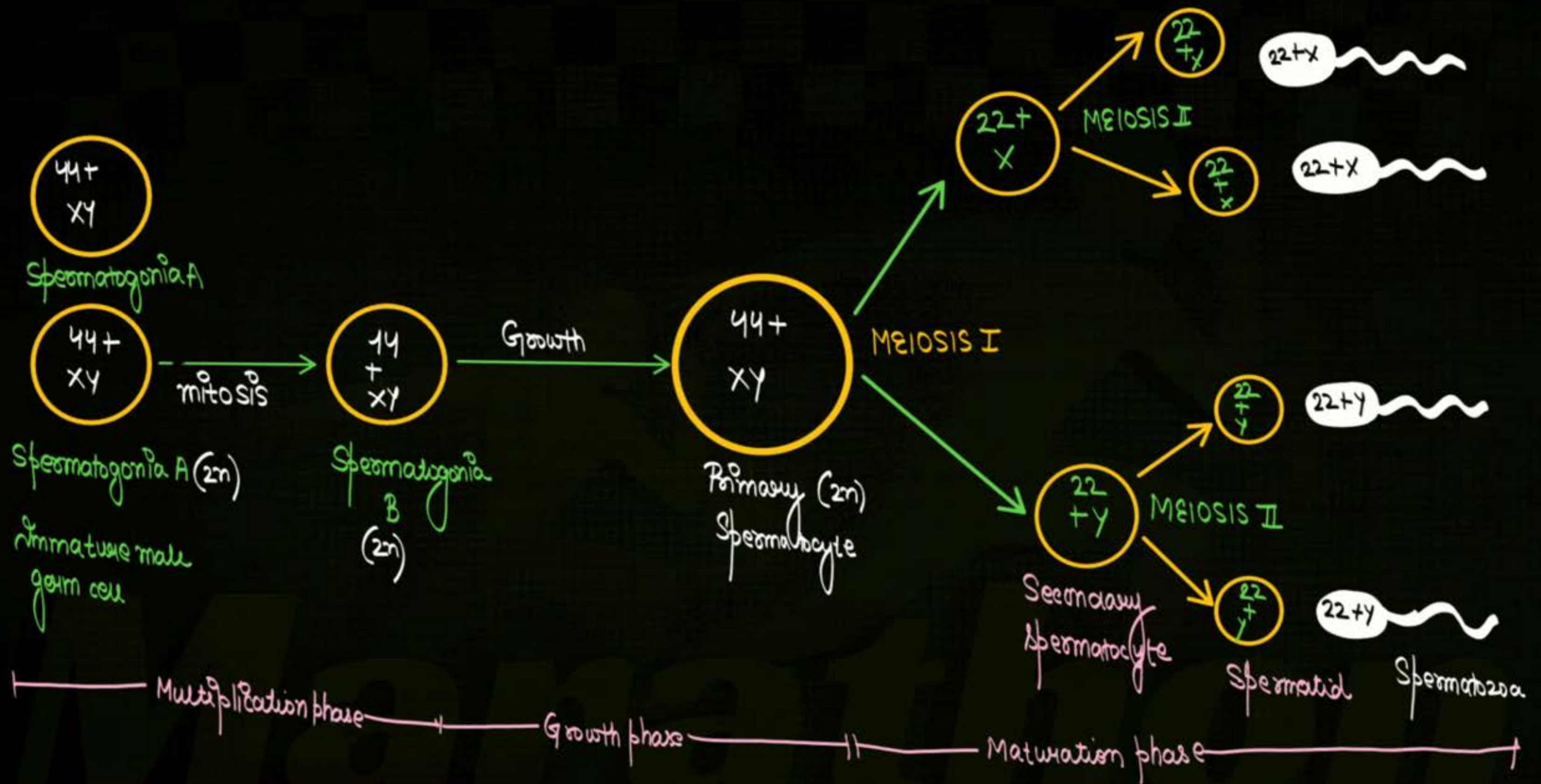
- (i) Multiplication phase
- (ii) Growth phase
- (iii) Maturation phase

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SPERMATOGENESIS

In humans, spermatogenesis takes 65–75 days.

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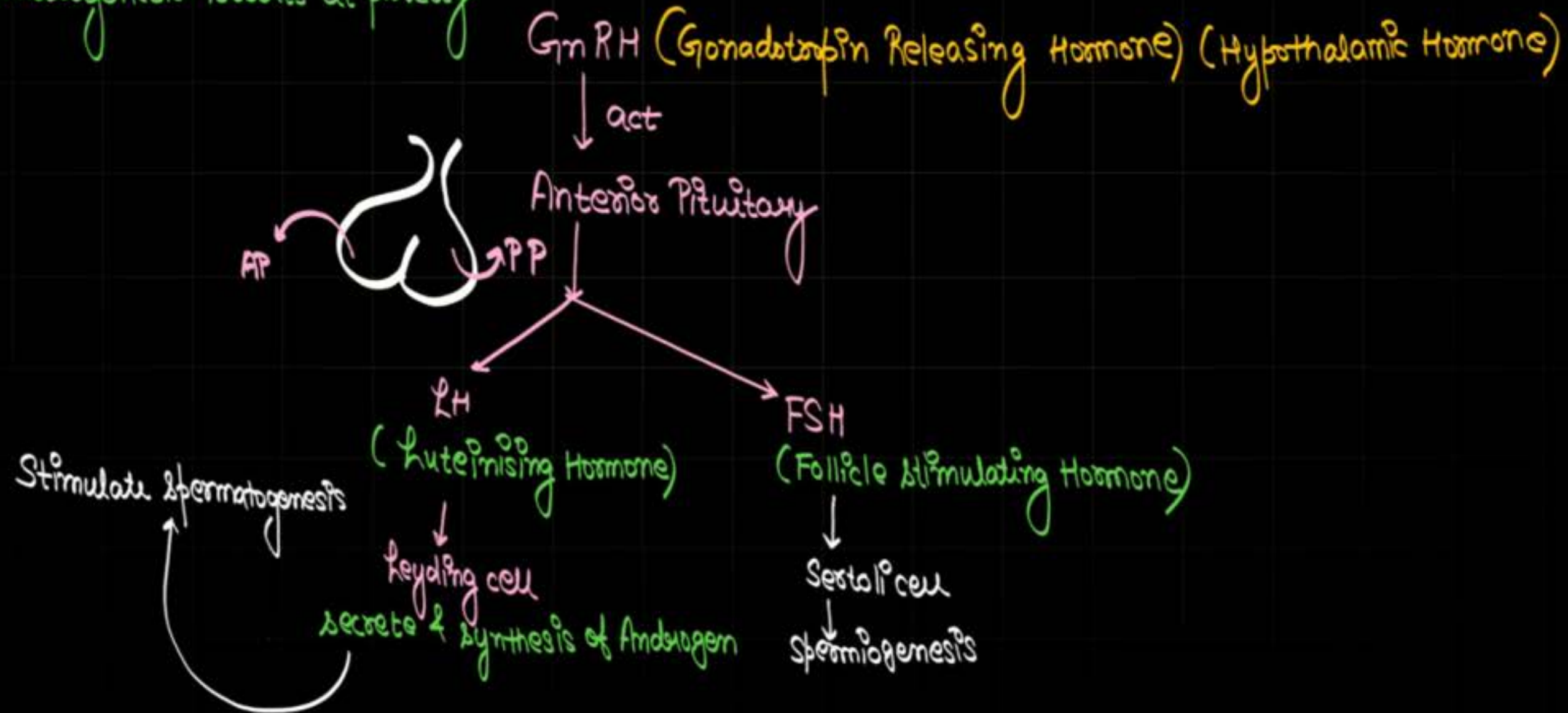
Spermiogenesis : It is the process of Transformation of spermatid into spermatozoa.

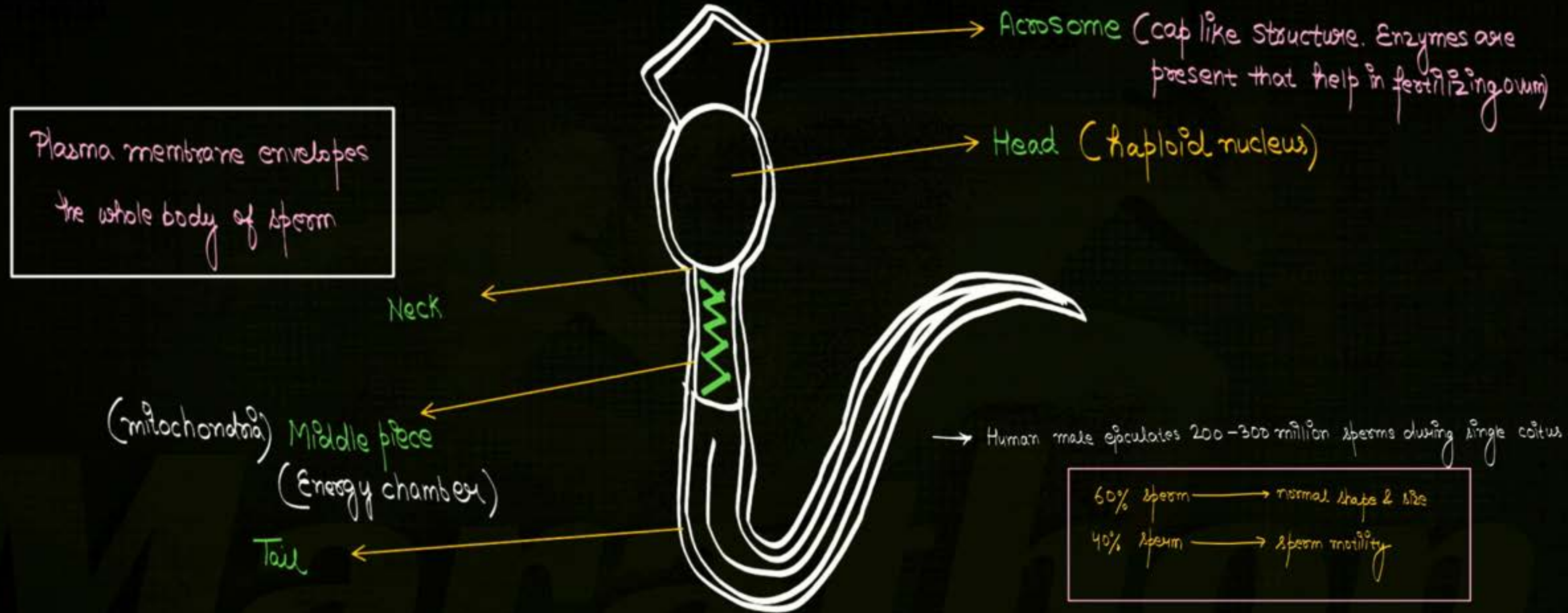
Spermiation

Release of sperm into the lumen of seminiferous tubule from Sertoli cell.

MALE REPRODUCTIVE HORMONES ★

Spermatogenesis starts at puberty





OÖGENESIS

Like spermatogenesis oogenesis process also can be divided into three stages:

- a. Multiplication phase
- b. Growth phase
- c. Maturation phase

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PROCESS OF OOGENESIS

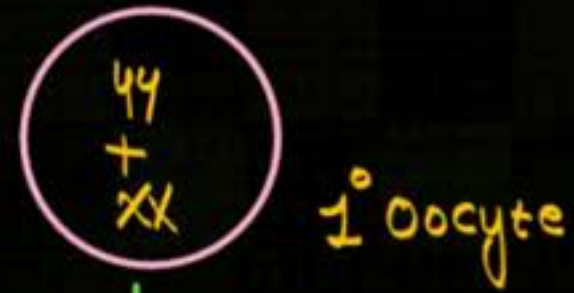


Intrauterine life



Multiplication Phase

Growth Phase



1° Oocyte

Meiosis I
(get arrested at prophase I)

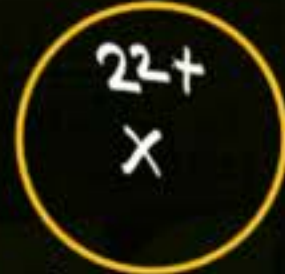


Primary oocyte

At time Birth

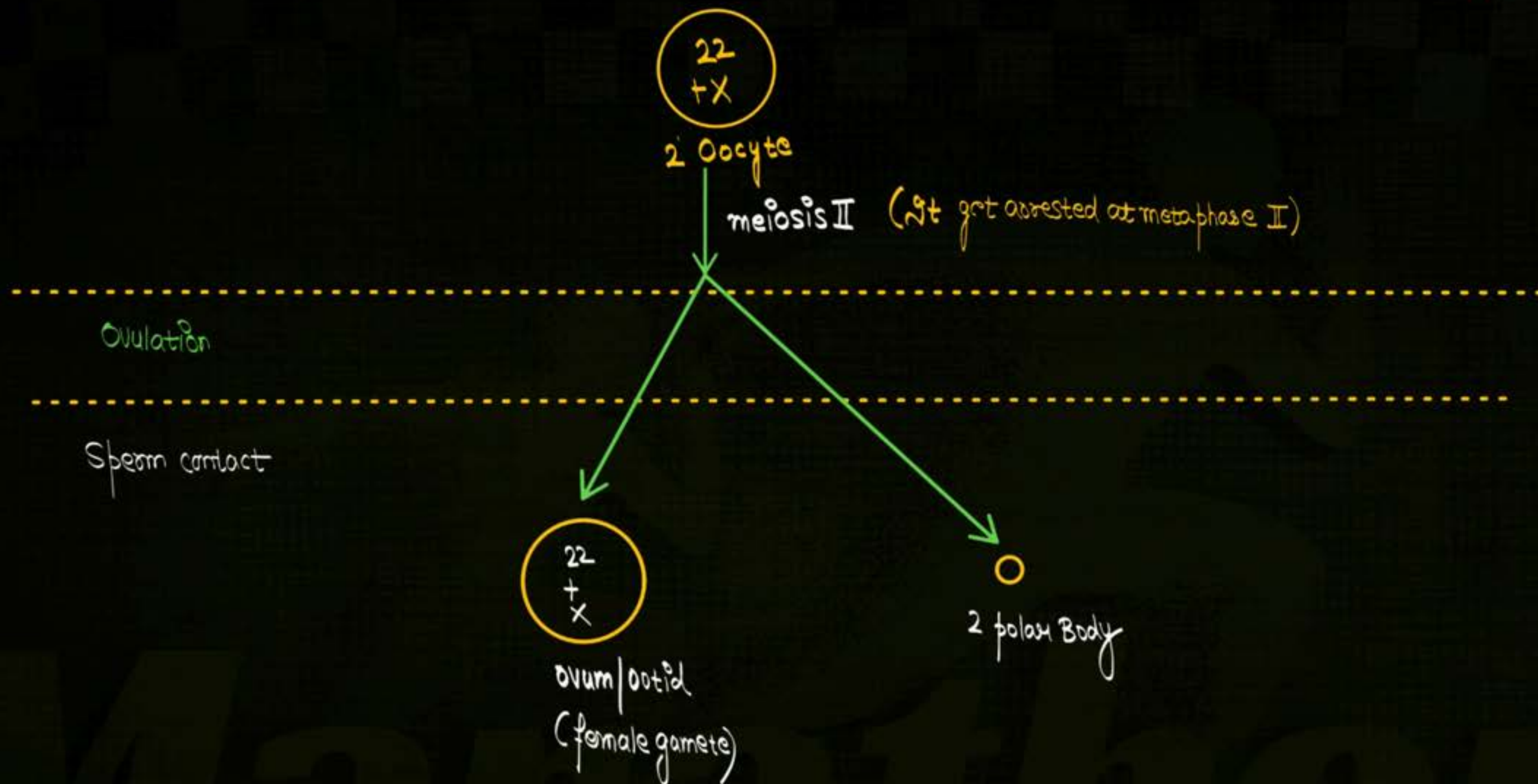
2 lakhs to 20 lakhs of primary oocyte remains in each ovary

Puberty → 60,000 - 80,000
Primary oocyte



2° Oocyte

1st polar Body

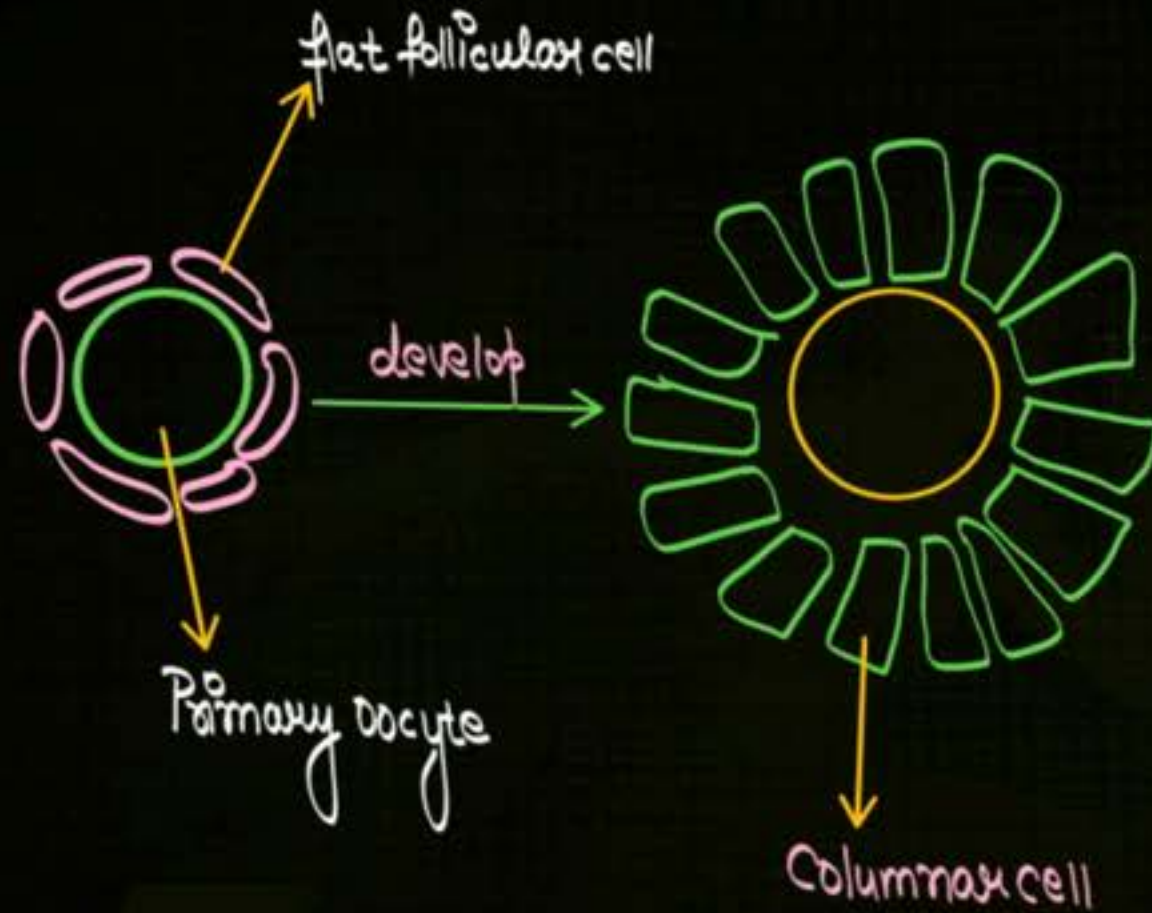


FORMATION OF OVARIAN OR GRAAFIAN FOLLICLE

The stages of formation of Graafian follicle are as follows:

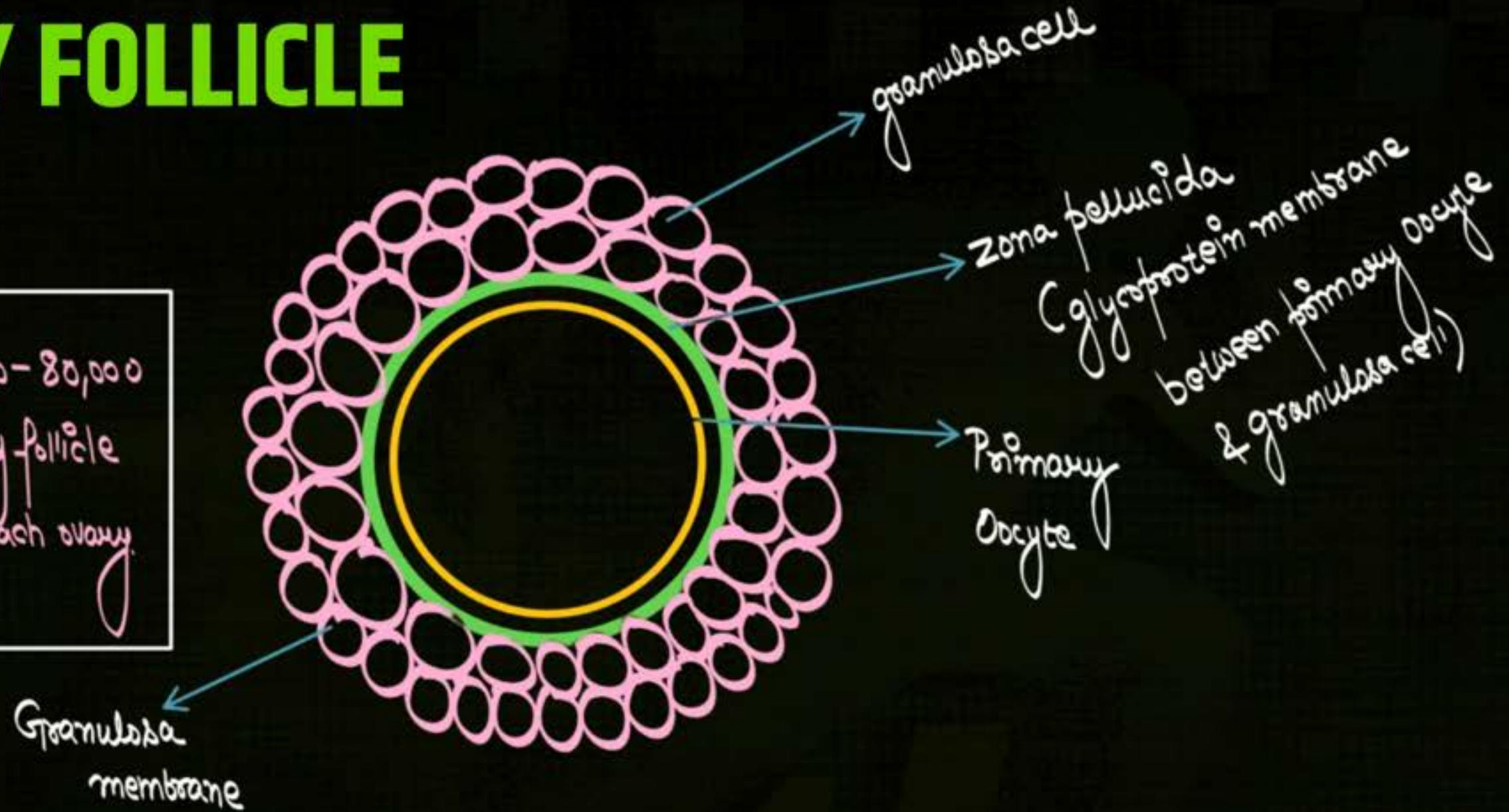
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PRIMORDIAL FOLLICLE (DEVELOPING PRIMARY FOLLICLE) :-

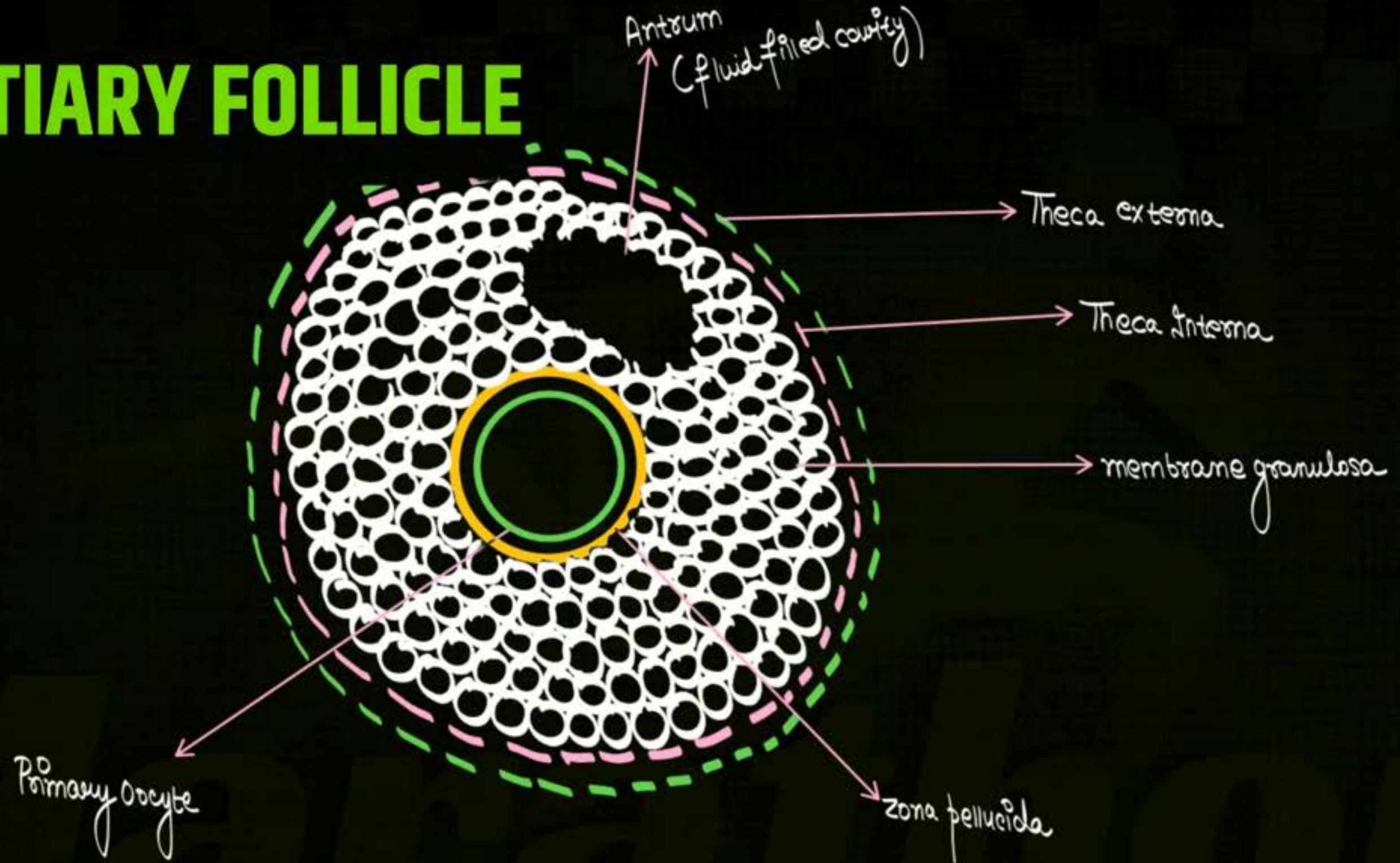


PRIMARY FOLLICLE

At puberty— 60,000–80,000
Primary follicle
left in each ovary.



TERTIARY FOLLICLE



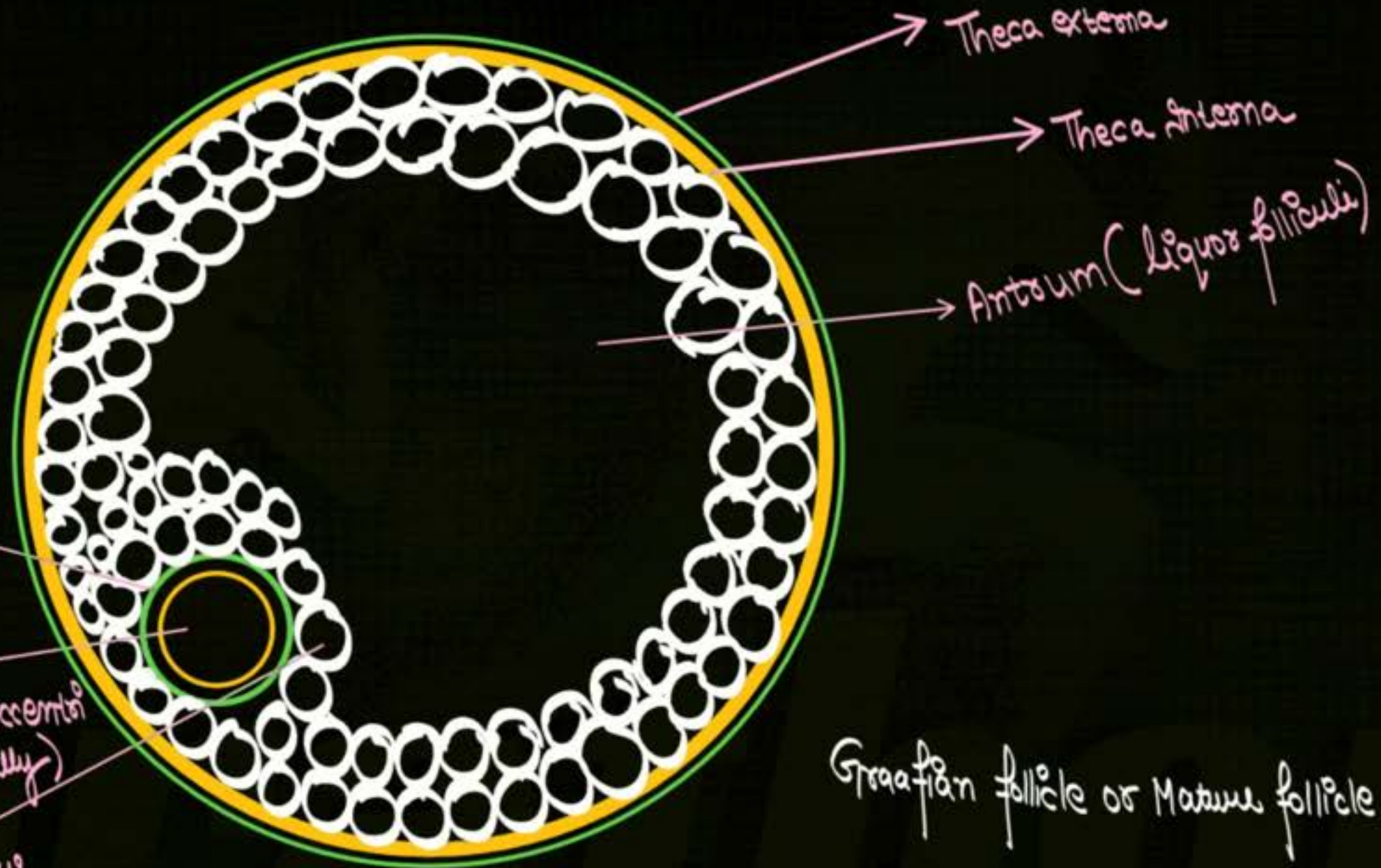
MATURE TERTIARY FOLLICLE / GRAAFIAN FOLLICLE:

During 14th Day of menstrual cycle graafian follicle ruptures & secondary Oocyte is released

zona pellucida

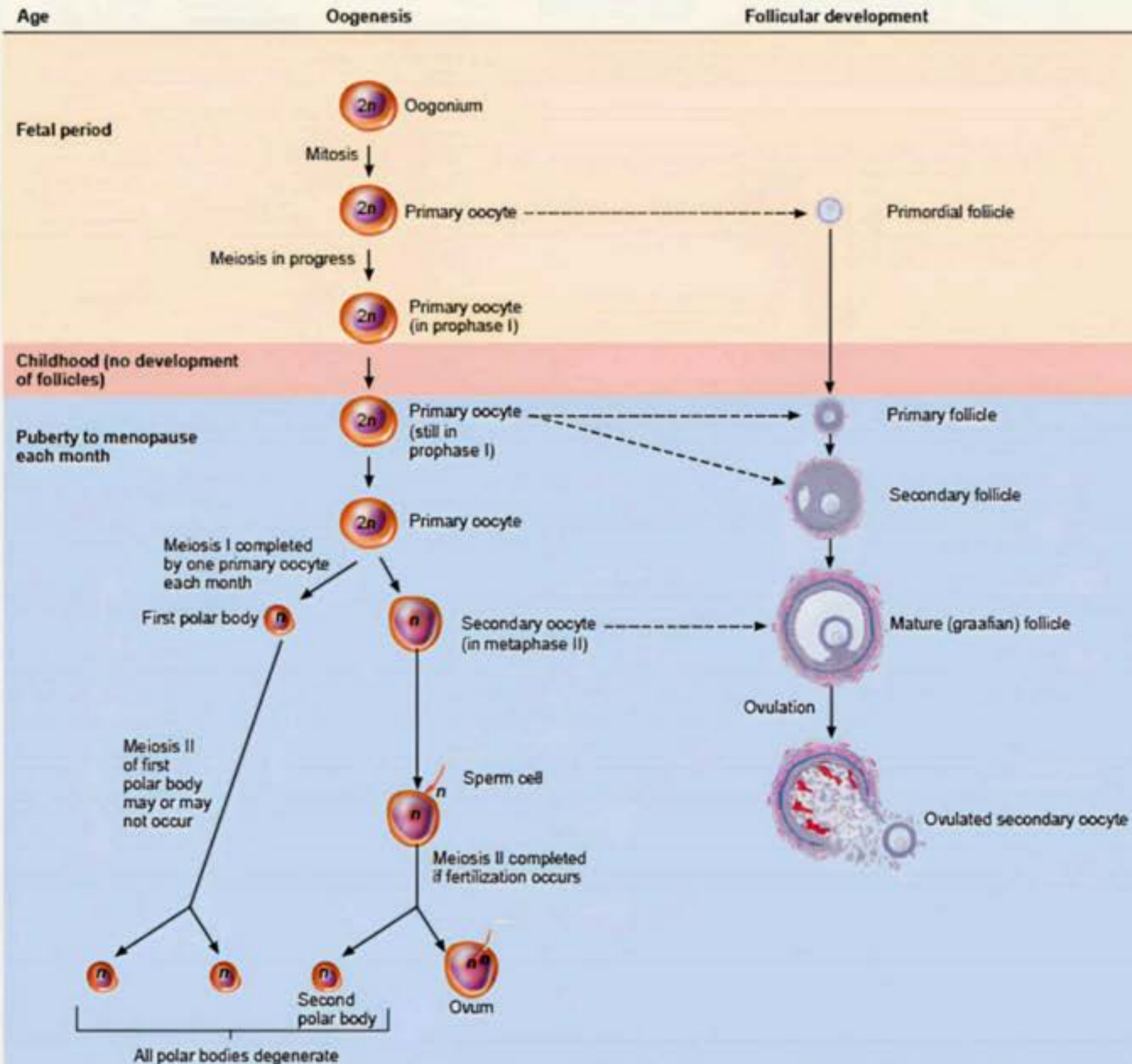
Secondary Oocyte (1st eccentric - callus)

Cumulus Oophorus



Graafian follicle or Mature follicle

Summary of Oogenesis and Follicular Development



MENSTRUAL CYCLE ★

The reproductive cycle in the female primates (e.g. monkeys, apes and human beings) is called menstrual cycle.

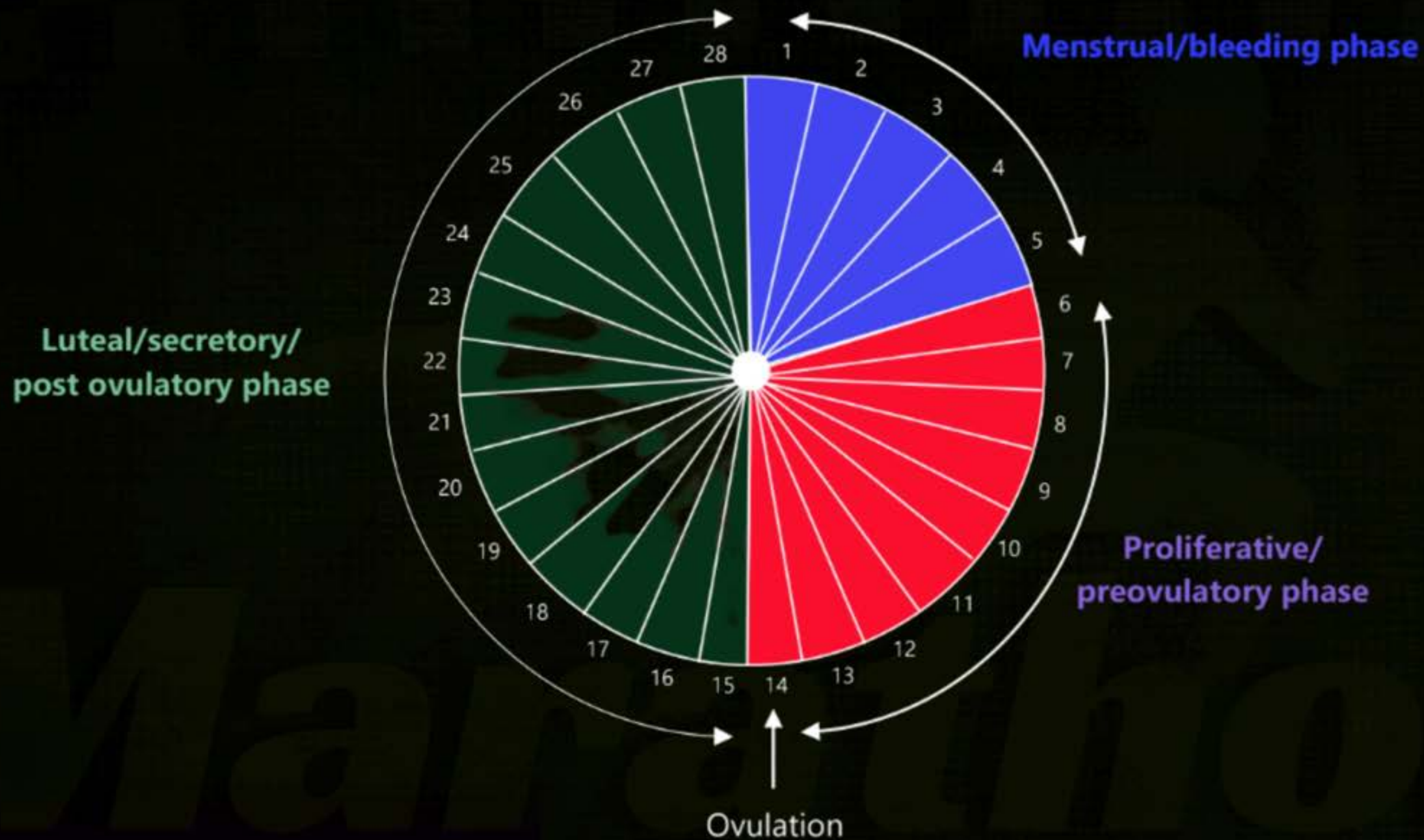
The first menstruation begins at puberty and is called **menarche**.

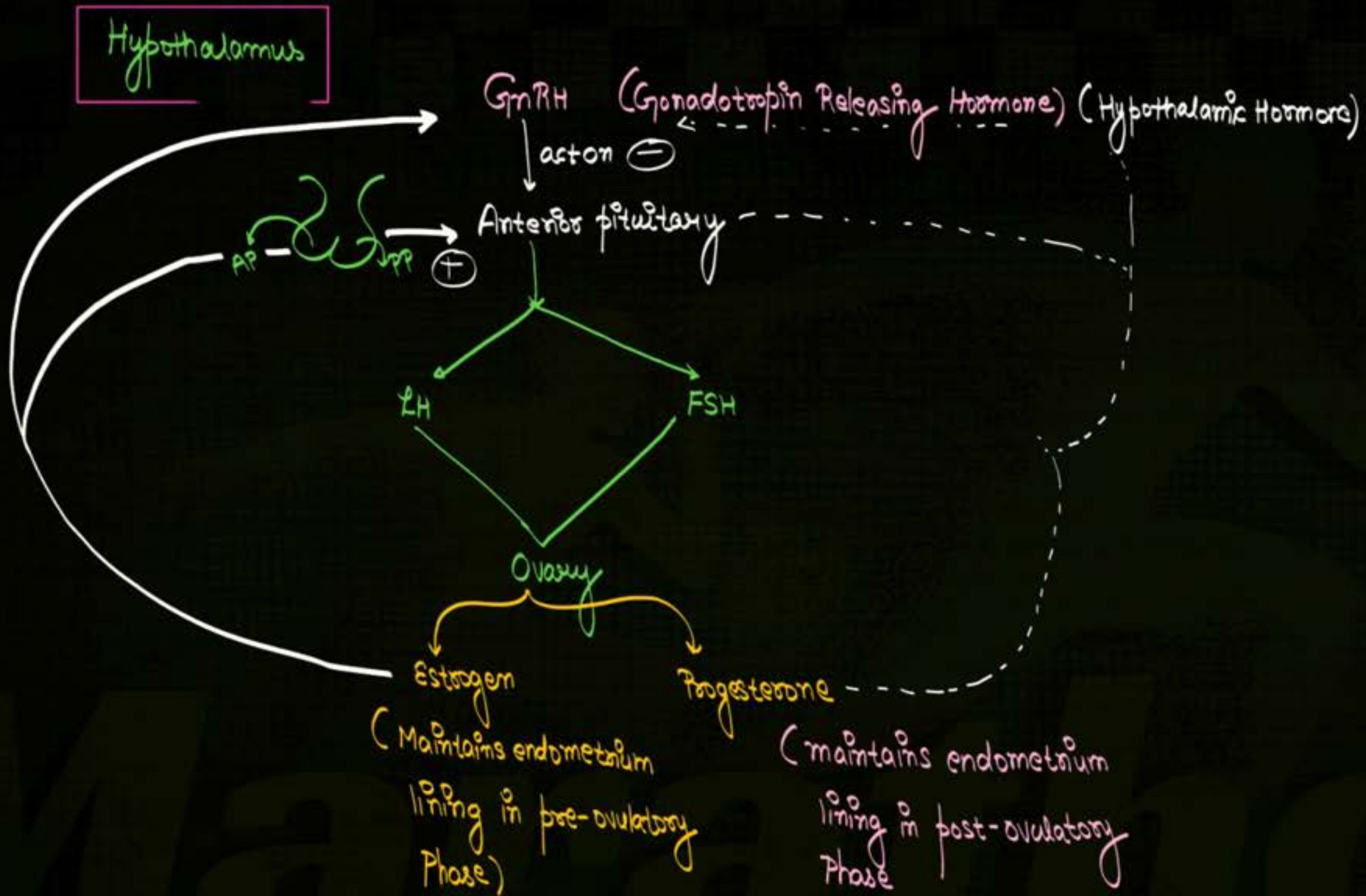
In human females, menstruation is repeated at an average interval of about 28/29 days, and the cycle of events starting from one menstruation till the next one is called the menstrual cycle.

MENSTRUAL CYCLE HAS THREE MAIN PHASES:

- Bleeding phase or menstruation phase.
- Proliferative/preovulatory/follicular phase.
- Secretory/post ovulatory/luteal phase

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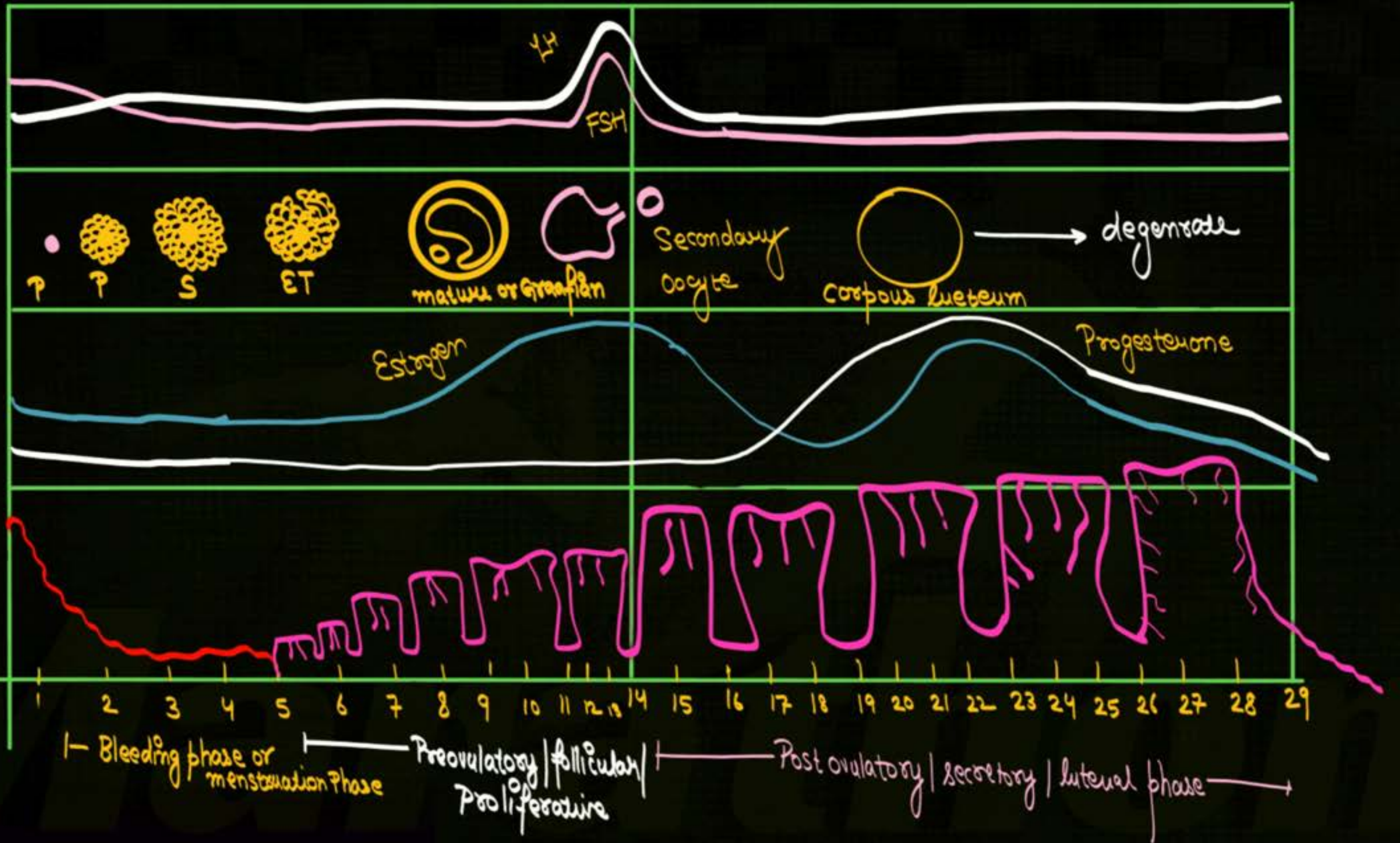
GnRH

Pituitary
Hormone
level

Ovarian
changes

Ovarian
Hormones
level

Uterine
changes



	Phase	Hormonal changes	Ovarian changes	Uterine changes
1. BLEEDING PHASE (4-5 DAYS)				
(a)	Initial stage	GnRH, FSH, LH, Estrogen and progesterone are low	Complete degeneration of corpus luteum into corpus albicans.	Due to withdrawal of sex hormones. This bleeding continues for 4-5 days and clotting does not occur due to presence of fibrinolytic enzymes. Average 40 to 80 ml blood loss per cycle.
(b)	Terminal stage	GnRH ↑, FSH ↑, LH ↑, due to Positive feedback by estrogen	6-12 primary follicles are stimulated and start formation of secondary follicle.	Uterine bleeding is gradually reduced.

	Phase	Hormonal changes	Ovarian changes	Uterine changes
2. FOLLICULAR/PROLIFERATIVE/ESTROGENIC/PREOVULATORY PHASE				
(a)	Initial stage	GnRH ↑, FSH ↑, LH ↑, Estrogen ↑	1-2 Secondary follicle → 1 Tertiary follicle	Uterine bleeding is stopped.
(b)	Terminal stage	High level of estrogen gives positive feedback which results in surge of LH & FSH.	Tertiary follicle → 1 mature tertiary follicle (Graafian follicle)	Increase in size of myometrial cells. Thickness of uterine wall is increased.

			Swelling of Graafian follicle due to increase in antral fluid. Synthesis of proteolytic enzymes resulting in rupturing of Graafian follicle & ovarian wall resulting in ovulation	
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	Phase	Hormonal changes	Ovarian changes	Uterine changes
LUTEAL/SECRETORY/PROGESTERONIC/POST-OVULATORY PHASE (Fix of 14 days)				
(a)	Initial stage	GnRH, LH, FSH are comparatively low than terminal state of follicular phase.	Ruptured graafian follicle ↓ Corpus hemorrhagicum Corpus luteum (maximum developed on 22nd day)	More secretory (glandular) and adhesive nature of endometrium. Thickness of uterine wall is maximum on 23rd day

(b)	Terminal stage	Increased progesterone give negative feedback GnRH, LH are significantly low. Decrease of progesterone and estrogen due to degeneration of corpus luteum	Degeneration of corpus luteum into corpus albicans begins (Corpus albicans formed on 28th day does not secrete any hormone)	Thickness of uterine wall decreases.
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- Lack of menstruation may be indicative of pregnancy. However, it may also be caused due to some other underlying causes like stress, poor health etc.
- In human beings, menstrual cycles ceases around 50 years of age; that is termed as **menopause**.

FERTILISATION

Fusion of male & female gamete $\xrightarrow{\text{fertilization}}$ Diploid zygote ($2n$)

Male & female gametes should present at a same time in fallopian tube for the process fertilization

Not all copulation result in pregnancy.

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(1) **Capacitation**: Sperm undergoes changes in female Reproductive tract & become capable to fertilize

Ovum

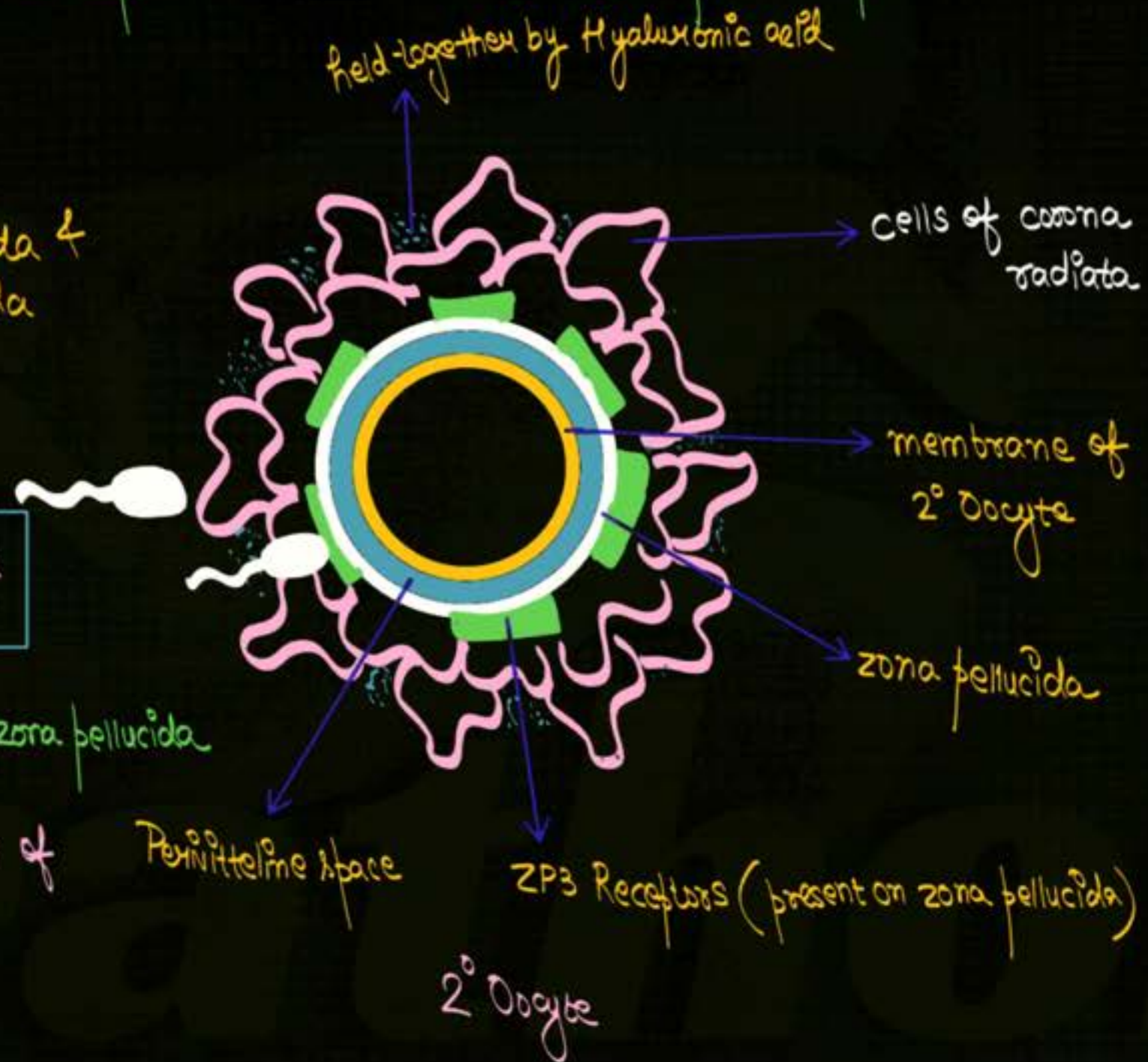
To Fertilize ovum sperm → Corona radiata & Zona pellucida

→ Enzyme that helps in penetration of

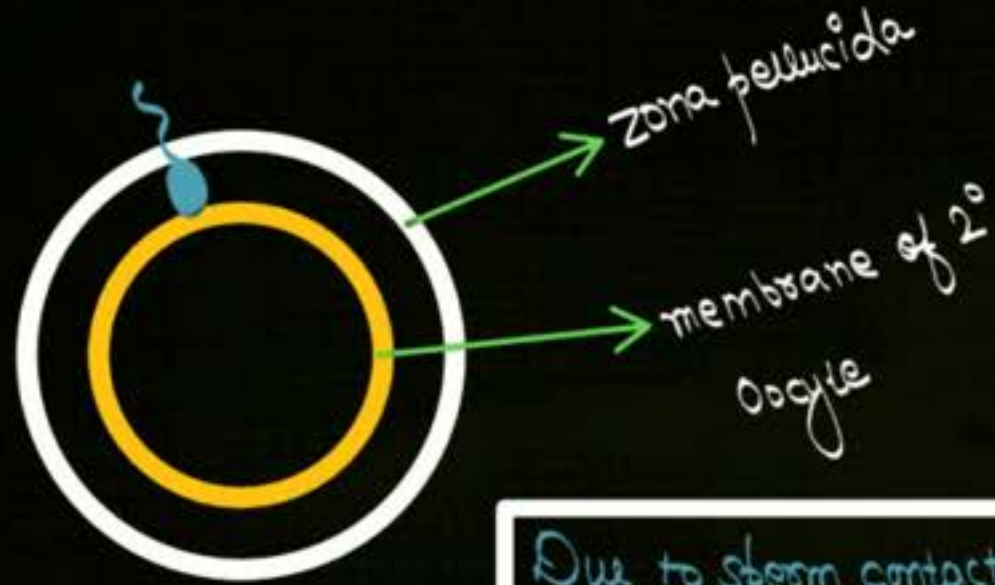
Corona radiata → **Hyaluronidase enzyme**

→ Sperm Bind to ZP3 Receptor that is present on zona pellucida

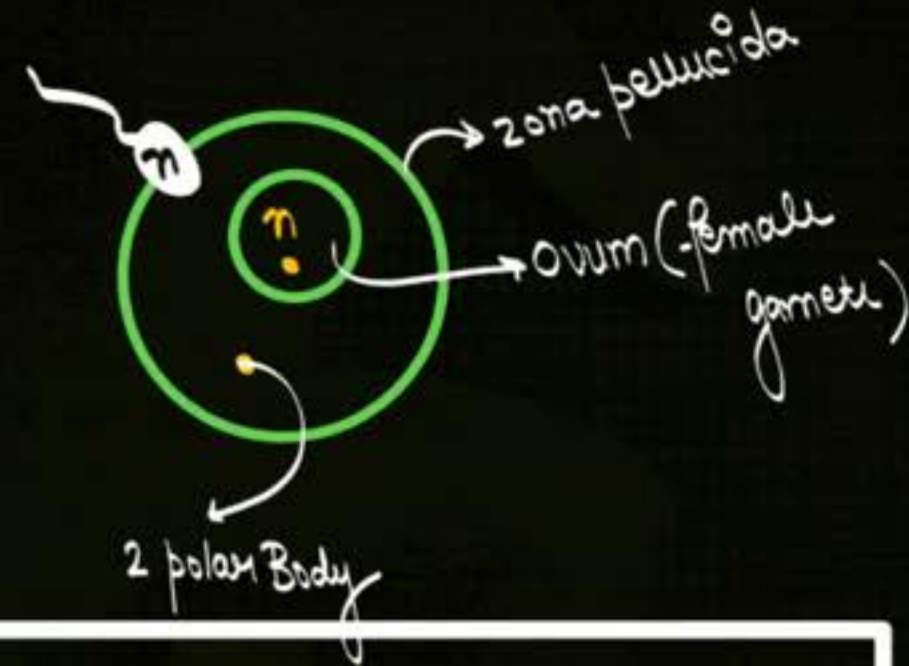
→ **Acrosin** (zona lysin enzyme) helps in penetration of
Zona Pellucida



Acosomal Rxn: Release of enzyme so that sperm can penetrate the membrane of oocyte



Due to sperm contact
2° oocyte complete its
meiosis II division
that result in formation
of ovum & 2 polar Body
(female gamete)

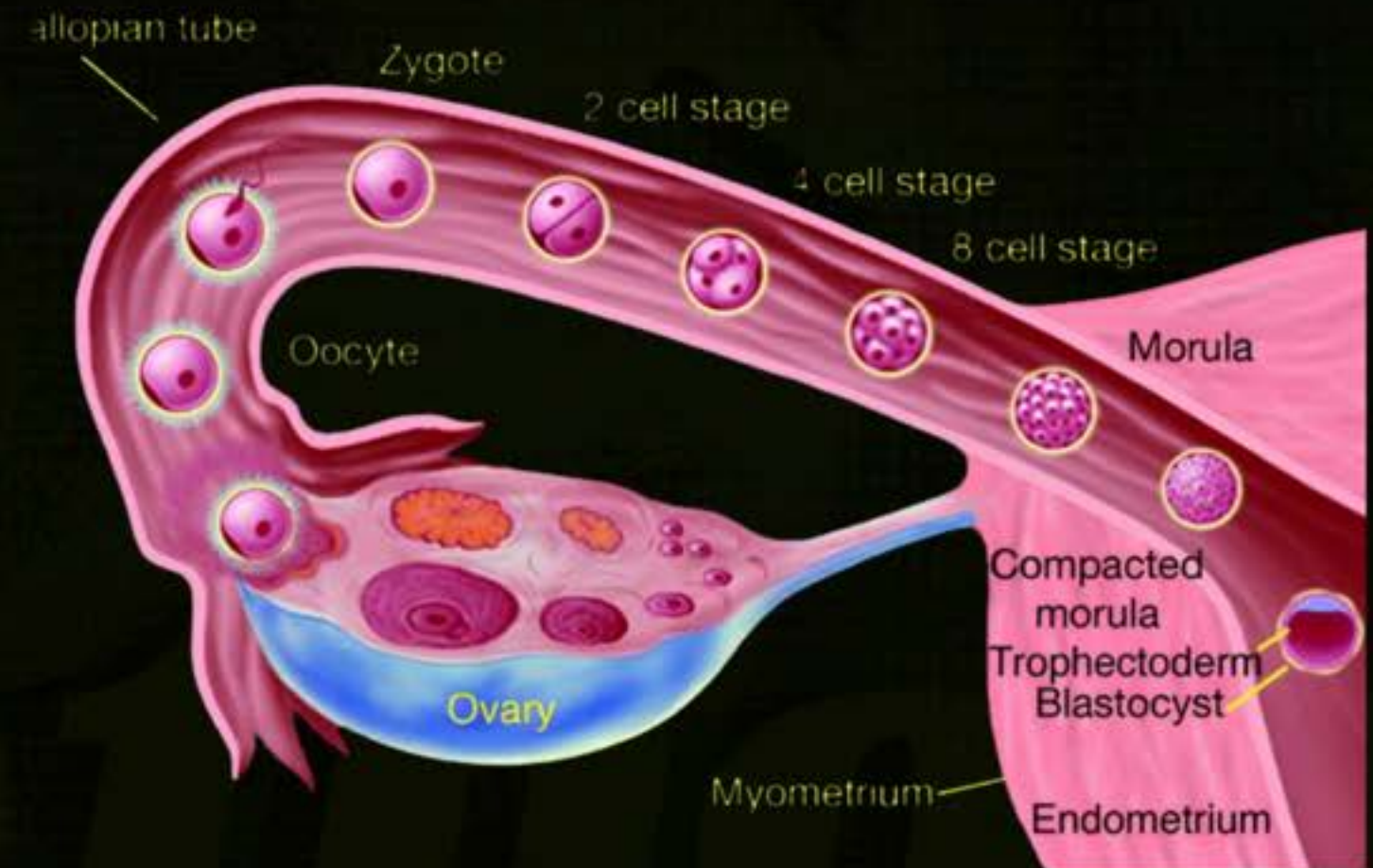
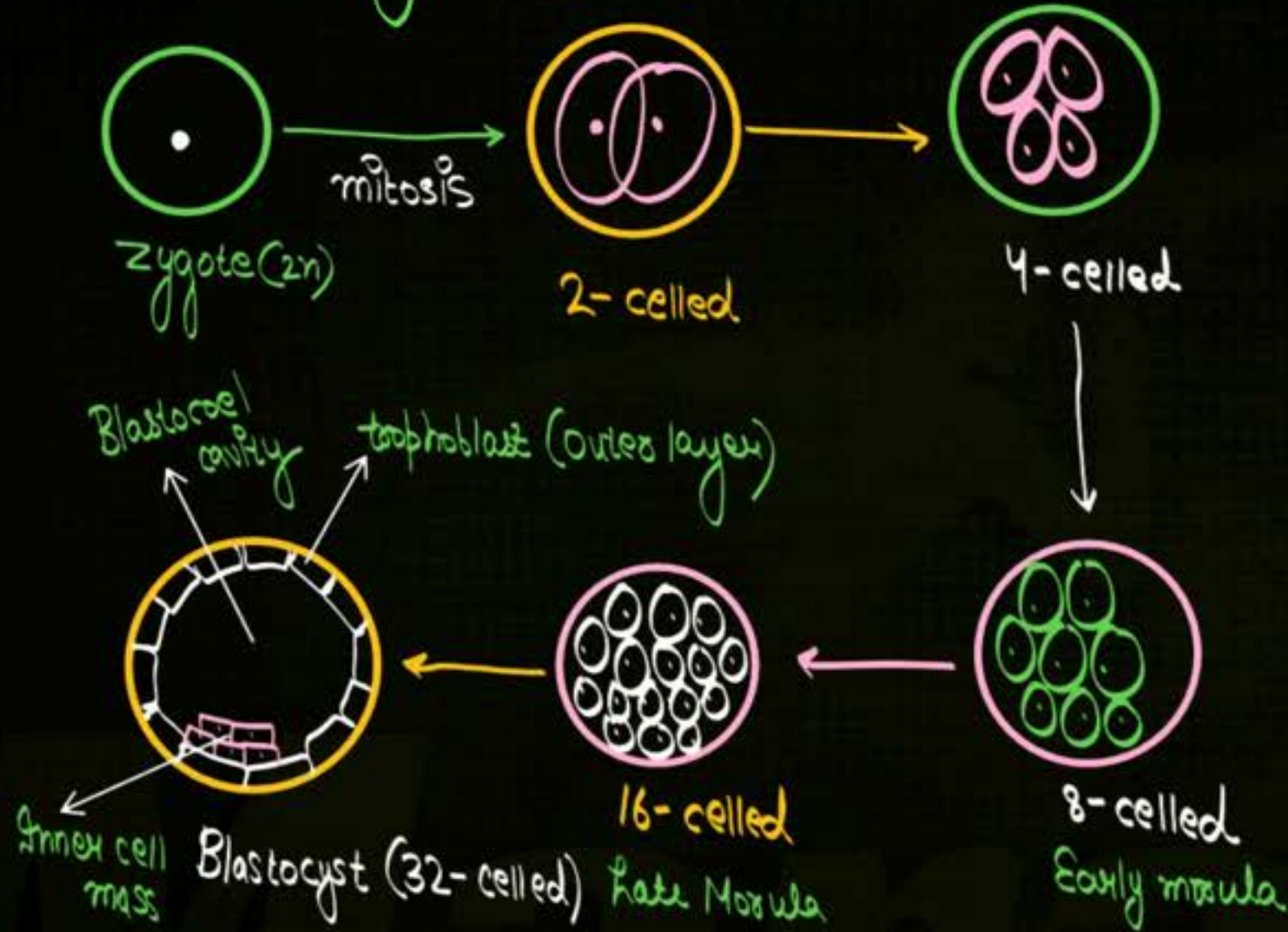


Fusion of male & female haploid nucleus
that result in formation of Diploid Zygote (2n)

Cleavage:

Zygote divides mitotically when it travels from Isthmus to Uterus

8-16 Blastomere → morula



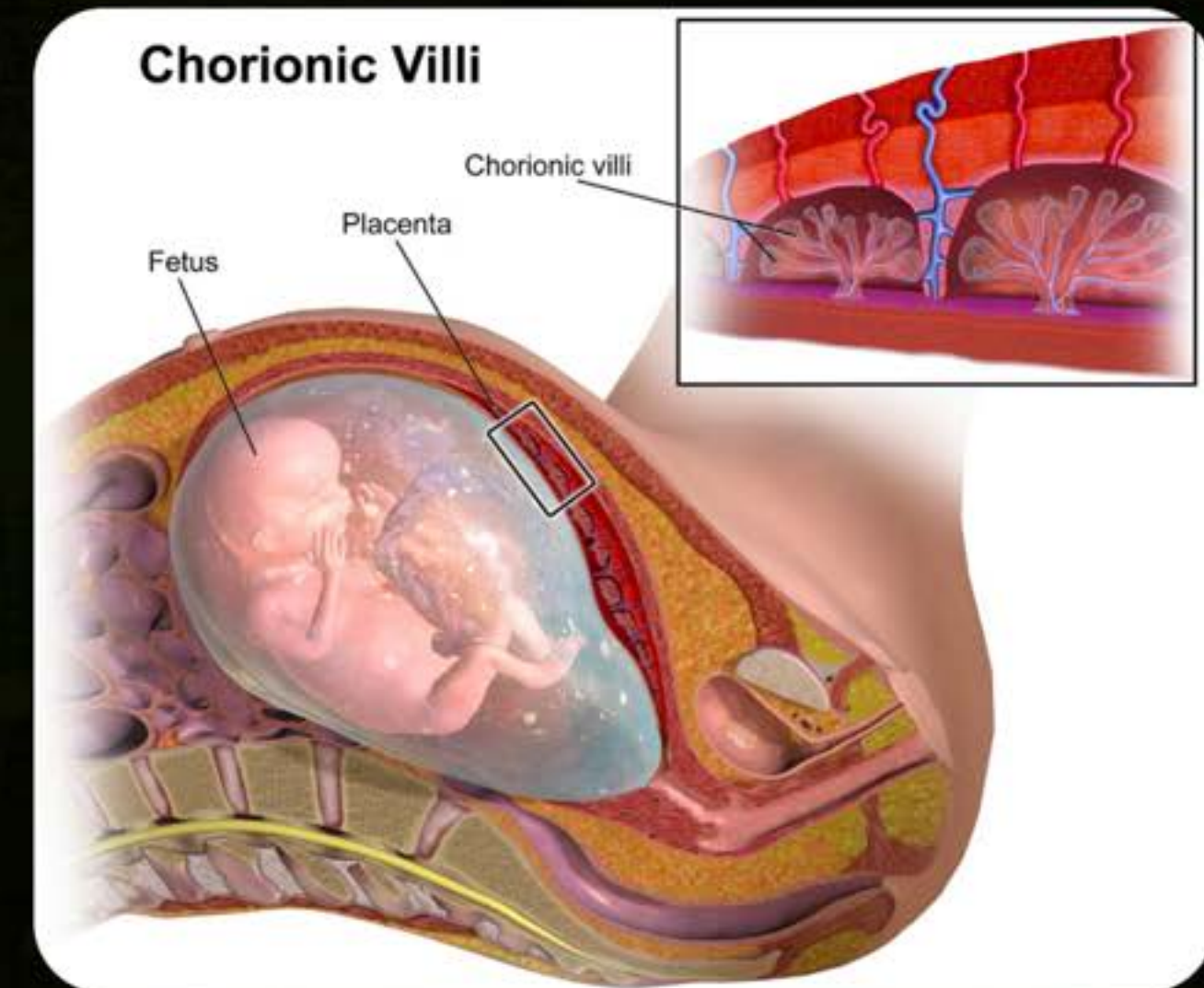
Inner cell mass $\xrightarrow{\text{differentiate}}$ Embryo
Trophoblast $\longrightarrow$ attaches to endometrium
of uterus

Blastocyst attaches to the endometrium
of uterus

Uterine cells divide rapidly & they cover
the Blastocyst & it gets embedded in uterus
this process is called Implantation & that
leads to pregnancy

PREGNANCY AND EMBRYONIC DEVELOPMENT

After implantation, finger-like projections appear on the trophoblast called chorionic villi which are surrounded by the uterine tissue and maternal blood

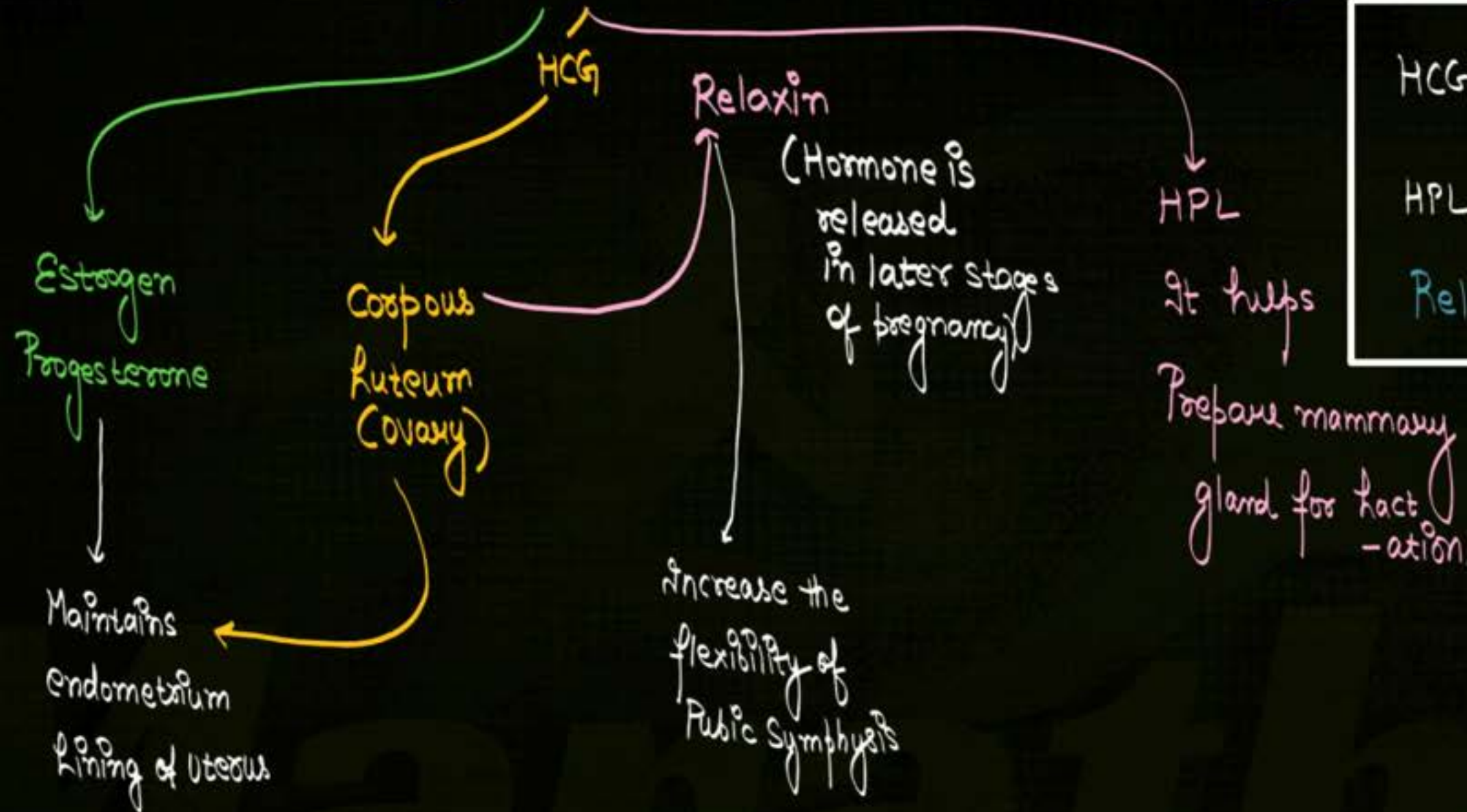


- The chorionic villi and uterine tissue become interdigitated with each other and jointly form a structural and functional unit between developing embryo (foetus) and maternal body called placenta
- The placenta is connected to the embryo through an umbilical cord which helps in the transport of substances to and from the embryo.



- The placenta facilitate the supply of oxygen and nutrients to the embryo and also removal of carbon dioxide and excretory/waste materials produced by the embryo.

PLACENTA (ENDOCRINE TISSUE)



Hormones secreted during pregnancy

HCG (Human chorionic
Gonadotropin)

HPL (Human Placental Lactogen)

Relaxin

- Inner Cell Mass differentiates into an outer layer called ectoderm and an inner layer called endoderm. Mesoderm soon appears between the ectoderm and the endoderm. These three layers give rise to all tissues (organs) in adults.
- Inner cell mass contains certain cells called stem cells which have the potency to give rise to all the tissues and organs.

SUMMARY OF DEVELOPMENTAL STAGES IN HUMAN

Pregnancy Stage	Development in Foetus
After 1 month	Embryo's heart is formed.
End of 2nd month	Foetus develops limbs and digits.
End of 12 weeks (First Trimester)	Most of the major organ systems are formed.
5th month	First movements of the foetus are observed and hair appears on the head.
End of 24 weeks (Second Trimester)	Body is covered with fine hair, eyelids separate, and eyelashes are formed
End of 9 months	Foetus is fully developed and ready for delivery.

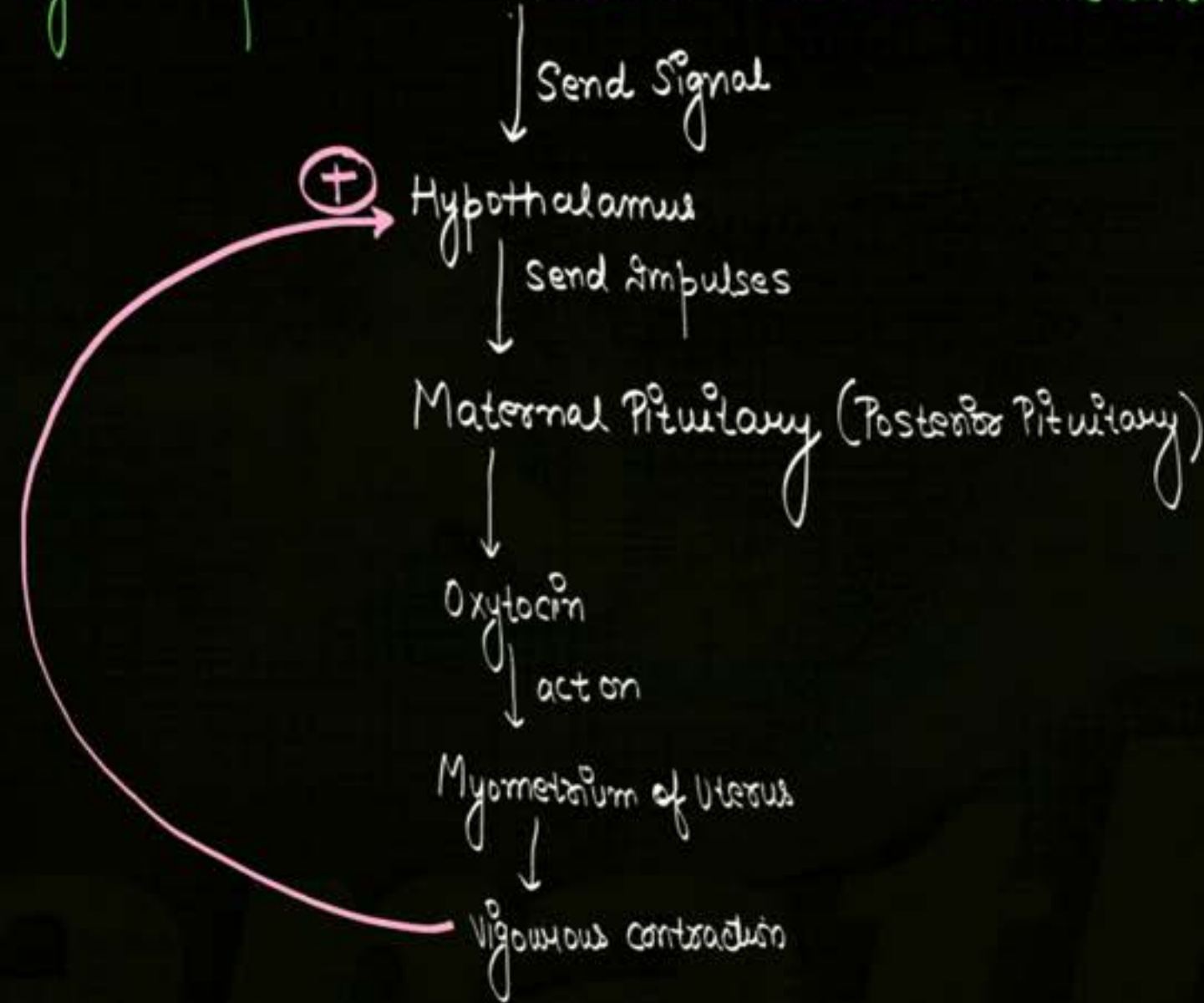
PARTURITION (Delivery of Baby.)

Gestation Period $\longrightarrow$ 9 month

Foetal Ejection Reflex $\longrightarrow$ Fully Developed Fetus & Placenta induce mild uterine contractions

Marathon

Fully Developed Fetus & Placenta induce mild uterine contraction

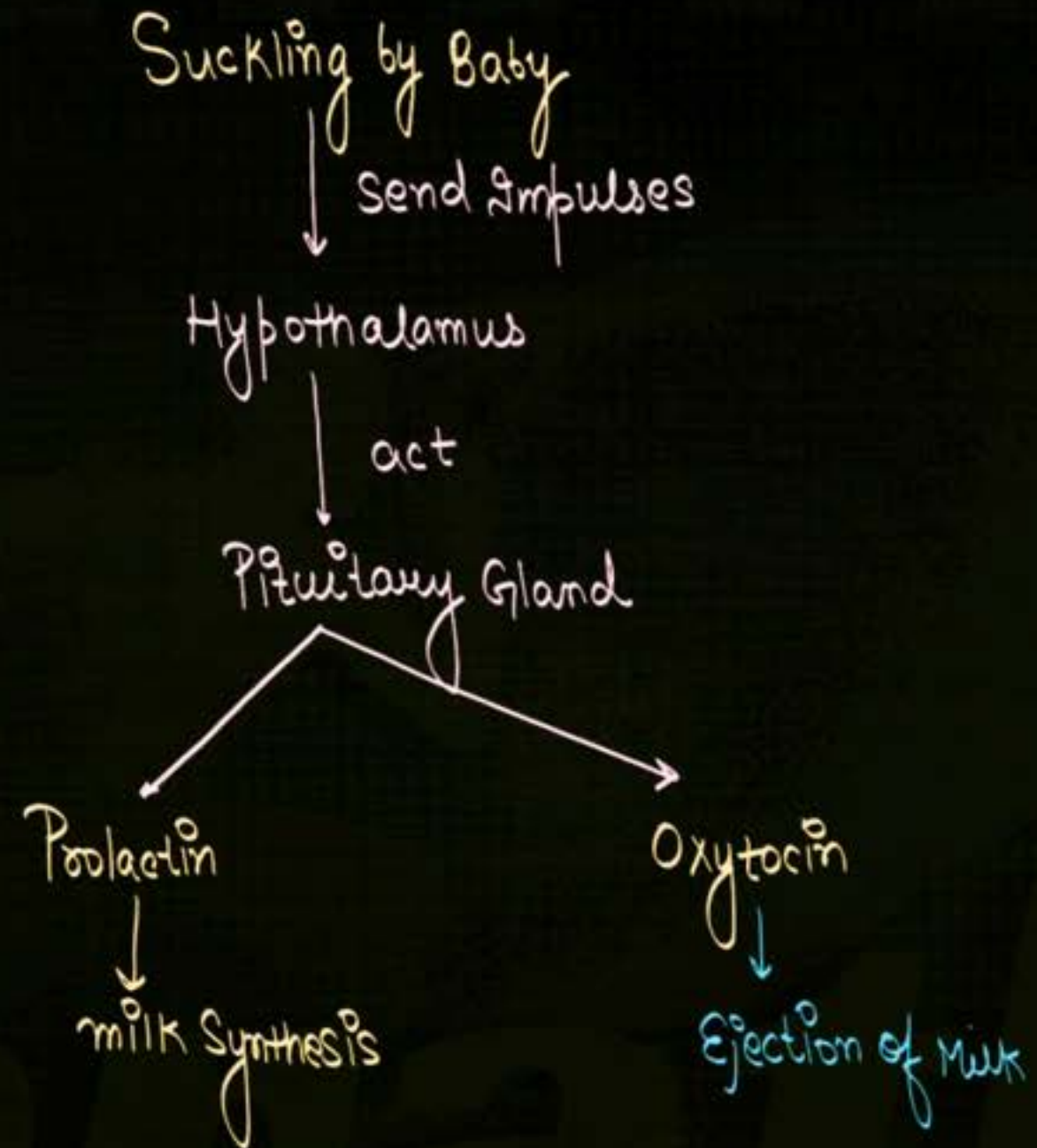


It is induced by
Complex neuro-
-endocrine mechanism

LACTATION

- The milk produced during the initial few days of lactation is called colostrum which contains several antibodies absolutely essential to develop resistance for the new-born babies.

Marathon



2 min

Reproductive Health

Chapter-3

REPRODUCTIVE HEALTH



According to WHO (World Health Organisation) well being in all aspects of Reproduction
Physical, mental, Emotional, social well being.

Marathon

REPRODUCTIVE HEALTH – PROBLEMS AND STRATEGIES

India was first country to launch action plans & programmes

→ Family planning (1951) ★

→ Improved programme → RCH (Reproductive & child Health care) ★

Goals:

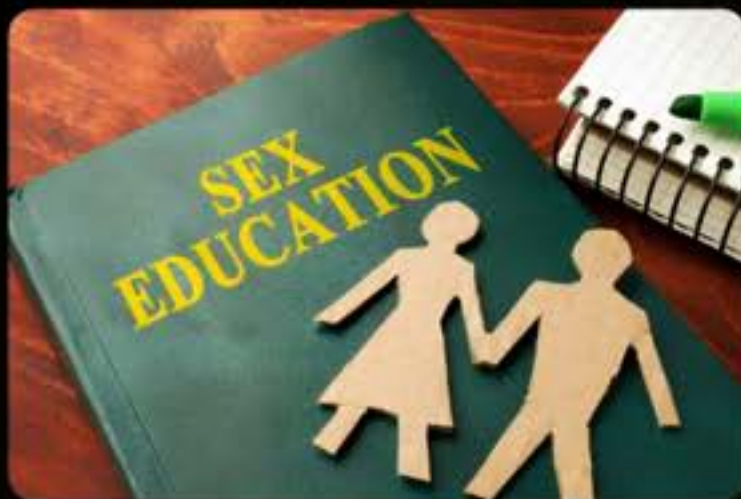
Used Audio visual & print media to Create Awareness:

- Introduction of Sex education in School
- Proper Information regarding Reproductive Health this will lead to Reproductively Healthy Society.
- STD (Sexually Transmitted Diseases).
- Adolescence & Age related changes
 - Uncontrolled population.
 - Birth control & Contraceptive methods.

- Proper Information Regarding Reproductive Organs
- Importance of Breast feeding, post natal care
- Social evils like sex abuse & sex related crime Rapes

Implementation of action plans & programmes required:

- Strong Infrastructure.
- professional expertise.
- Material support.



AMNIOCENTESIS

(Statutory Ban on Amniocentesis for Sex Determination)

Diagnostic prenatal test

Procedure With the help of needle Amniotic fluid is collected.

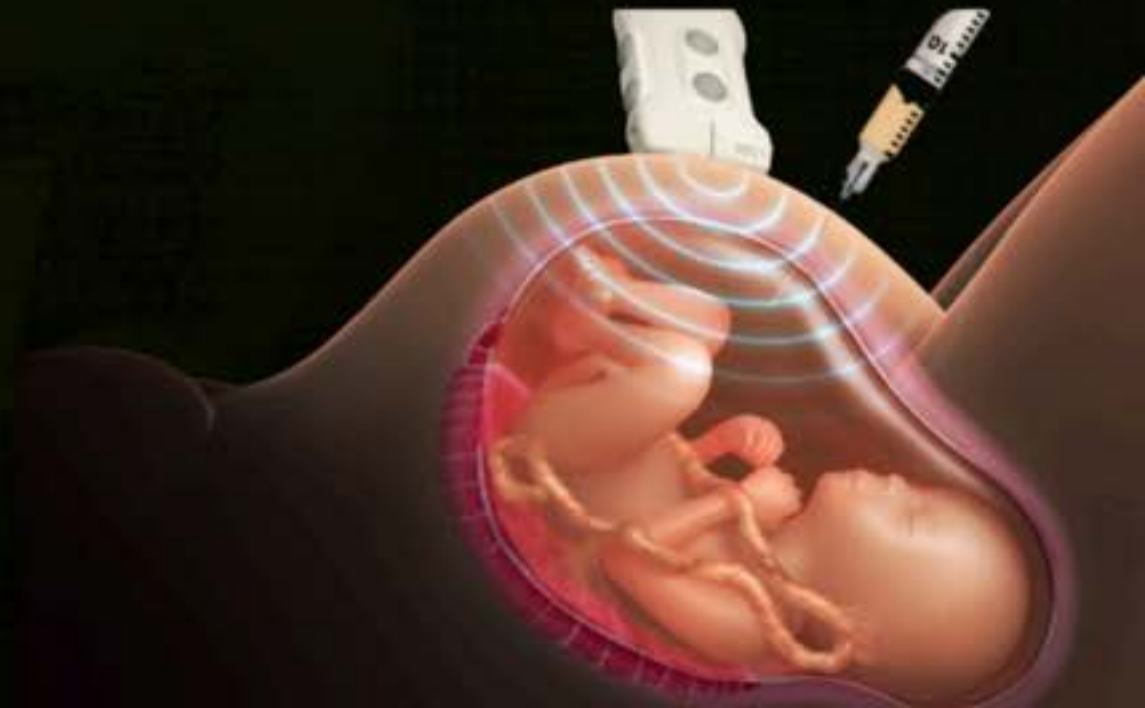
fetal cells are used to analyze

→ Genetic Disorder

→ Sickle cell Anemia

→ Sex Determination

Due to ↑ in female foeticide amniocentesis is ban for Sex Determination





Saheli (oral contraceptive pill for females)

non-steroidal developed by Scientist of CDRI (Central Drug Research Institute, Lucknow)

↑ number of medical Assisted deliveries : ↑ Post natal care



↓ • Maternal mortality rate (MMR) measures deaths of women during pregnancy or within 42 days of termination.

$$\text{MMR} = \left(\frac{\text{Number of Maternal Deaths}}{\text{Number of Live Births}} \right) \times 100,000$$



↓ • Infant mortality rate (IMR) measures deaths of infants under one year old.

$$\text{IMR} = \left(\frac{\text{Number of Deaths Under 1 Year of Age}}{\text{Number of Live Births}} \right) \times 1,000$$

POPULATION EXPLOSION AND BIRTH CONTROL

Data ★

Year	World Population
1900	2 Billion (2000 million)
2000	6 Billion
2011	7.2 Billion

Year	India
At the time of Independence	350 million
2000	close to 1 Billion
2011 (May)	1.2 Billion

Reasons :-

- ↓ in Maternal mortality rate
 - ↓ in Infant mortality rate
 - ↑ in number of people in Reproducible Age
- } due to medical assisted deliveries

Due to ↑ in population → Scarcity of Basic requirements (food, shelter & clothing)

Measures taken by Government to Control population:-

- Introduction of contraceptive methods.
- Advertisement/posters/bills etc (Hum do Hamare Do. EK bacha sibse ache)
- Adoption of "One child norm"
- Incentives
 - ↑ in marriageable age

Females	→	18 yrs
Males	→	21 yrs.

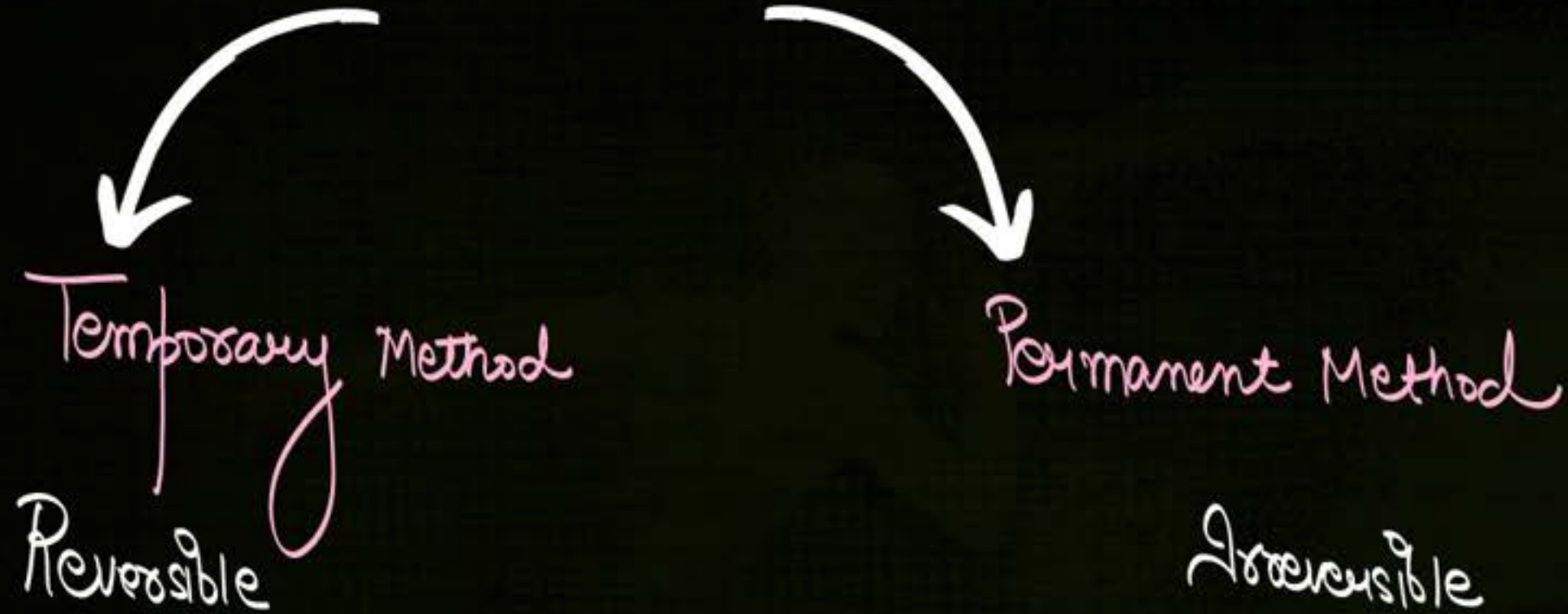
According to the 2011 census report, the population growth rate was still around 2 per cent i.e. 20/1000/year, a rate at which our population could increase rapidly.

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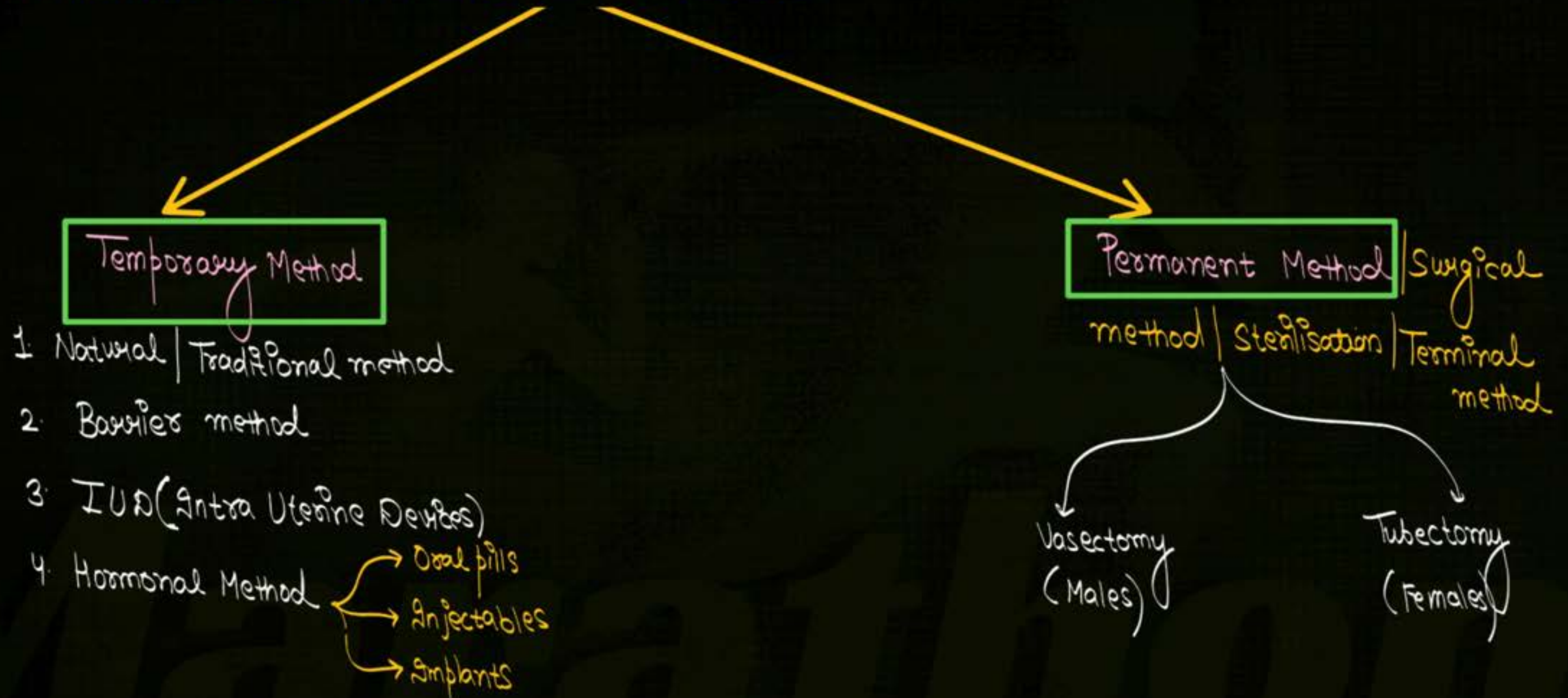
properties of Ideal Contraceptive ★

- User-friendly
- Less side-effects
- Easily Available
- Effective
- Reversible
- It should not interfere in sexual act / drive / desire.
- It should give privacy to user.

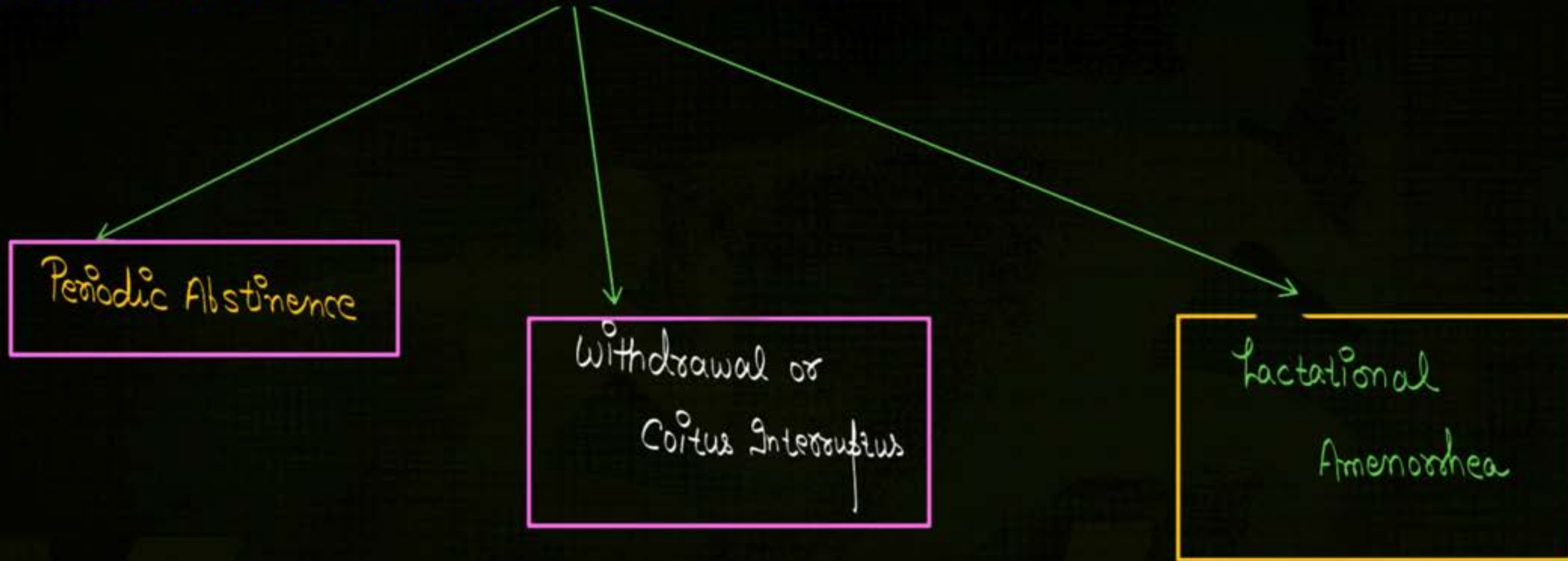
CONTRACEPTIVE METHODS



CONTRACEPTIVE METHODS



NATURAL METHODS



Periodic Abstinence / Rhythm method / Calendar Method

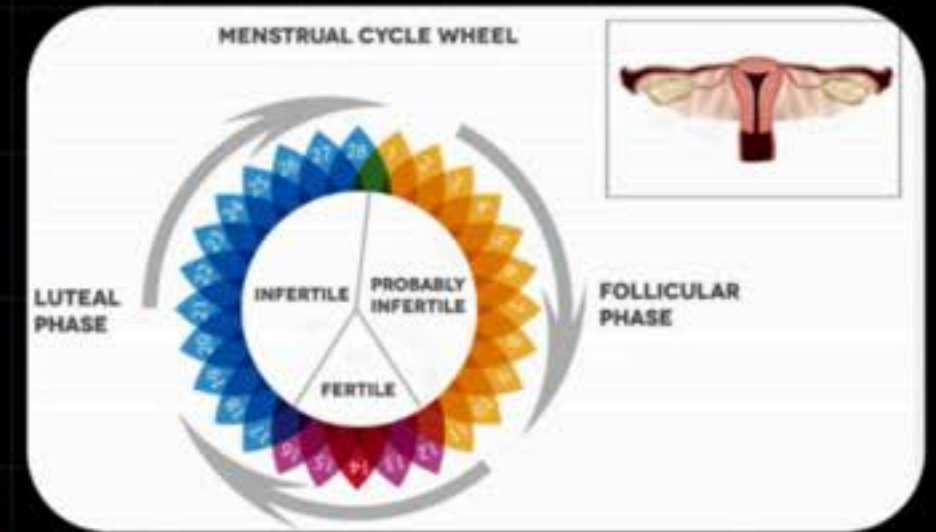
Couples abstain or avoid coitus during 10-17 Days

10-17 Days → Fertile Period (Ovulation is expected)

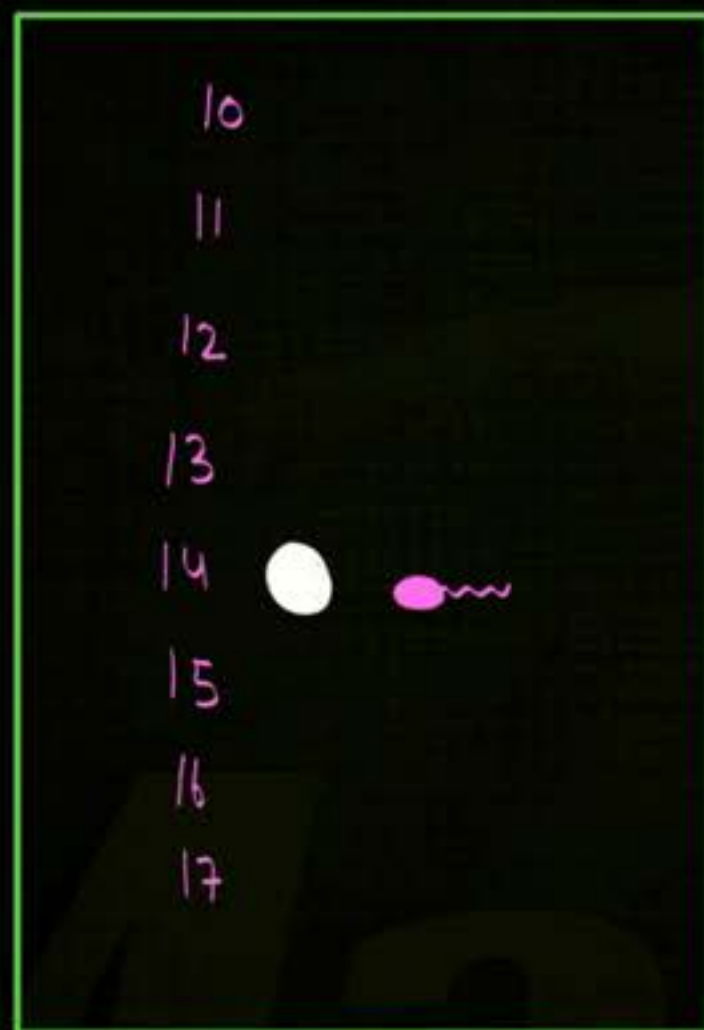
Chance of fertilization is very high.

Ovum → 24-48 hrs (viable)

Sperm → 48-72 hrs (viable)

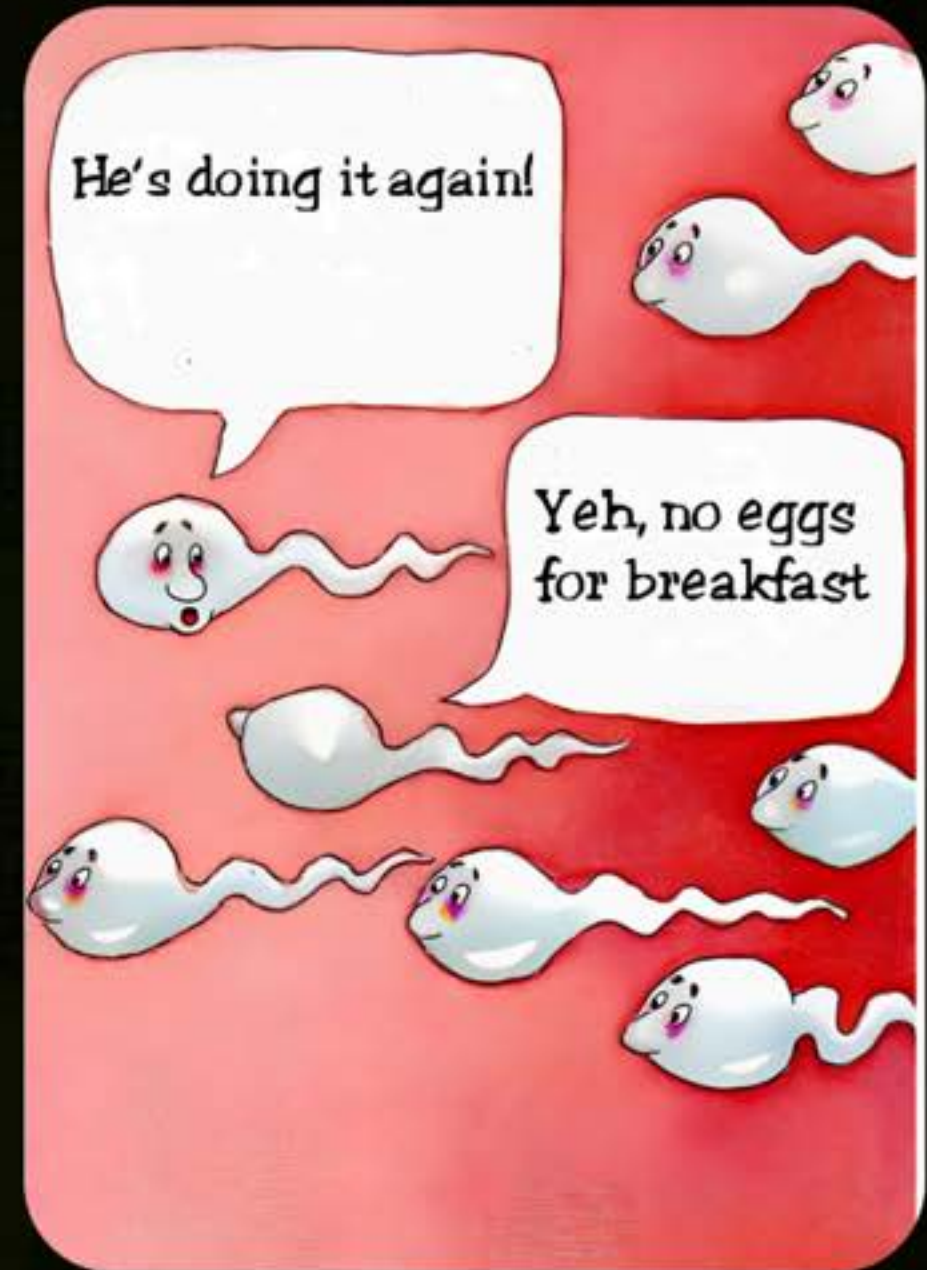


Average Menstrual cycle $\longrightarrow$ 28 Days (28-14)
Ovulation $\longrightarrow$ 14 Day



WITHDRAWAL OR COITUS INTERRUPTUS

Male partner withdraws its penis just before the ejaculation to prevent Insemination (Transfer of semen in female reproductive tract)



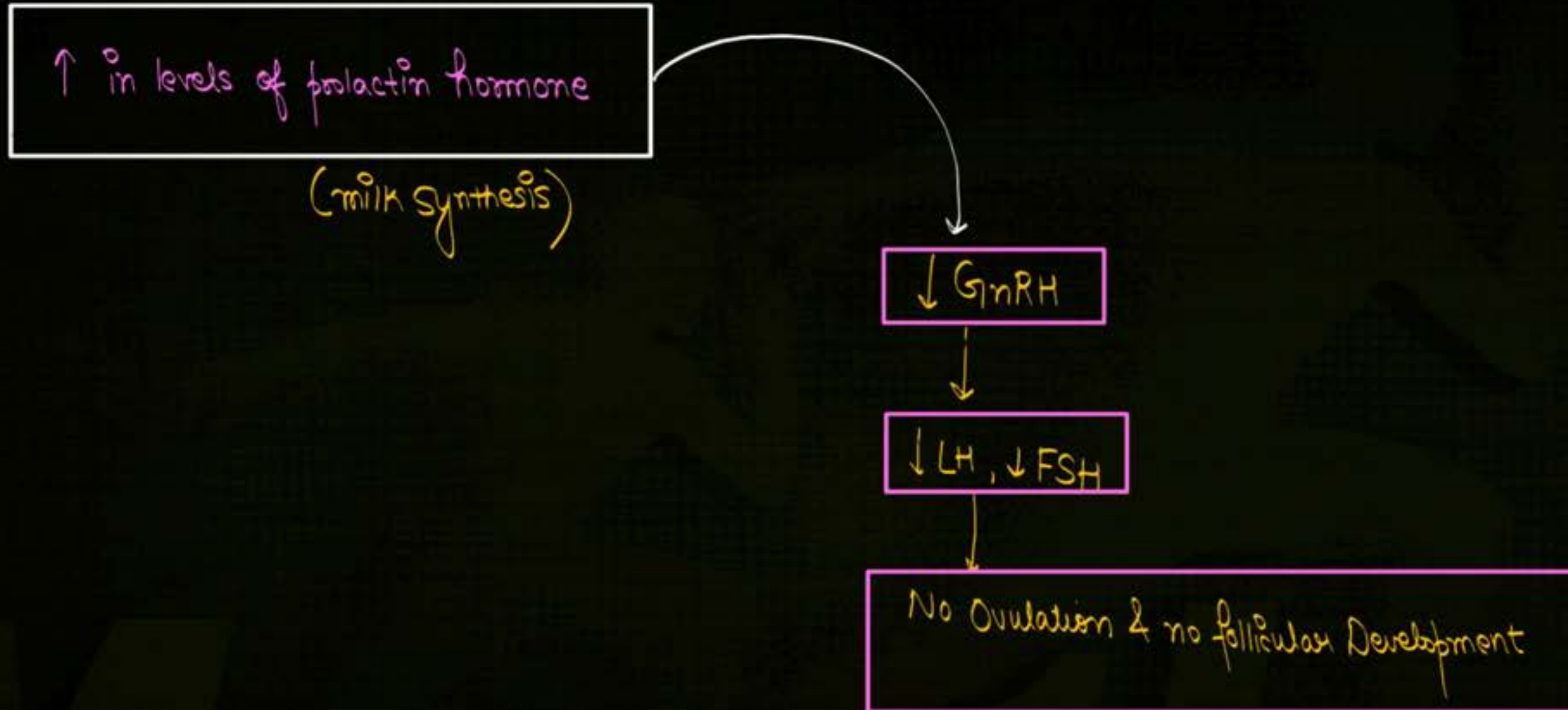
LACTATIONAL AMENORRHEA

Lactation.

Absence of menstruation

Ovulation don't occur during the period Intense Lactation.

Method is effective $\xrightarrow{\text{upto}}$ 6 months (chances of conception is nil)



BARRIER METHOD

In this method ovum (egg) and sperms are prevented from physically meeting with the help of barriers.

Marathon

CONDOMS

→ It is made up of thin rubber / latex sheath

Male condoms → cover penis

Female condoms → covers vagina & cervix

→ Prevent Insemination

→ "Nirodh" popular Brand of male condom

Benefits of Condoms

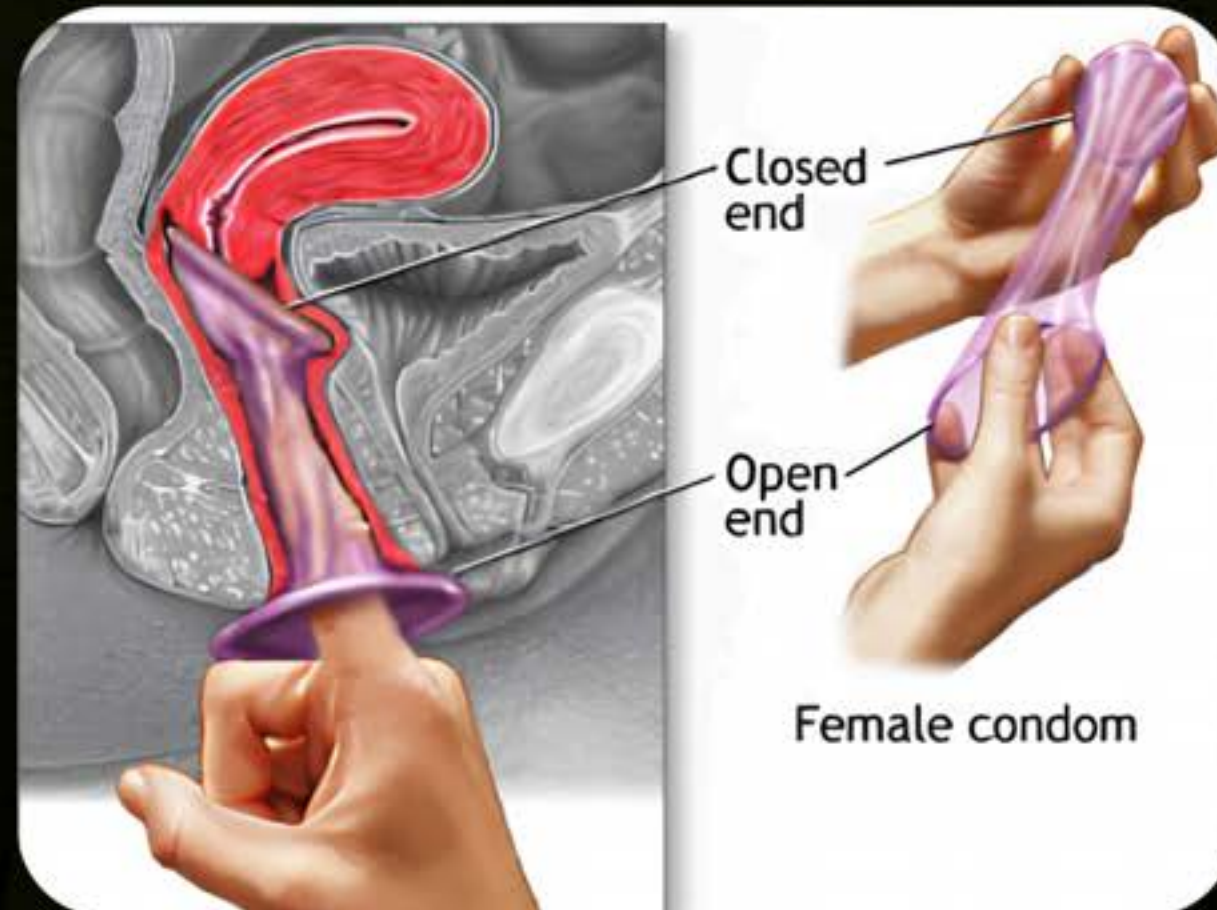
1. It protect from STI or STD
2. Self inserted
3. Disposable
4. It give privacy to user.



Male condom

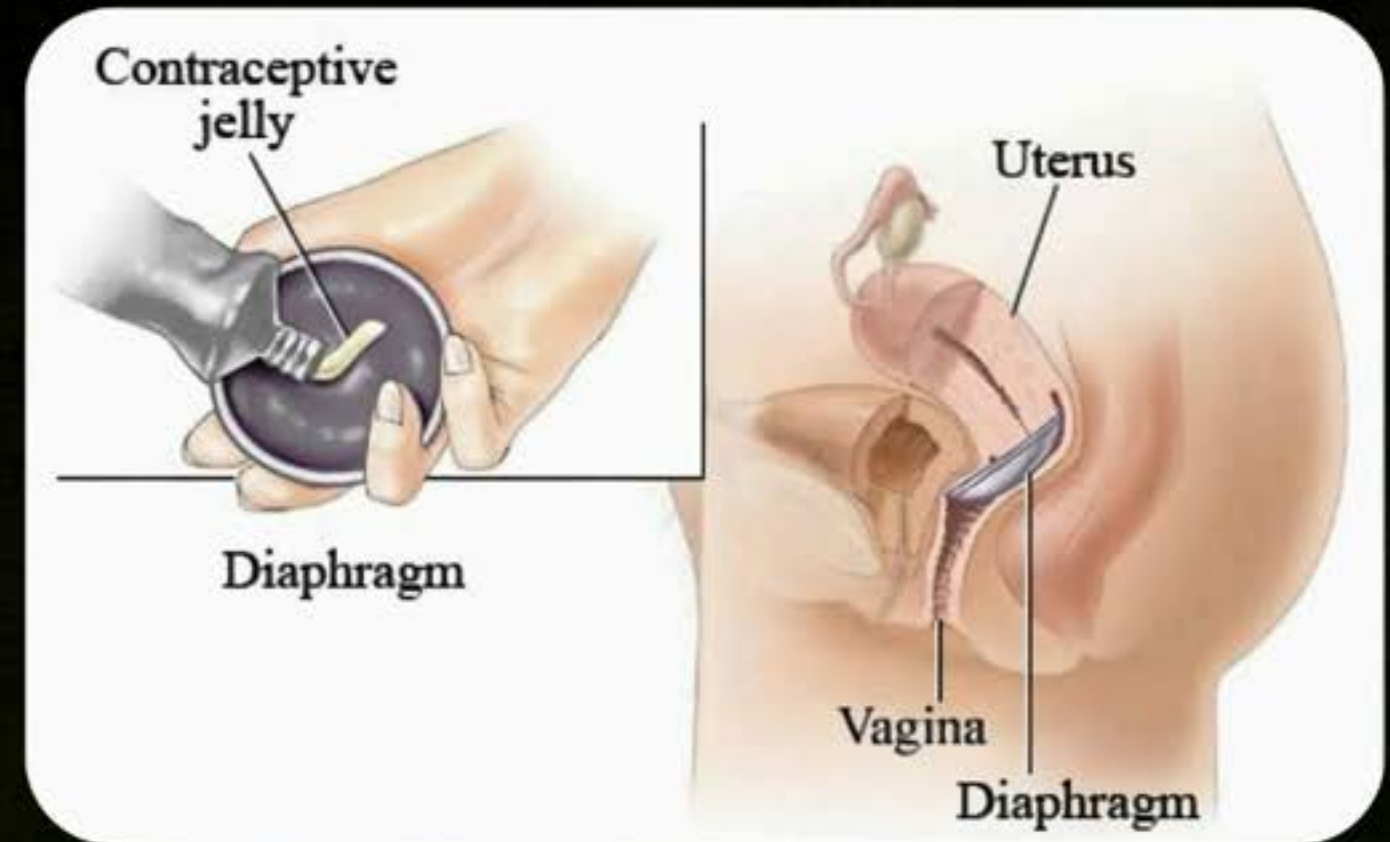
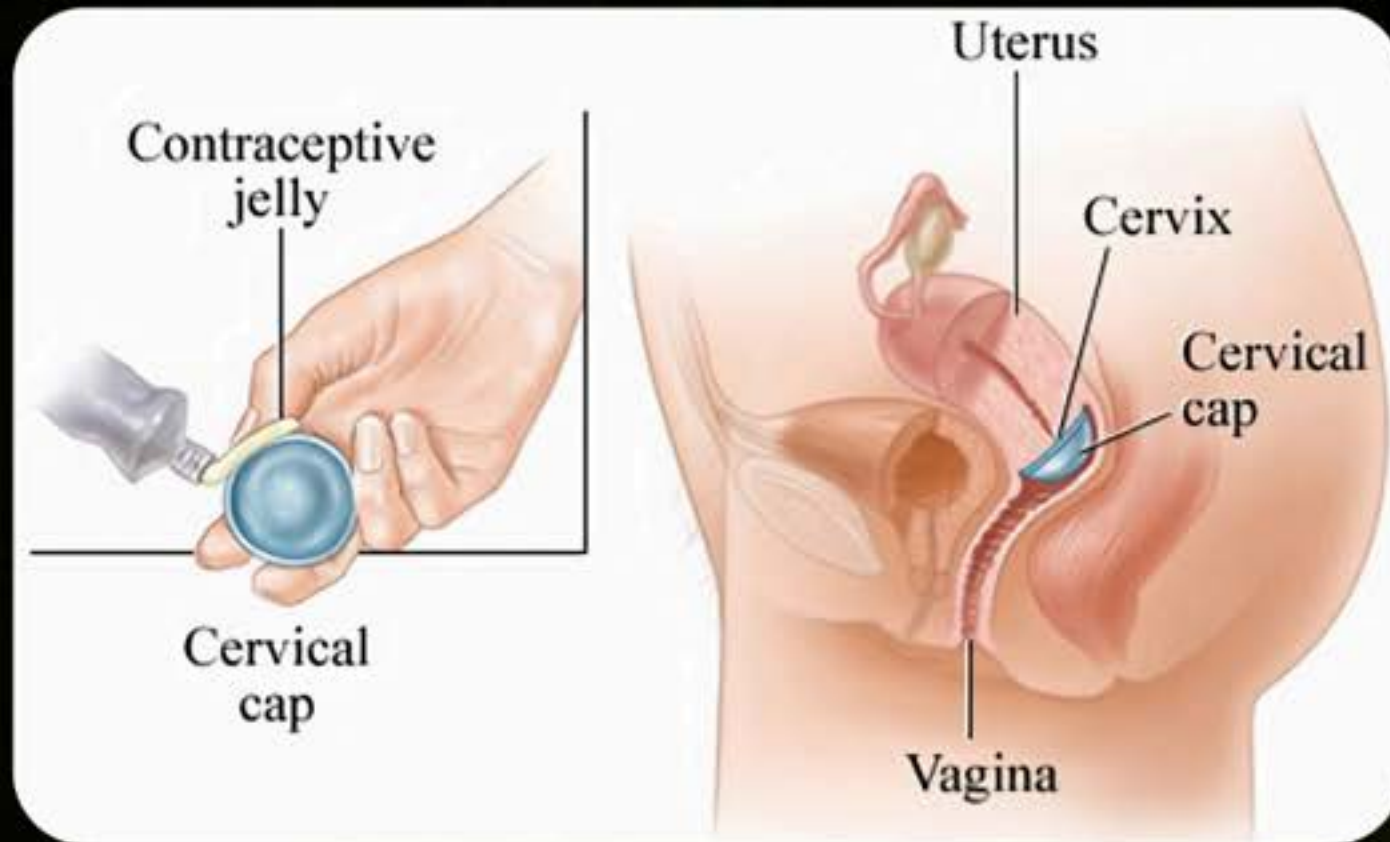


Female condom



DIAPHRAGMS, CERVICAL CAPS & VAULTS

- Made up of Rubber.
- Inserted in female Reproductive tract to cover cervix
- Blocks the entry of sperm through Cervix
- They are reusable. Spermicidal creams, jellies & foams are used along cervical caps to increase contraceptive efficiency
- They don't protect from STD or STI



INTRA UTERINE DEVICES (IUDS)

- IUD's are inserted by expert doctor & nurses.
- Ideal contraceptive method for females who want's to delay pregnancy / space between children.
- Most widely used method of contraception in India.

INTRAUTERINE DEVICES



- Non-medicated IUDs (e.g., Lippes loop)
- Copper releasing IUDs (CuT, Cu7, Multiload 375)
- Hormone releasing IUDs (Progestasert, LNG-20)

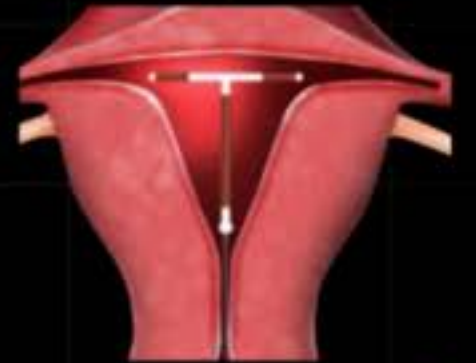
Lippes loop: Serpentine or S shaped made up plastic & fine nylon tail

It is no longer manufactured & used

Year → 1980



Lippes loop



Copper Releasing IUD



Hormone Releasing IUD

Mechanism

It act as foreign body inside uterus



Stimulate Immune Response



Attracting white blood cells (macrophages) near
endometrium



↑ Phagocytosis.

Copper Releasing IUD's

Cu ions suppress the motility of sperm & fertilizing capacity of sperm

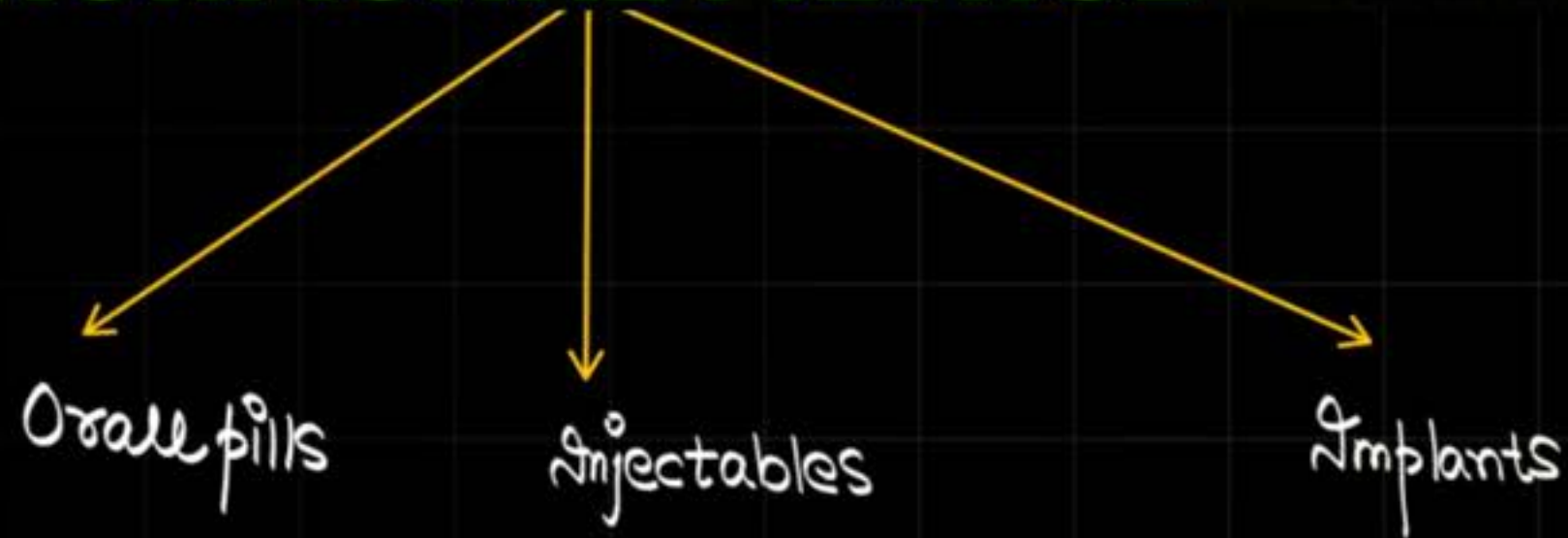
Hormone Releasing IUD's

They make uterus unsuitable for implantation & makes cervix hostile to sperm.

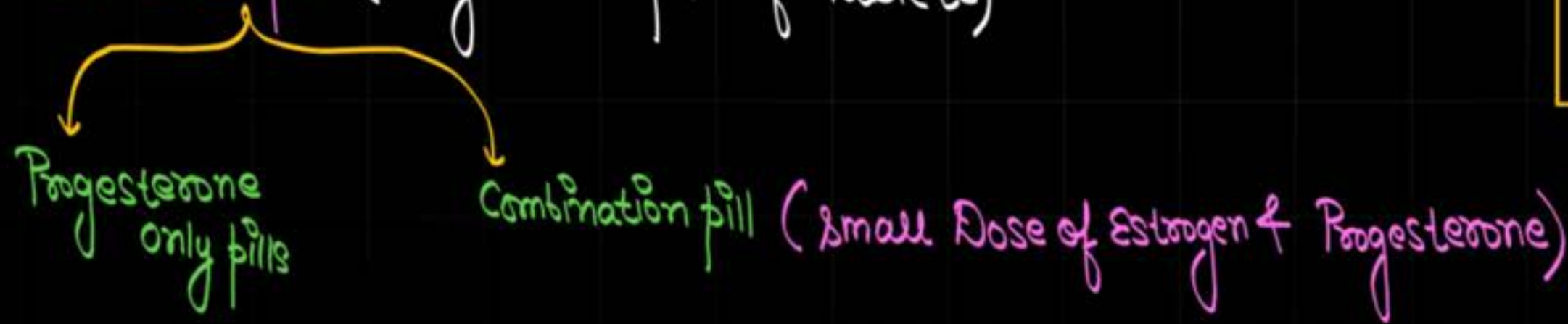
(thick mucus)

Retard the entry of sperm

HORMONAL METHOD

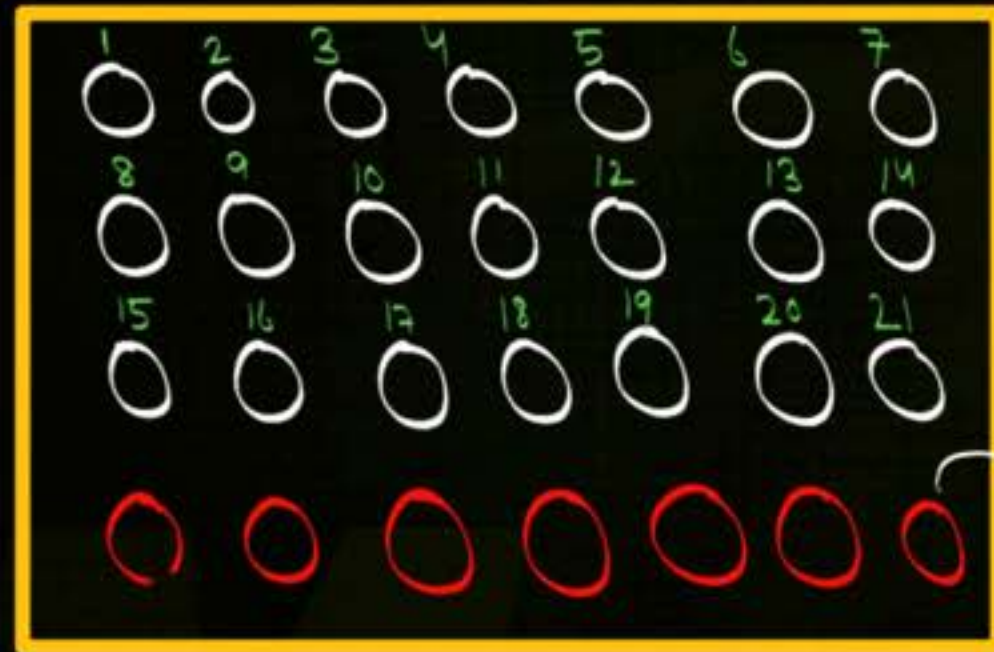


(1) Oral pills (They are in form of Tablets)



Progesterone + Combination pill
only pills
└──────────────────┘
Steroidal pills.

Dosage: Taken for 21 days preferable starts from 1 to five days of menstrual cycle & Gap of 7 days. In this gap Iron Tablets are given to compensate Blood loss.



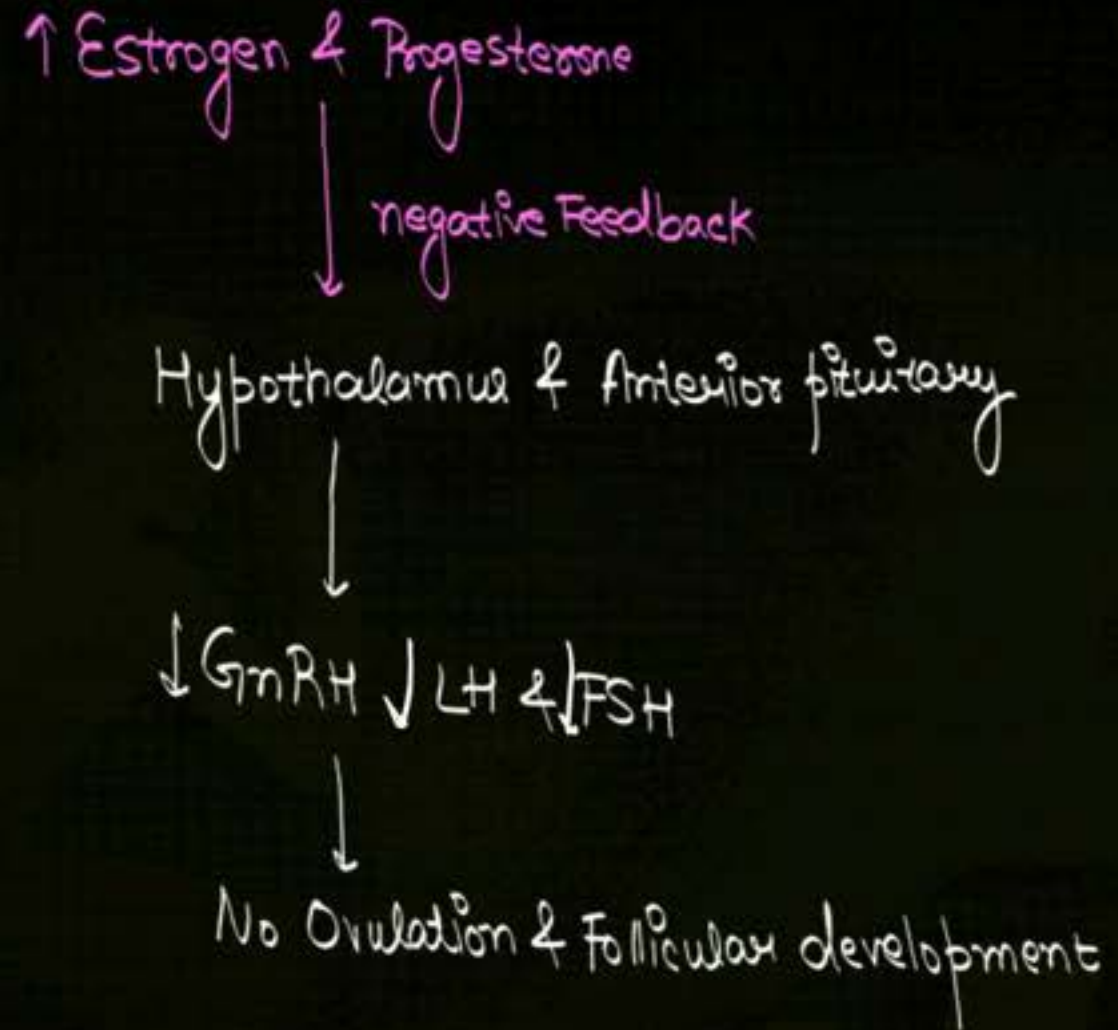
ex Mala N & Mala D

→ Prevent Ovulation

→ Alter cervical mucus (thick)
& Blocks entry of sperms

→ Prevent Implantation. (thin endometrium unsuitable for implantation)

Mechanism



SAHELI

Mechanism:

Blocks the estrogen Receptor

↓
Prevent the Binding of
Estrogen with Receptor

↓
Thin Endometrium lining
↓
Unsuitable for Implantation.

1. Non-Steroidal pill
2. Once a week pill
3. Less sideeffects.
4. ↑ Contraceptive Value.





IMPLANTS & INJECTIONS

Progesterone or combined (Estrogen + Progesterone) given in the form of Injections & Implants (under the skin)

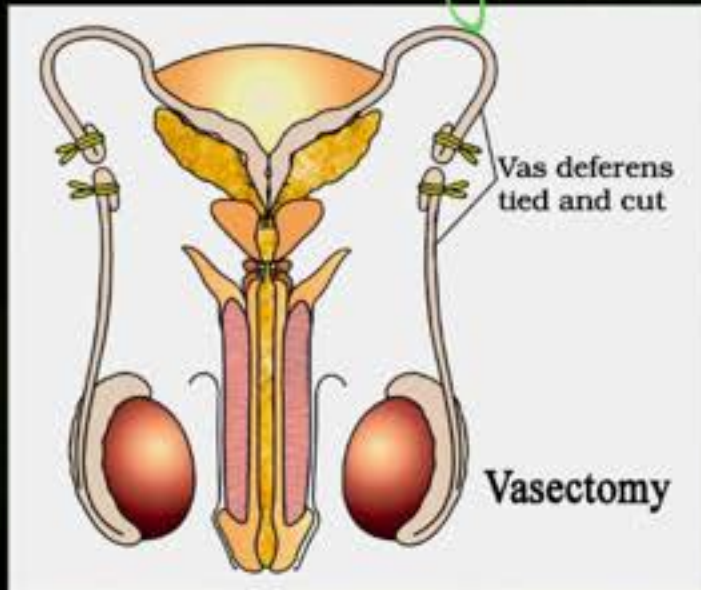
eg: Norplant

Mechanism: Similar to Oral pills.

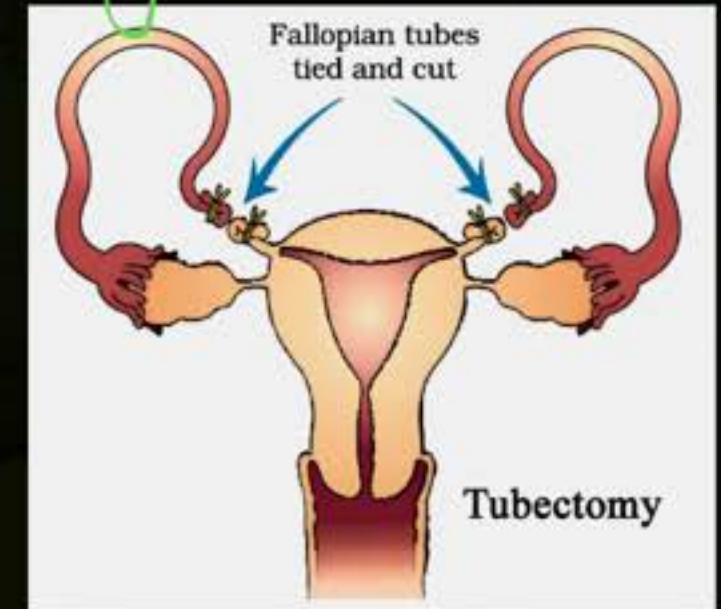


TERMINAL METHOD

Vasectomy (males)



Tubectomy (females)



MEDICAL TERMINATION OF PREGNANCY (M.T.P.)

Intentional or voluntary termination of pregnancy before full term is called medical termination of pregnancy (MTP) or induced abortion.

Reason:-

- (1) To get rid of unwanted pregnancy (due unprotected sexual intercourse)
- (2) Failure of contraception during coitus / Rapes
- (3) Pregnancy could be harmful or fatal for both mother & child.

- Nearly 45 to 50 million MTPs are performed in a year all over the world which accounts to 1/5th of the total number of conceived pregnancies in a year.
- Government of India legalised MTP in 1971 with some strict conditions to avoid its misuse.

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- The Medical Termination of Pregnancy (Amendment) Act, 2017. According to this Act, a pregnancy may be terminated on certain considered grounds within the first 12 weeks of pregnancy on the opinion of one registered medical practitioner.
- If the pregnancy has lasted more than 12 weeks, but fewer than 24 weeks, two registered medical practitioners must be of the opinion. The grounds for such termination of pregnancies are:

MTP'S are safe during first Trimester or upto 12 weeks

- (i) The continuation of the pregnancy would involve a risk to the life of the pregnant woman or of grave injury physical or mental health
- (ii) There is a substantial risk that of the child were born, it would suffer from such physical or mental abnormalities as to be seriously handicapped.

SEXUALLY TRANSMITTED INFECTIONS (STIS)

- Diseases or infections which are transmitted through sexual intercourse are collectively called sexually transmitted infections (STI) or venereal diseases (VD) or reproductive tract infections (RTI).
- Gonorrhoea, syphilis, genital herpes, chlamydiasis, genital warts, trichomoniasis, hepatitis-B and HIV leading to AIDS are some of the common STDs.

Symptoms

Early Symptoms (minor) → fluid Discharge, pain, swelling in genital organs

- Major symptoms include pelvic inflammatory diseases (PID), abortions, still births, ectopic pregnancies, infertility or even cancer of the reproductive tract.

Reasons

- Sharing Infected needles.
- Blood Transfusion
- Multiple sex partners
- Surgical Instrument.
- Infected mother to fetus

Measures:

- (1) Avoid sex with Unknown partners/multiple partners.
- (2) Always Use condoms during coitus
- (3) In case of Doubt seek medical help.

INFERTILITY

- If couples are unable to produce children inspite of unprotected sexual cohabitation up to 2 years this is called infertility.

Marathon

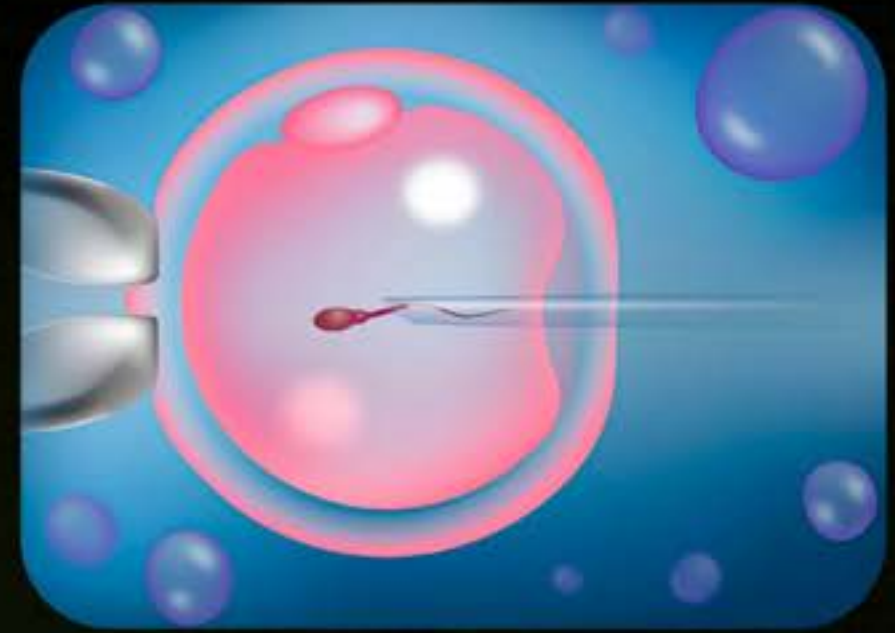
IN-VITRO FERTILISATION (TEST TUBE BABY)

- Fertilisation occurs outside the body of female in almost similar conditions as that in the body and after it, embryo is transferred into uterus or fallopian tube of surrogate mother or same mother.

EMBRYO TRANSFER METHODS -

- (a) Zygote Intra Fallopian Transfer (ZIFT) – Zygote or early embryos (with up to eight blastomere) could be transferred into the fallopian tube of surrogate or same mother.
- (b) Intra Uterine Transfer (IUT) – Embryo with more than eight blastomeres (commonly 32 cells stage) are transferred into uterus.

Intra-cytoplasmic Sperm Injection (ICSI) - It is a specialised procedure to form an embryo in the laboratory in which a sperm is directly injected into the cytoplasm of ovum.



IN-VIVO FERTILISATION

- Fertilisation occurs inside the body of female, either naturally or artificially.
- **Gamete Intra Fallopian Transfer (GIFT)** – Transfer of an ovum collected from ovary into the fallopian tube of female who can't produce one, but can provide suitable environment for fertilisation, this is called GIFT.
- **Artificial insemination** – If male is unable to inseminate the semen into vagina or if there is very low sperm count in the semen then semen is artificially introduced either into vagina or into the uterus of the female (intrauterine insemination) IUI.

AI → Artificial Insemination
IUI → Intrauterine Insemination

Domain

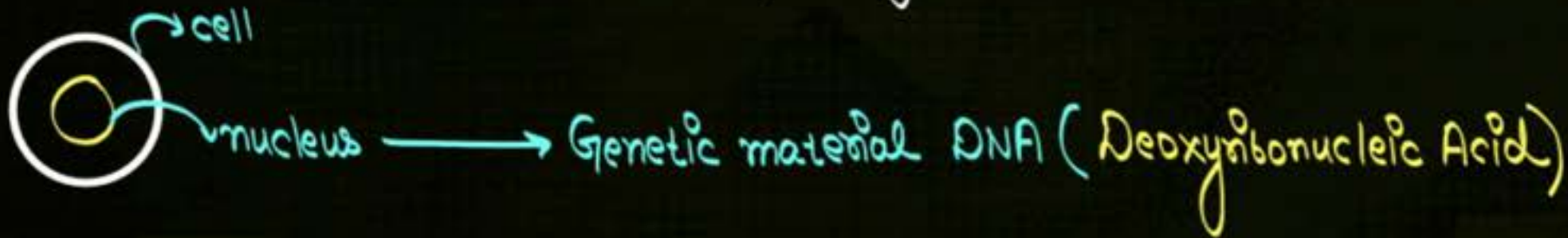
Principles of Inheritance and Variation

Chapter-4

Genetics : Study of Inheritance & Variations changes.

Transmission of Genetic characters from parents to progeny

(Height, Eye colour, Hair colour, Hair Density)



Gene: Small segment of DNA
(control character)

ex: character
Height (Pea plant) $\begin{cases} \text{Tall} \\ \text{Dwarf} \end{cases}$

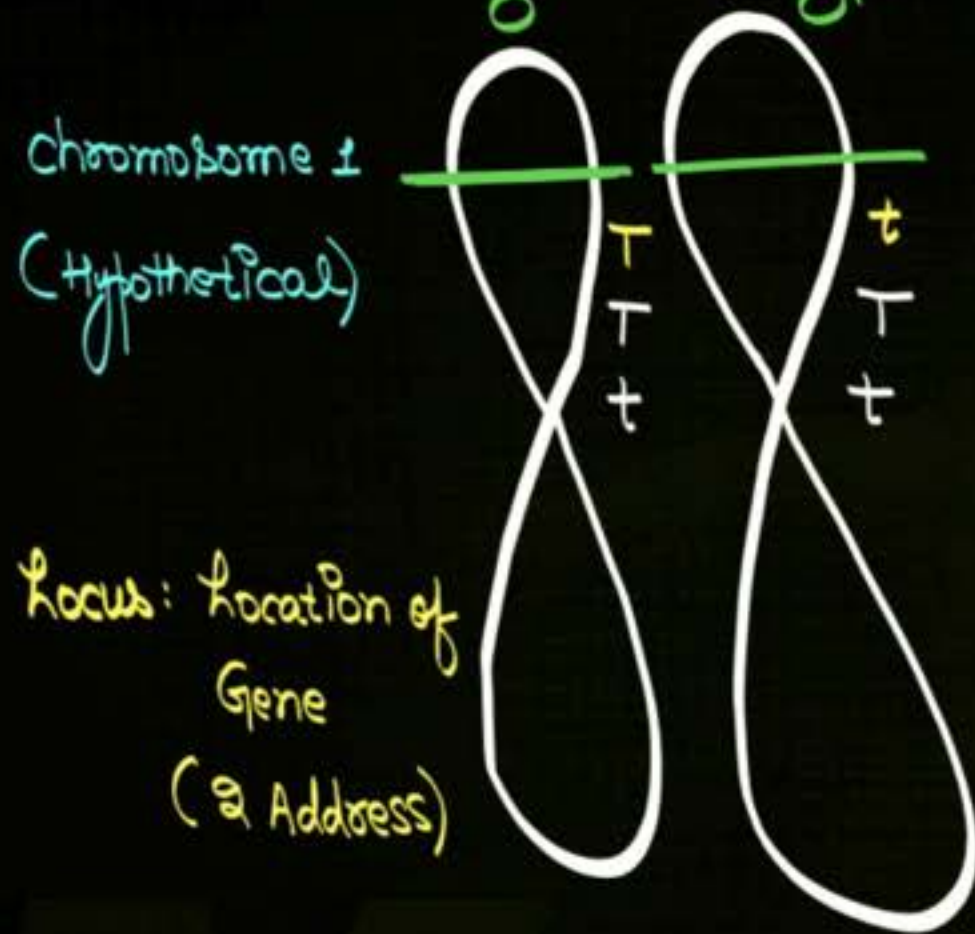
Eye colour $\begin{cases} \text{Black} \\ \text{Blue} \\ \text{Green} \\ \text{Brown} \end{cases}$

variants of
character

Traits

variants of gene (Alleles)

Diploid: Two set of chromosomes



Alleles.

Dominant

(Always express itself)

Recessive

(In Absence of Dominant Allele)

ex: Height
(Pea plant) → Tall T → Uppercase
→ Dwarf t → lowercase

Similar pairs
of allele
pure/pure lines

T	T	→	Homozygous Dominant	dissimilar pair of allele impure/Hybrid
T	t	→	Heterozygous Dominant	
t	t	→	Homozygous Recessive	

{	Tall	←	T T	}	Genotype → Genetic makeup
	Tall	←	T t		
	Dwarf	←	t t		

Phenotype: Physical Appearance

Father of Genetics → Gregor Mendel

Father of Modern Genetics → Bateson

Father of experimental Genetic → T.H Morgan.

INTRODUCTION OF GENETICS

- Genetics term was given by W. Bateson.
- Genetics: Collective study of heredity & Variations.
- Heredity: Transmission of genetic characters from parents to offspring.
- Variation: Individuals of same species have some differences, these are called variation.

MENDEL LAW OF INHERITANCE

- Gregor Johann Mendel was an Austrian Monk.
- Conducted many experiments with garden pea plants (7 years 1856- 1863) and is considered as the 'Father of Genetics'.

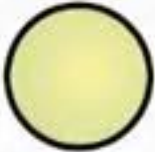


Gregor Johann Mendel
"Father of Genetic"

MENDEL SELECTED PEA PLANT AS HIS EXPERIMENTAL MATERIAL BECAUSE

- Was easily available, flowers were easy to handle.
- Flowers of pea plants remain closed till pollination.
- It showed seven pairs of contrasting characters.
- Self and cross-pollination both were possible in the plant.
- It had a short life cycle.
- Pure line varieties were present.
- Large progeny per mating

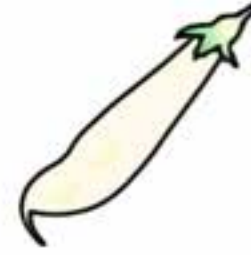


Character	Dominant trait	Recessive trait
Seed shape	 Round	 Wrinkled
Seed colour	 Yellow	 Green
Flower colour	 Violet	 White
Pod shape	 Full	 Constricted

Pod colour



Green



Yellow

Flower
position



Axial



Terminal

Stem
height



Tall



Dwarf

WHY MENDEL'S WORK WAS RECOGNIZED SO LATE ?

- Communication was not easy
- Approach of using mathematical & statistical analysis was new & unacceptable.
- He talked about certain factors that people did not believe in.
- During that time scientists were more interested in the work of Darwin that they could relate with.

Marathon

REASONS FOR ACCEPTANCE OF MENDEL'S WORK

- In 1900, his results were independently rediscovered by three biologists namely, Hugo De Vries, Carl Correns and Enrich Von Tschermak.
- Statistics method
- Large sampling size
- Mathematical logic
- Accurate records
- Theoretical explanation



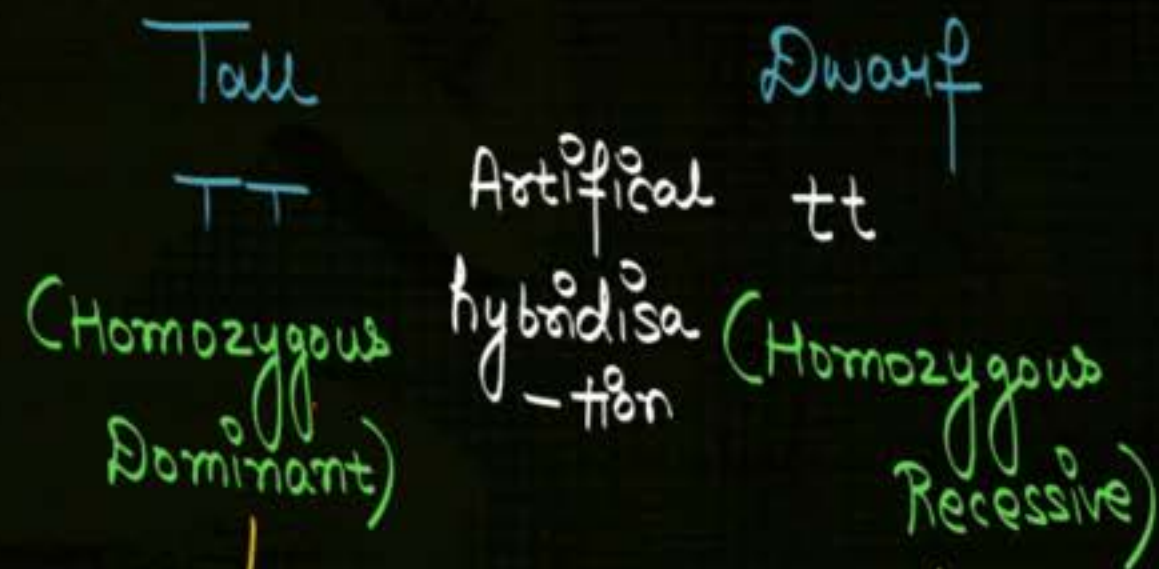
INHERITANCE OF ONE GENE

Monohybrid cross:

one pair of contrasting characters

Height $\begin{cases} \rightarrow \text{Tall} \\ \rightarrow \text{Dwarf} \end{cases}$

Parental Generation

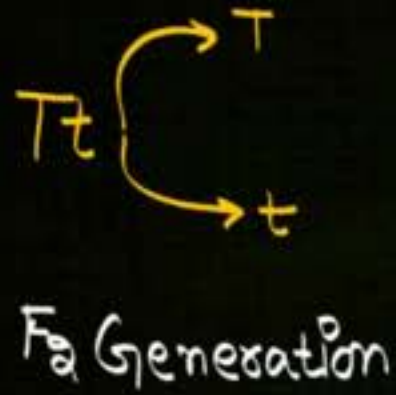


Gametes

F_1 (Filial 1) Generation

Tall Tt (Heterozygous Dominant)

INHERITANCE OF ONE GENE



Reginald Punnett
(British Scientist)

$Tt \times Tt$
Selfing

	T	t
T	TT Tall	Tt Tall
t	Tt Tall	tt Dwarf

Genotype: TT Tt tt
 1 2 1

Phenotype: Tall Dwarf
 3 : 1

MENDEL'S FINDINGS

- F1 resembles only one parent.
- F2 generation obtained by self-pollination Dominant and recessive forms appear in a 3 : 1 ratio.(phenotypically)
- F2 generation obtained after self-pollination gave genotypic ratio as 1 : 2 : 1 ratio of pure and hybrid forms.

Marathon

Law of Dominance

Characters are controlled by Discrete Unit called

"Factors"

"Factors" $\longrightarrow$ pair

If Dissimilar pair is present (Tt) (Rr)

$\swarrow \searrow$
Dominant Recessive

$\longrightarrow$ Not Universally Applicable.

- (1) Incomplete Dominance
- (2) Co-dominance
- (3) Multiple Allelism.

- **Law of Segregation** : It states that the alleles remain together but segregate at the time of gamete formation.
- The alleles T and t segregate at the time of gamete formation and when the gametes fused the recessive trait appeared in F2 generation even when it was absent in F1 generation.

→ Universally Applicable.

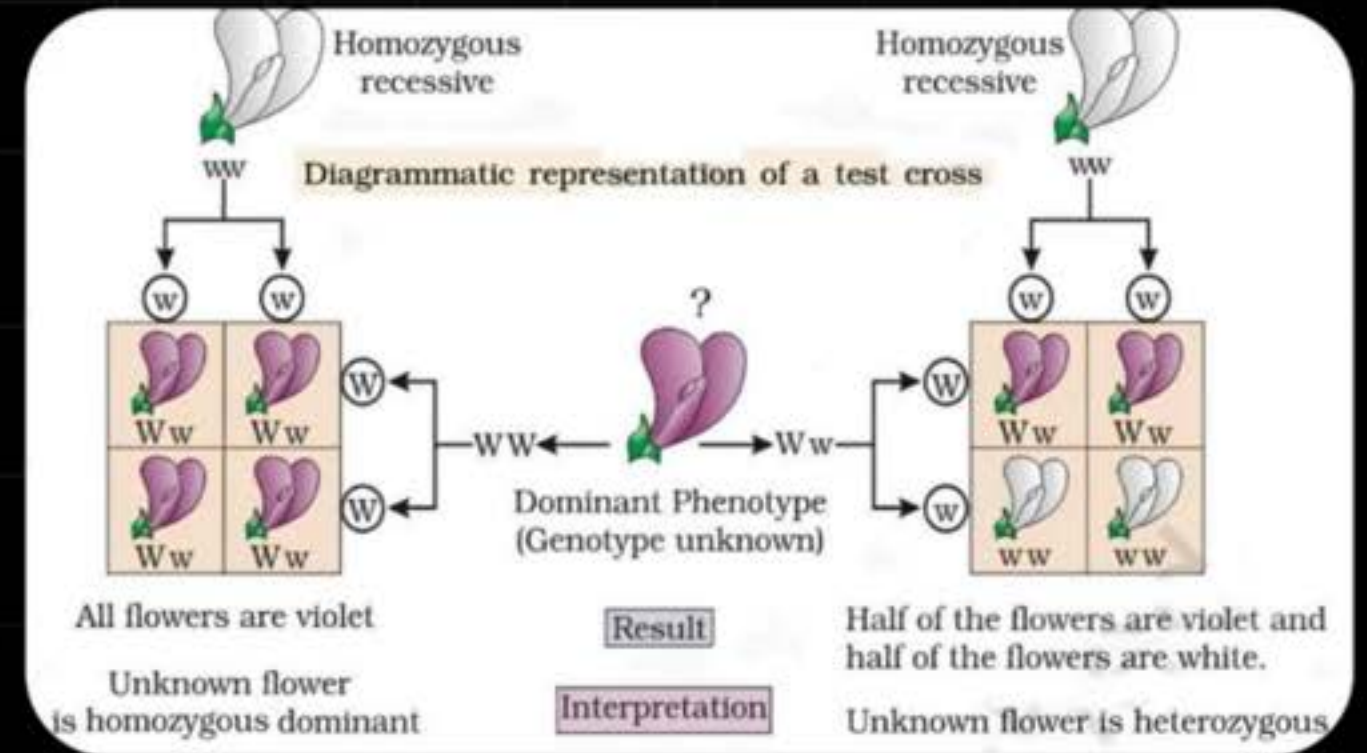
TEST CROSS

★ (Cross with Recessive Parent Genotype tt)

Tall
(Phenotype) $\rightarrow$ TT (Homozygous Dominant) ?
 $\rightarrow$ Tt (Heterozygous Dominant) ?

	t	t
T	Tt Tall	Tt Tall
T	Tt Tall	Tt Tall

All are Tall Genotype: **Homozygous Dominant**



	t	t
T	Tt Tall	Tt Tall
t	tt Dwarf	tt Dwarf

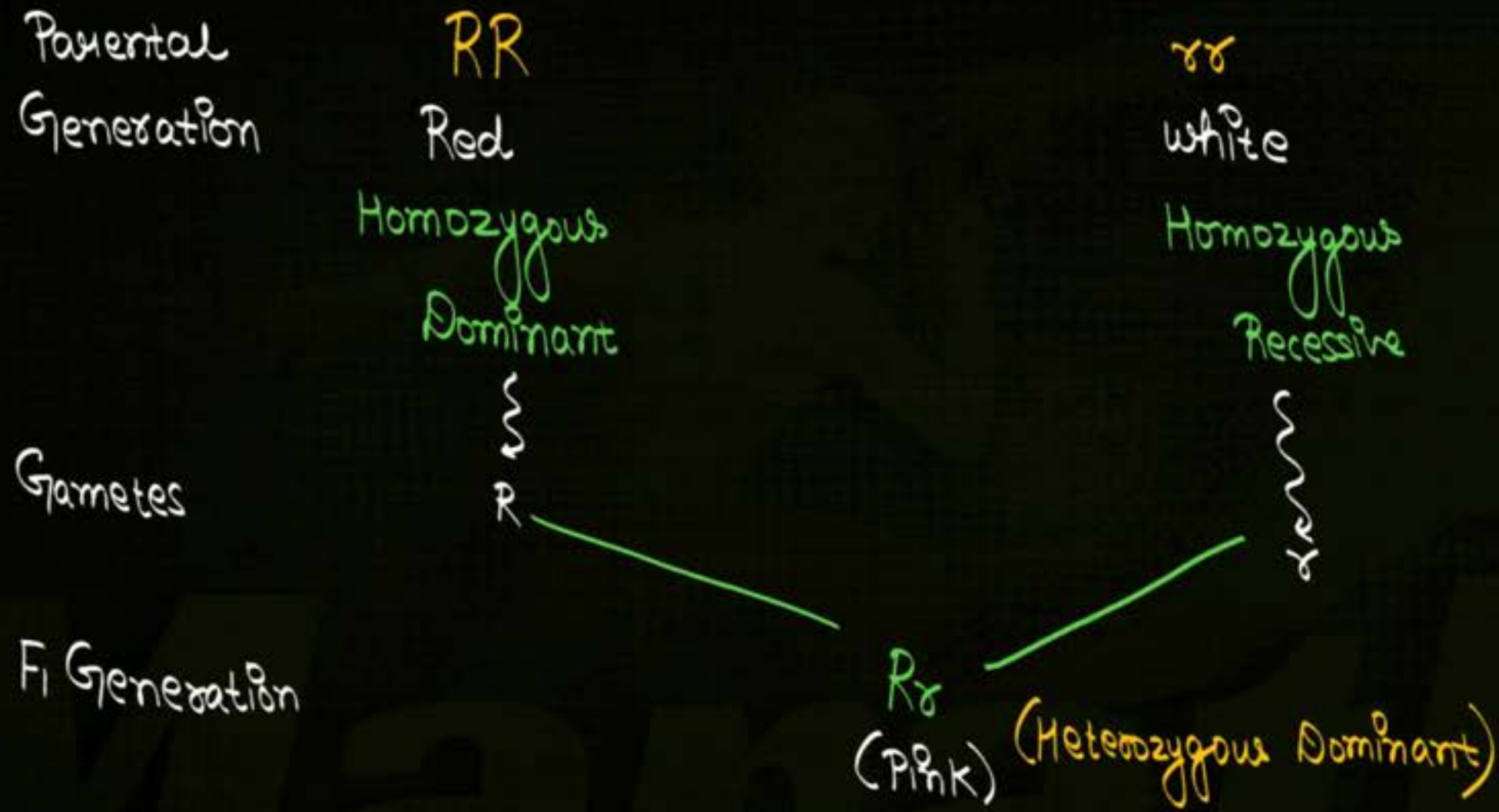
1:1

Genotype: Heterozygous Dominant



Incomplete co-dominance

ex:- Dog flower or Antirrhinum or Snapdragon
(ii) Flower colour of mirabilis Jalapa



$$Rr \times Rr$$

	R	r
R	RR Red	Rr Pink
r	Rr Pink	rr white

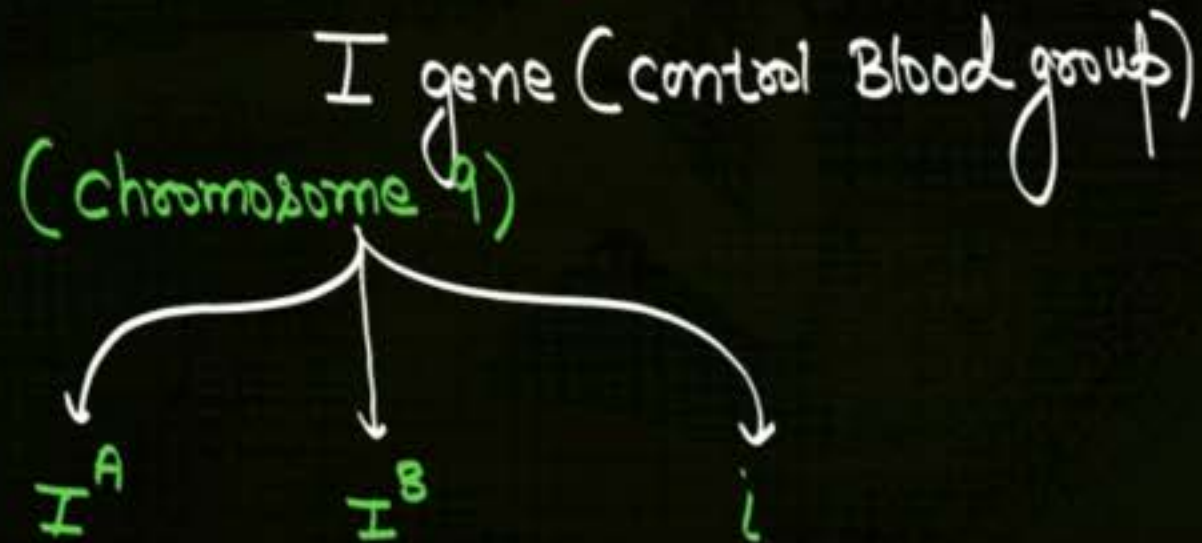
Genotypic Ratio: RR, Rr, rr 1:2:1

Phenotypic Ratio: Red: Pink: white 1:2:1

MULTIPLE ALLELE AND CODOMINANCE

ex:

Blood group: ABO Blood group.



Blood group A



Blood group: B



Blood group AB

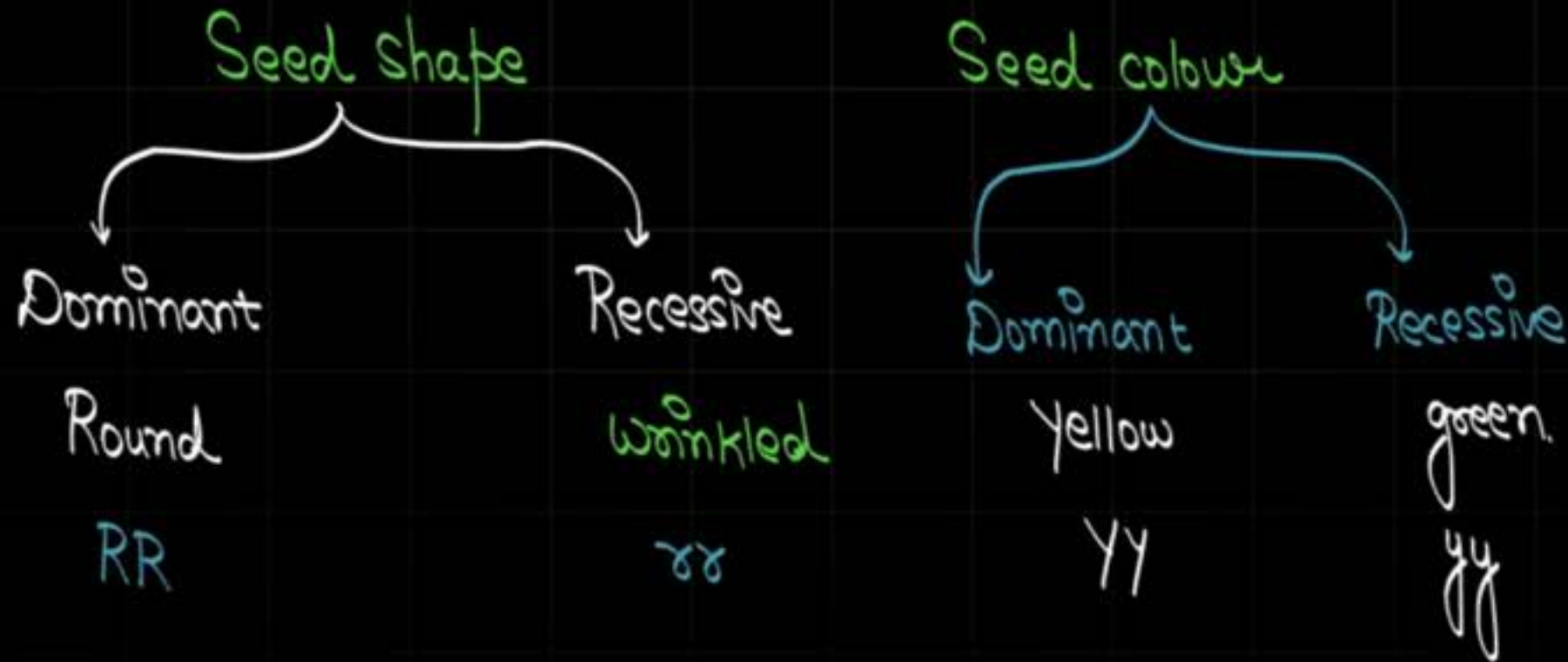


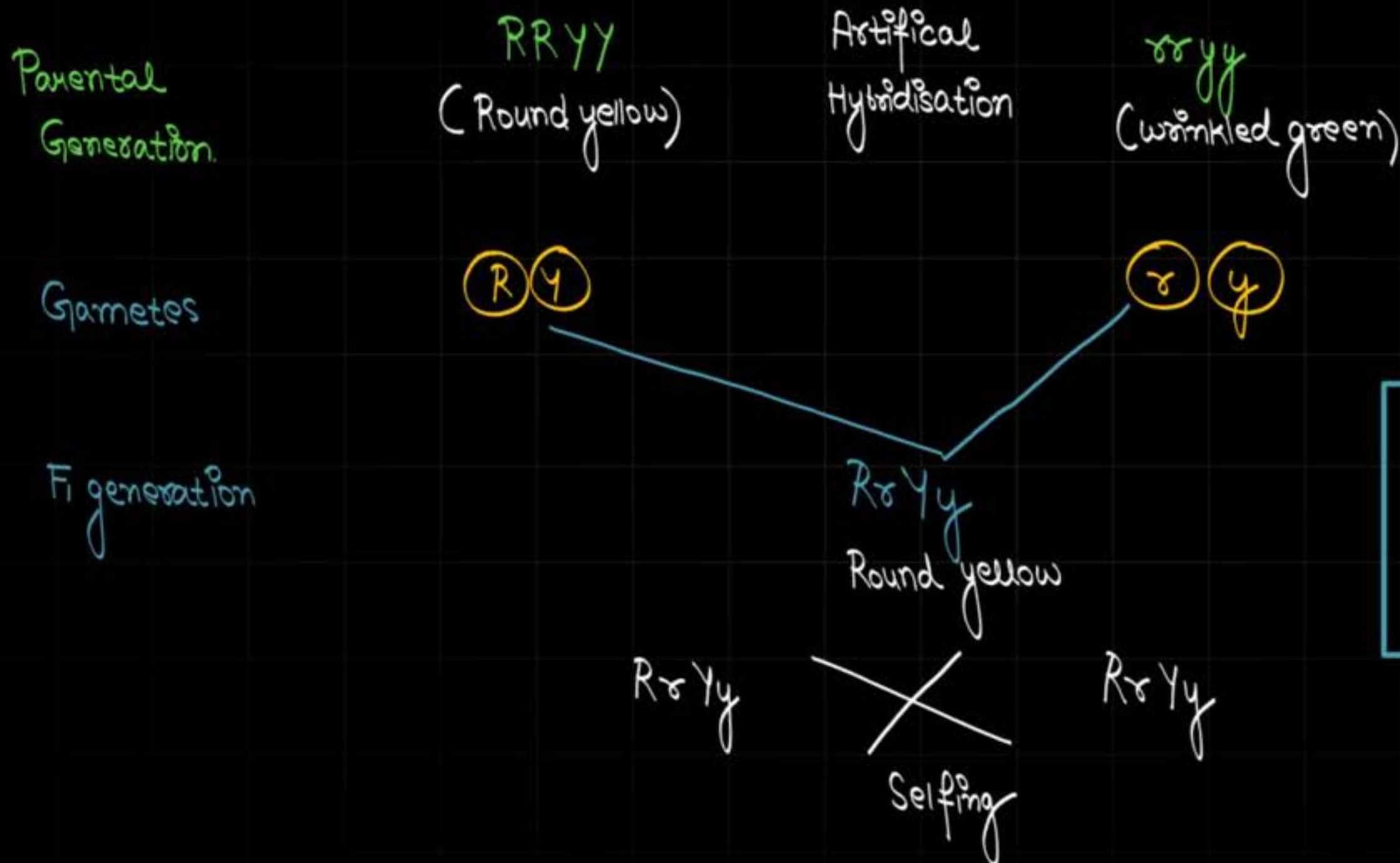
Blood group - O

Allele from Parent	Allele From Parent 2	Genotype of Offspring	Blood types of Offspring
I ^A	I ^A	I ^A I ^A	A
I ^A	I ^B	I ^A I ^B	AB → co-dominance
I ^A	i	I ^A i	A
I ^B	I ^A	I ^A I ^B	AB → co-dominance
I ^B	I ^B	I ^B I ^B	B
I ^B	i	I ^B i	B
i	i	i i	O

INHERITANCE OF TWO GENES

Two pairs of Contrasting characters.





$$2^n$$

n = no. of Heterozygous pair

$$(2)^2 = 4 \text{ gametes}$$



Fork line
method

Gametes

		$R \swarrow \searrow$ $Y \quad y$		$r \swarrow \searrow$ $y \quad Y$	
		RY	Ry	ry	ry
RY	RY	$RRYY$	$RRYy$	$RrYY$	$RrYy$
Ry	RY	$RRYy$	$RRyy$	$RrYy$	$Rryy$
ry	Ry	$RrYY$	$RrYy$	$rrYY$	$rrYy$
ry	ry	$RrYy$	$Rryy$	$rrYy$	$rryy$

Phenotype: 9:3:3:1

Round yellow: Round green
9:3

wrinkled yellow: wrinkled green
3:1

Genotypic Ratio: 1:2:1:2:4:2:1:2:1

LAW OF INDEPENDENT ASSORTMENT

No effect of one gene on Inheritance of Other gene.

→ Universally not applicable

Exception: Linkage.

PLEIOTROPIC GENES

Single gene controls many characters.

ex:- Starch Synthesis in pea seed.

BB
(Dominant Allele)



Shape

Round seed

(↑ Starch synthesis)

Size

Large seed

bb
(Recessive Allele)



Wrinkled seed

(↓ Starch synthesis)

Small seed.

POLYGENIC INHERITANCE

(Quantitative Inheritance)

many gene control one character.

eg: Skin colour & Height (Human)

controlled by three types of gene
A B C

- (6) AA BB CC → Darkest (Negro)
- (5) AA BB Cc → Dark
- (4) AA BB cc → Fairly Dark
- (3) AA Bb cc → Intermediate (mulatto)
- (2) AA bb cc → Fairly light
- (1) Aa bb cc → light
- (0) aa bb cc → very light (Albino)





CHROMOSOMAL THEORY OF INHERITANCE

- Walter Sutton and Theodore Boveri noted that the behaviour of chromosomes was parallel to the behaviour of genes and used chromosome movement to explain Mendel's laws.

Marathon

- The chromosomes segregate at the time of gamete formation and along with them the alleles present on the chromosomes also segregate out .
- Each gamete has only one allele of each gene present in the chromosome.

LINKAGE AND RECOMBINATION

- T.H. Morgan conducted experiments with *Drosophila* (fruit fly) to show that genes are located on chromosomes

Marathon

WHY DORSOPHILA ?



- Easily Available
- Large sampling size (one mating = 100 offsprings)
- Short lifecycle (2 weeks)
- Small size
- male & females are distinguishable.
- 8 chromosomes ($2n$) $n = 4$

characters

Body colour

Eye colour

wings

Present on X chromosome

Dominant
(wild type)

Brown (y^+)

Red (w^+)

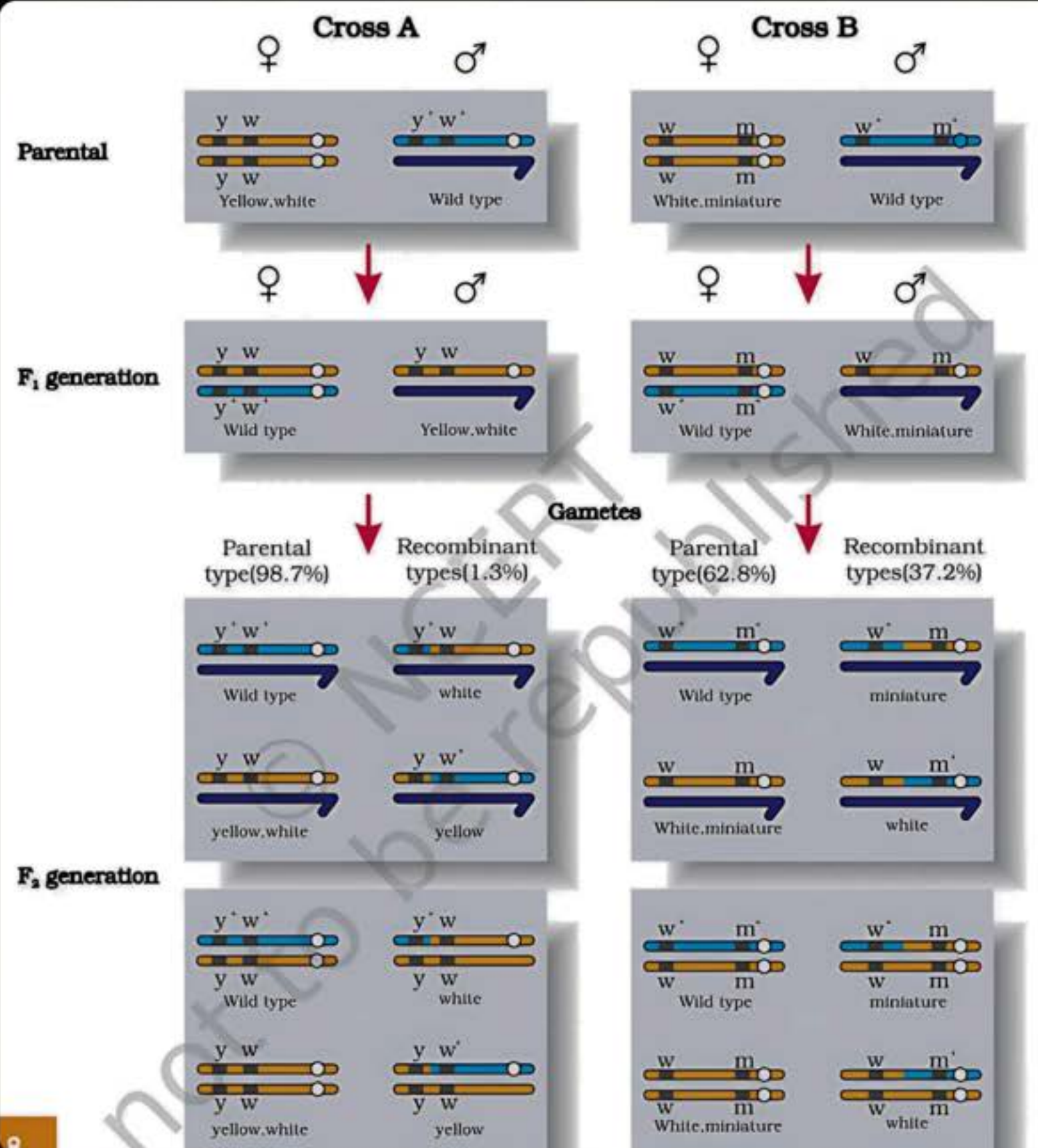
Normal (m^+)

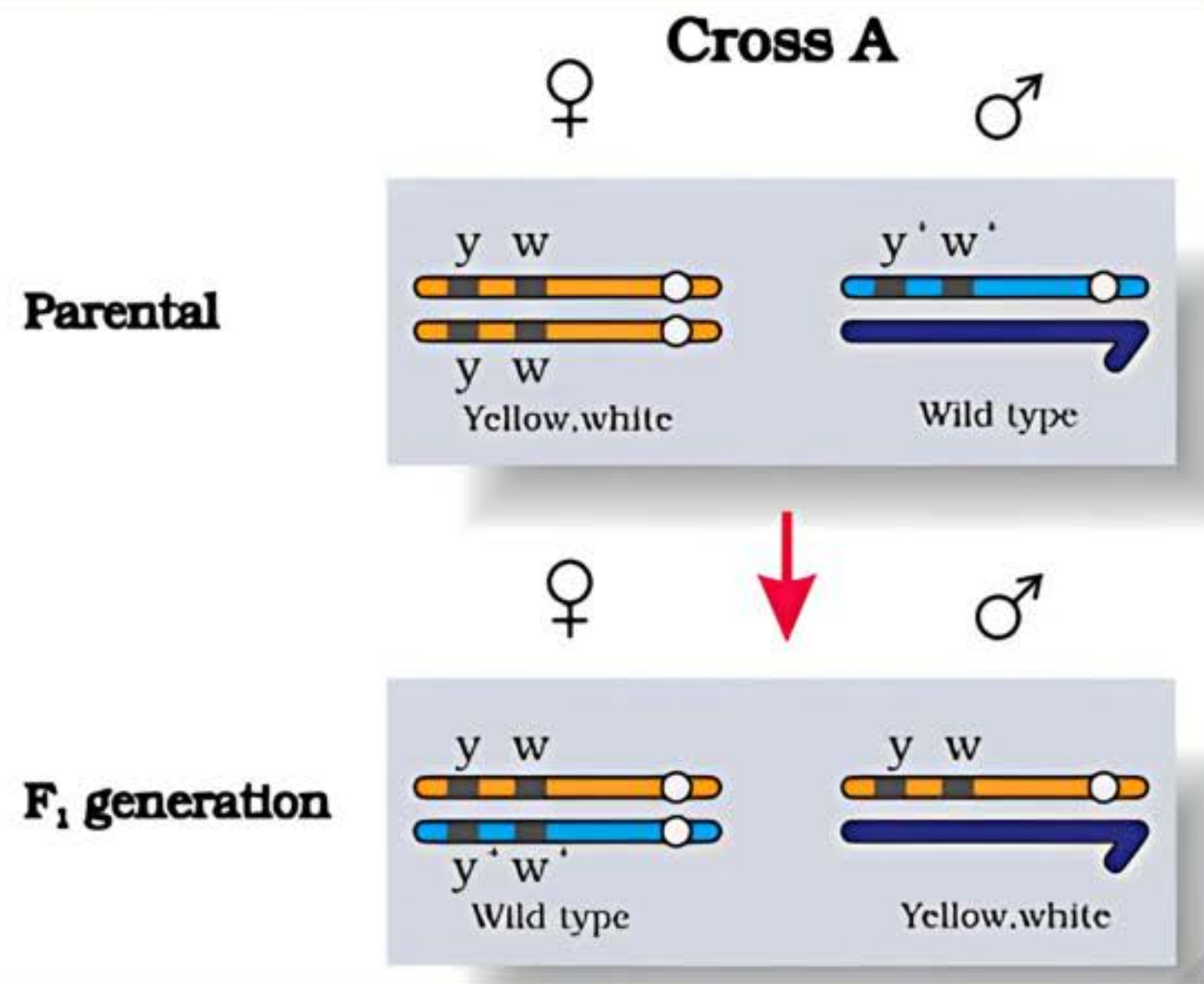
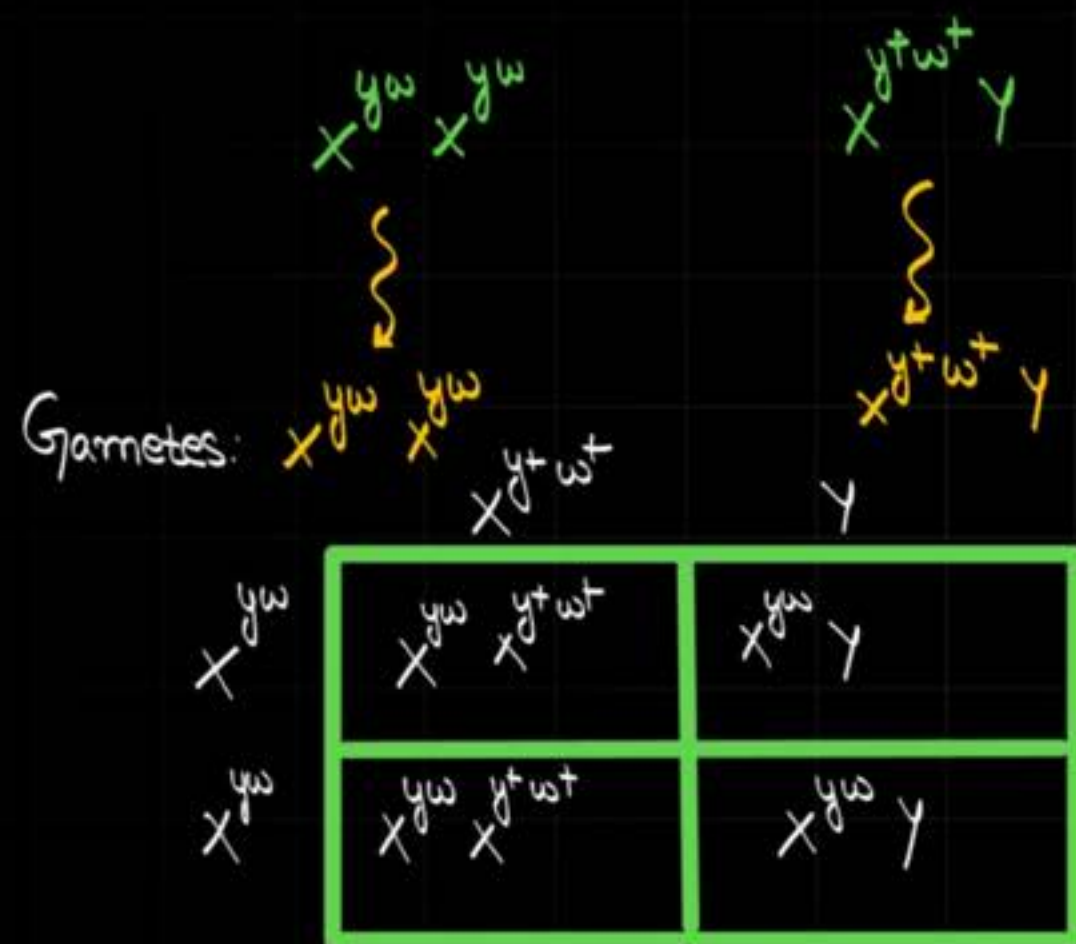
Recessive

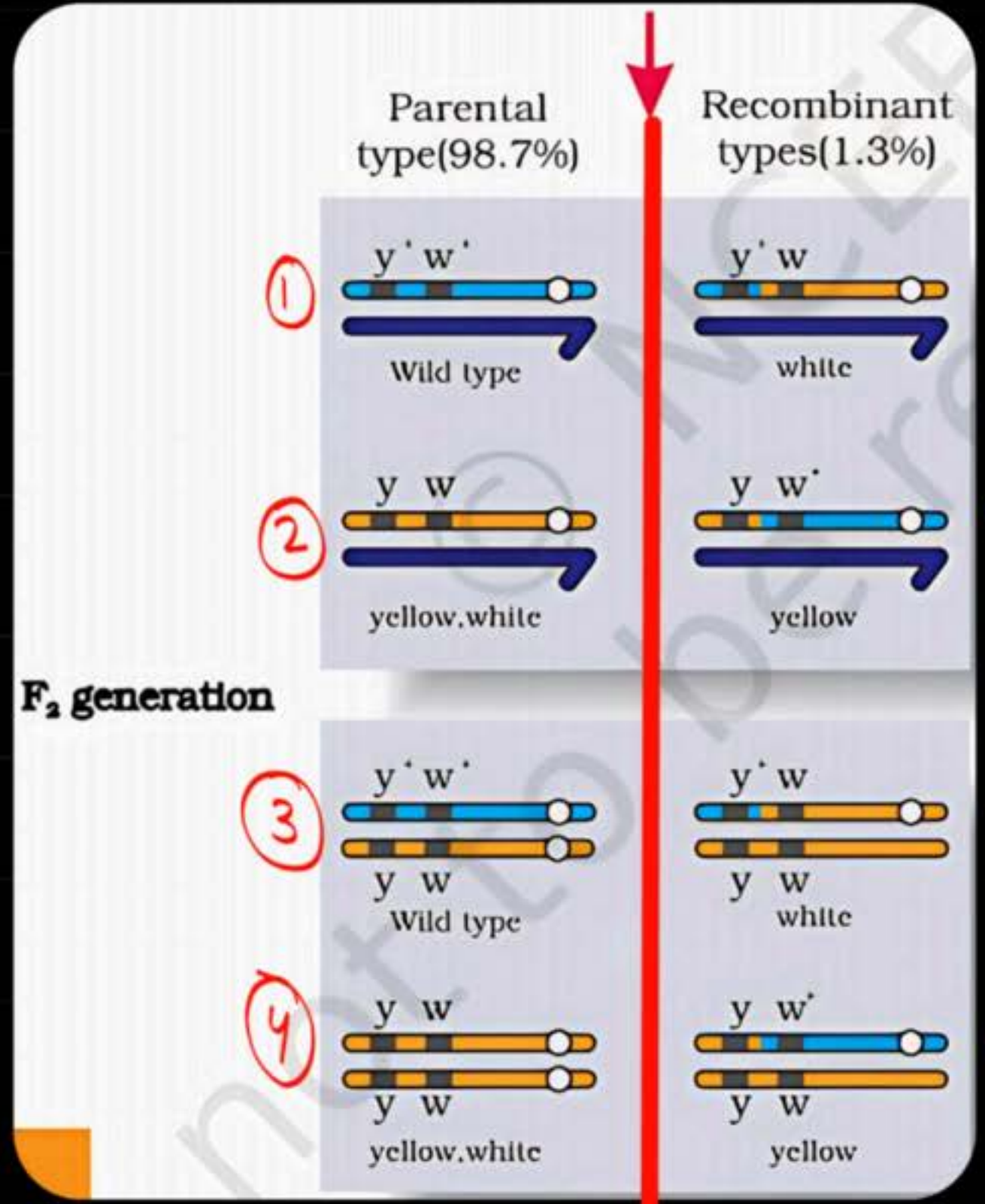
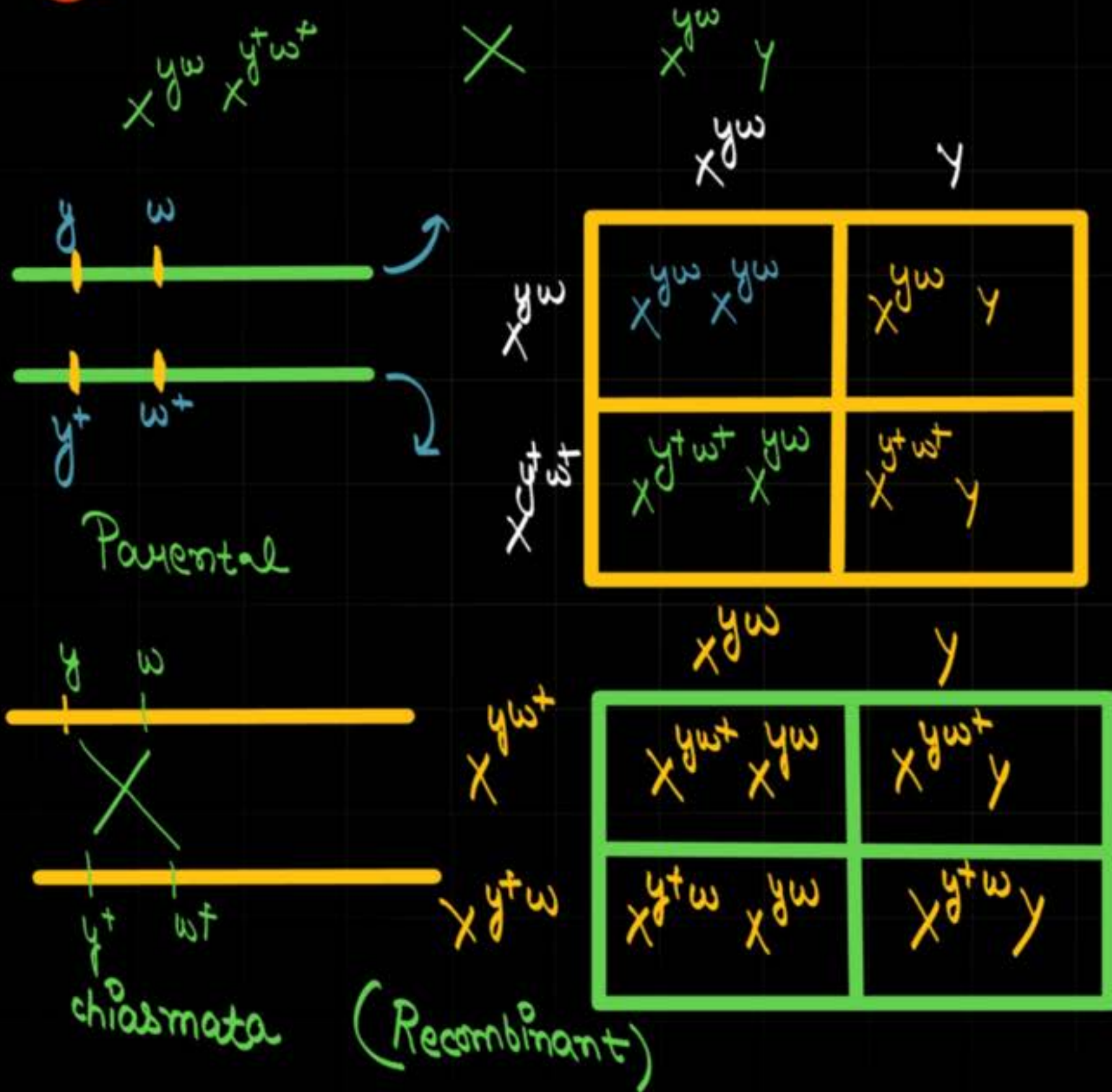
yellow (y)

white (w)

miniature (m)







1

2

3

4

Less Distance between gene $\longrightarrow$ closely linked (more parental)
 $\uparrow$ linkage

More Distance between gene $\longrightarrow$ $\downarrow$ linkage (Less parental)

$$\text{Linkage} \propto \frac{1}{\text{Recombination}}$$

$$\downarrow \text{Linkage} \propto \frac{1}{\uparrow \text{Recombination}}$$

$$\uparrow \text{Linkage} \propto \frac{1}{\downarrow \text{Recombination}}$$

SEX DETERMINATION

(During Embryonic period)

Environmental

Non-Allosomic

(no sex chromosomes)
sex determining gene is
present on Autosomes.

Allosomic

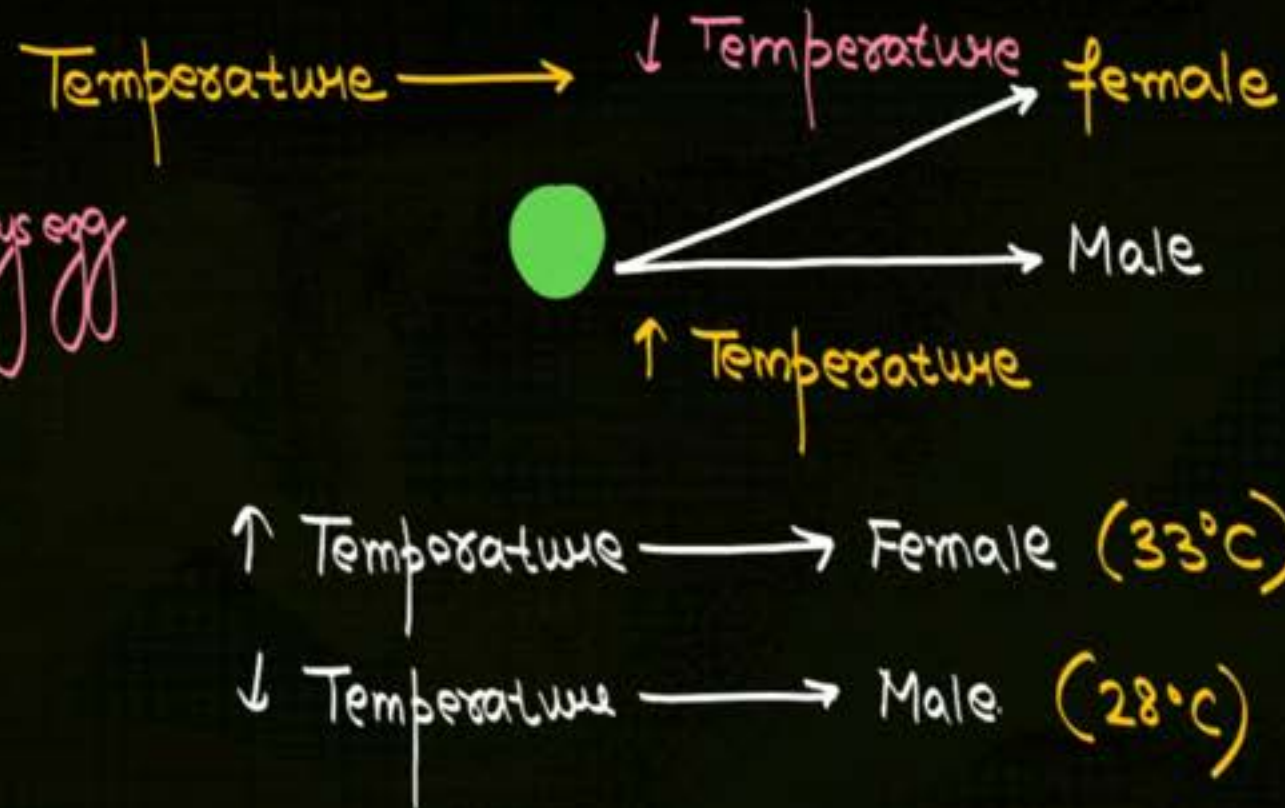
Sex chromosomes are present
(sex-determining gene is present on
Sex chromosomes)

ENVIRONMENT SEX DETERMINATION



Eg: Mr. Crocodile

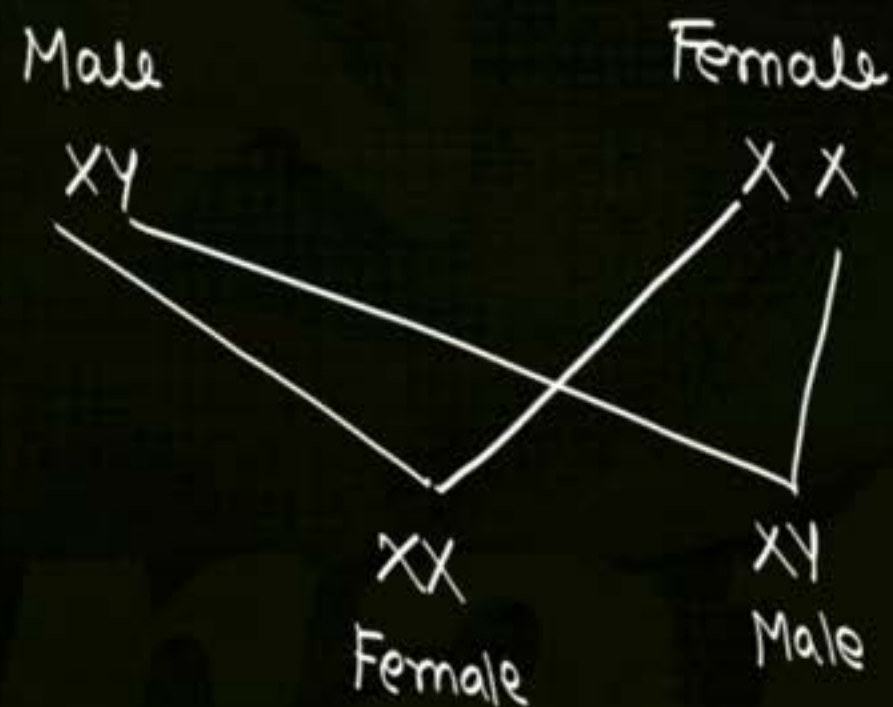
Oviparous → lays egg

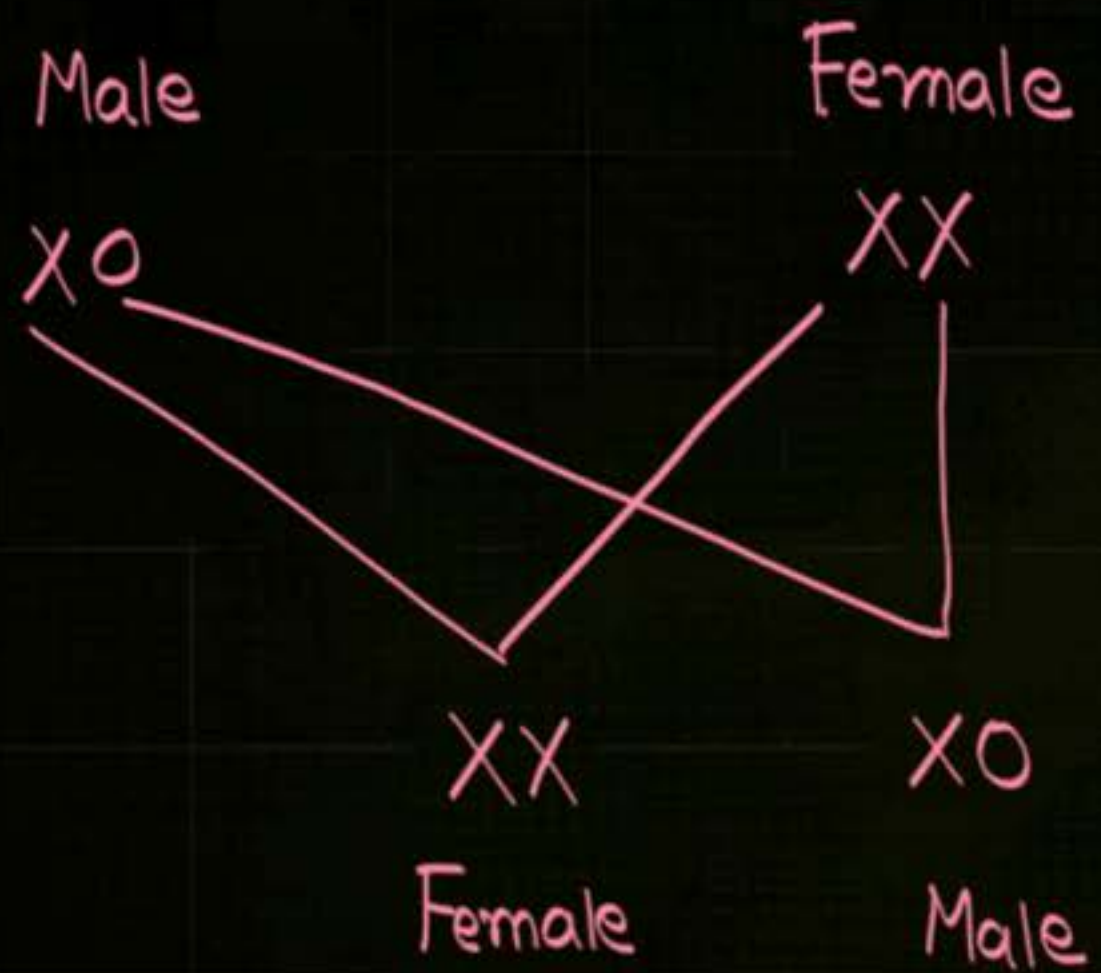


Sex chromosomes are present

(1) Male Heterogamety : Male decides the sex of next generation.
different gametes

eg. Human

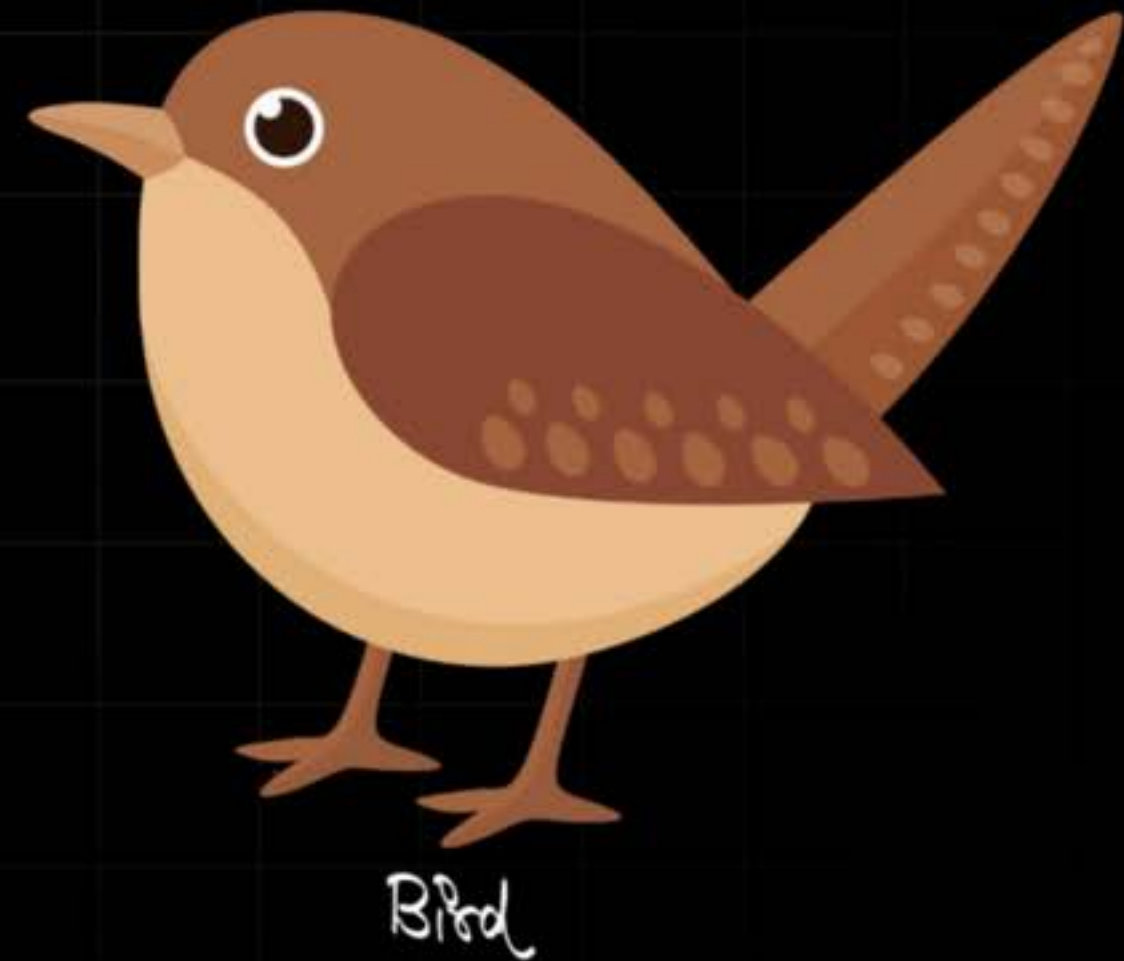
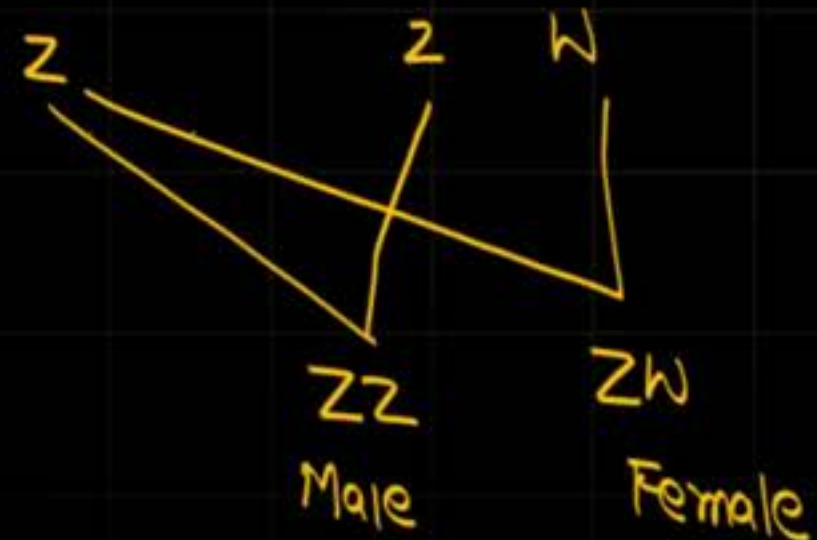
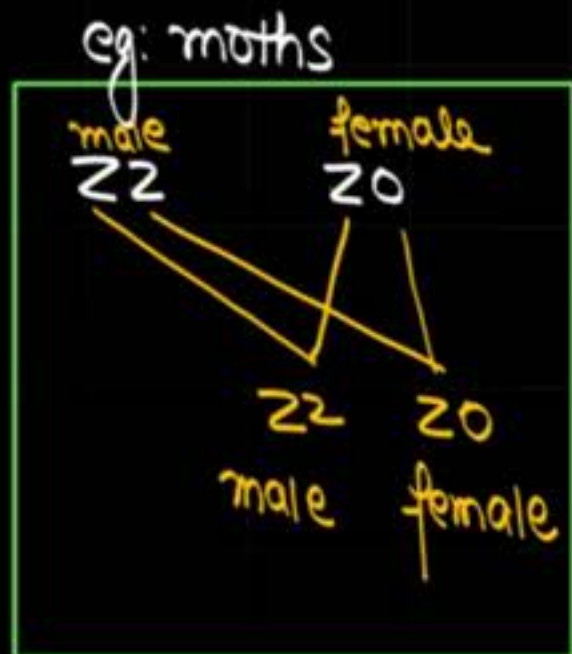




Female Heterogamety: Female decides the sex of next generation.

Male
ZZ

Female
ZW



SEX DETERMINATION IN HUMANS



$AA + XY$



$A + x$	$A + x$
$AA + XX$	$AA + XY$
$AA + xY$	$AA + xy$

$AA + XX$

$A + x$

50% → Male

50% → Female

HAPLOID- DIPLOID SEX DETERMINATION

eg: Honeybee



Queen Bee ($2n$) Diploid
32 chromosomes



Drone (haploid) n
16 chromosomes

Gametes



Parthenogenesis

Drone (n)

female



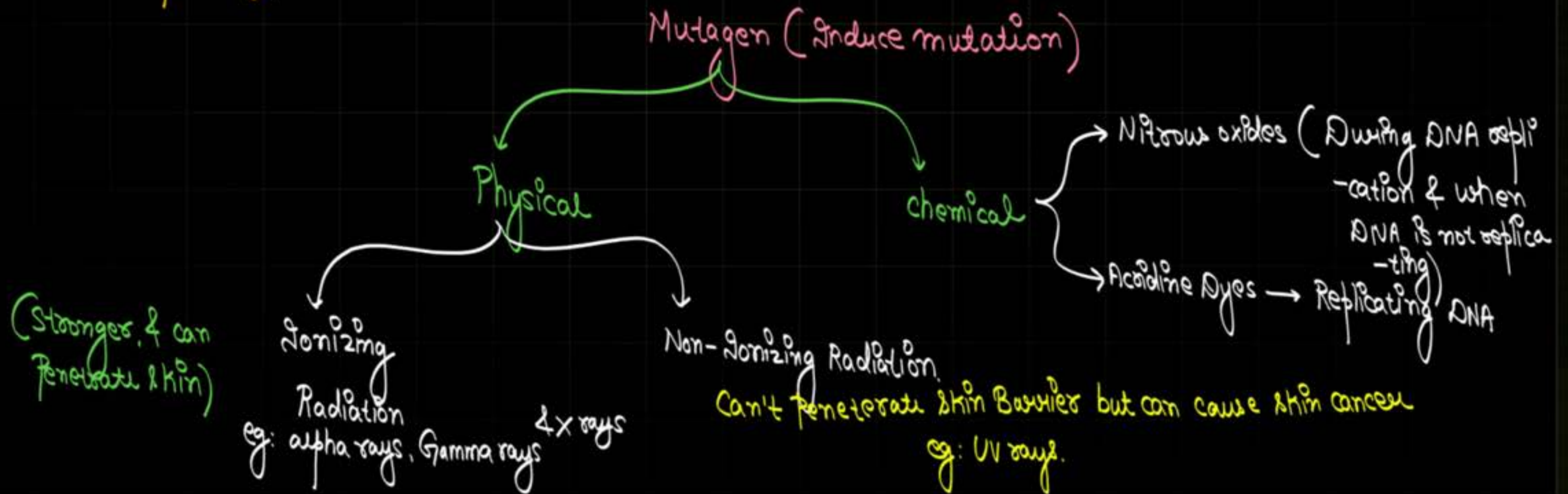
mitosis

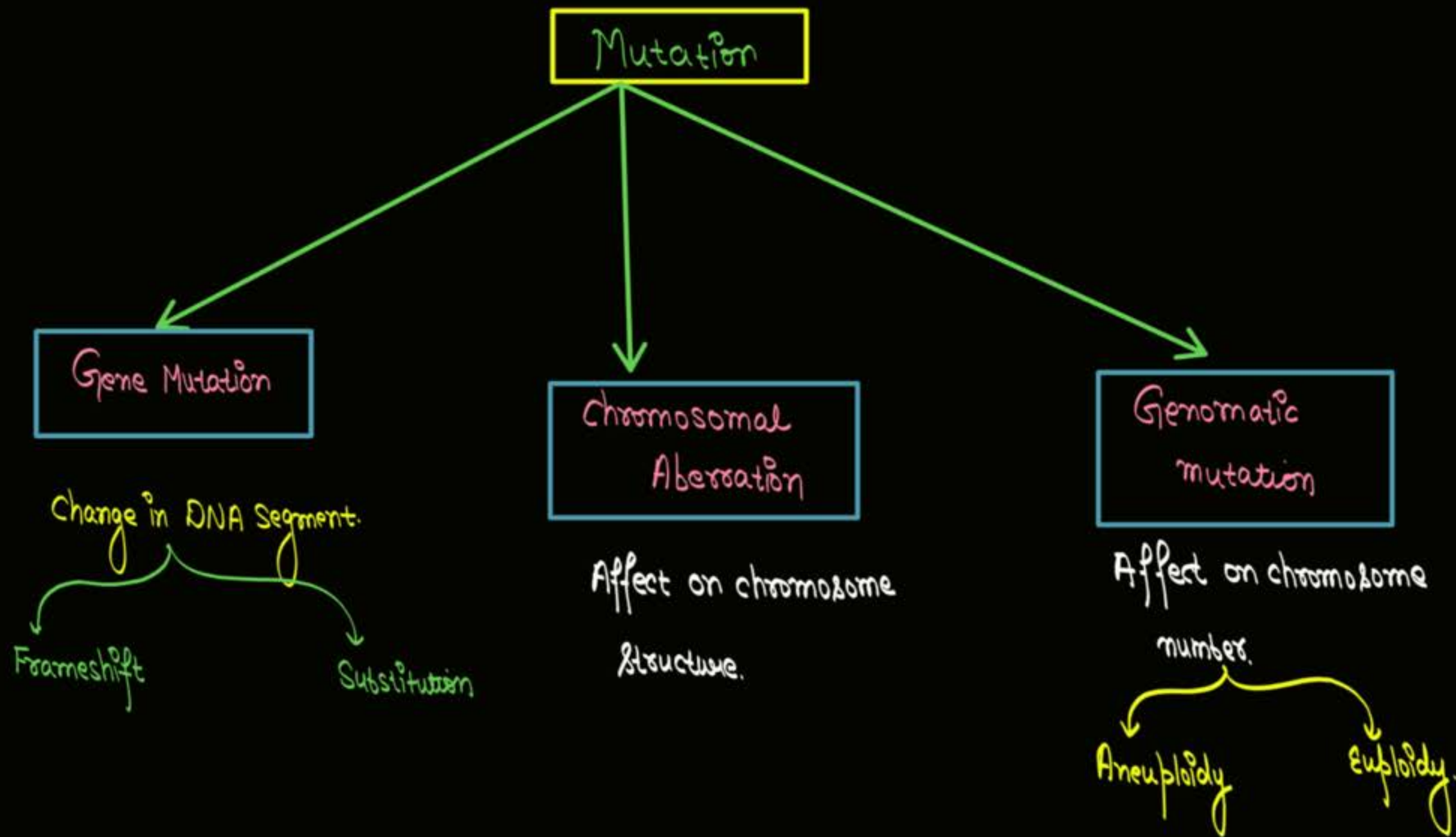


Parthenogenesis: Process of formation of embryo without fertilization

MUTATION

Sudden, random change in genetic material that result change in Genotype as well as phenotype





Gene Mutation

Original Sequence :

THE CAT ATE THE RAT
THE CAT TET HER AT

Mutated Sequence :

THE CAT TET HER AT
Frame-shift mutation

Deletion or
Frameshift or
Point mutation

→ Single nucleotide is involved.

Gross Mutation → more than one nucleotide is involved.

THE ~~CAT~~ ATE THE RAT
THE ATE THE RAT

Original Sequence Substitution

A T G C T A

mutated Sequence

A C G C T A

Aneuploidy

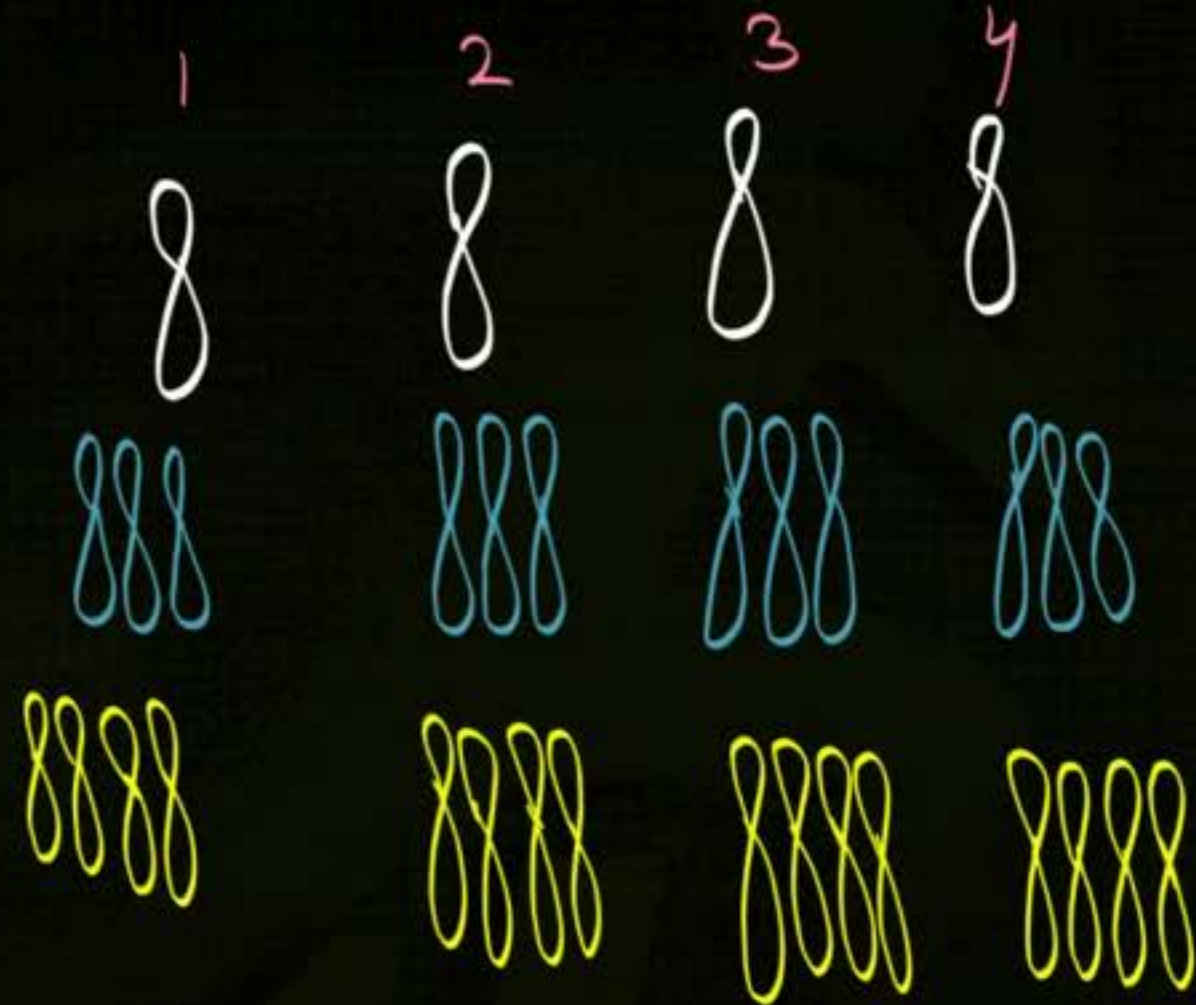
		1	2	3	4
Nullisomic ($2n-2$)					
Monosomic ($2n-1$)					
Double monosomic ($2n-1-1$)					
Trisomic ($2n+1$)					

Euploidy

Haploid (n)

Triploid ($3n$)

Tetraploid ($4n$)

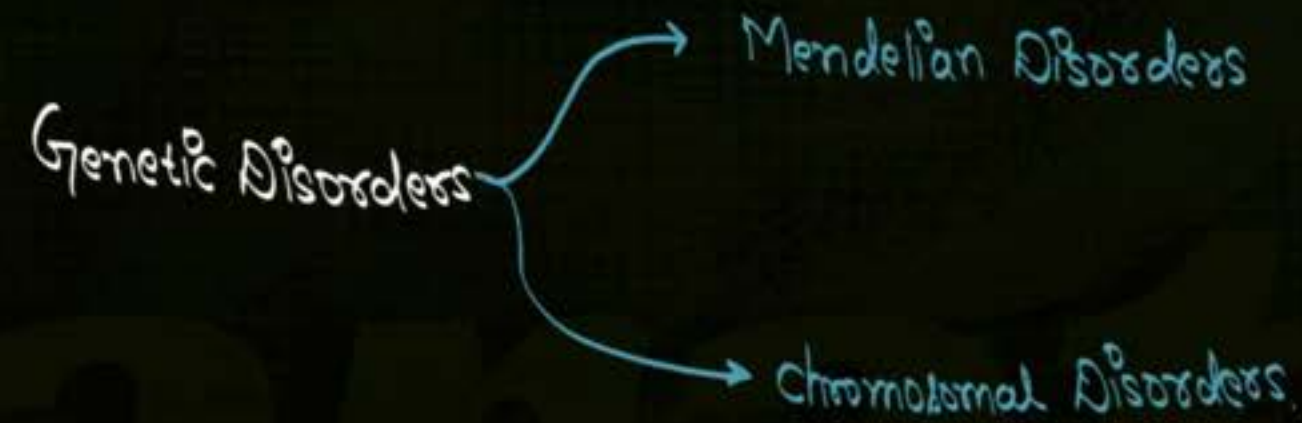


Gene mutation $\longrightarrow$ mendelian Disorders

Genomatic
mutation
or

$\longrightarrow$ Chromosomal Disorders.

Chromosomal
Aberration



Mendelian Disorder

Gene is affected. No change in chromosome number & structure.

Pedigree Analysis ✓

Disorders are Transmitted from parents to progeny

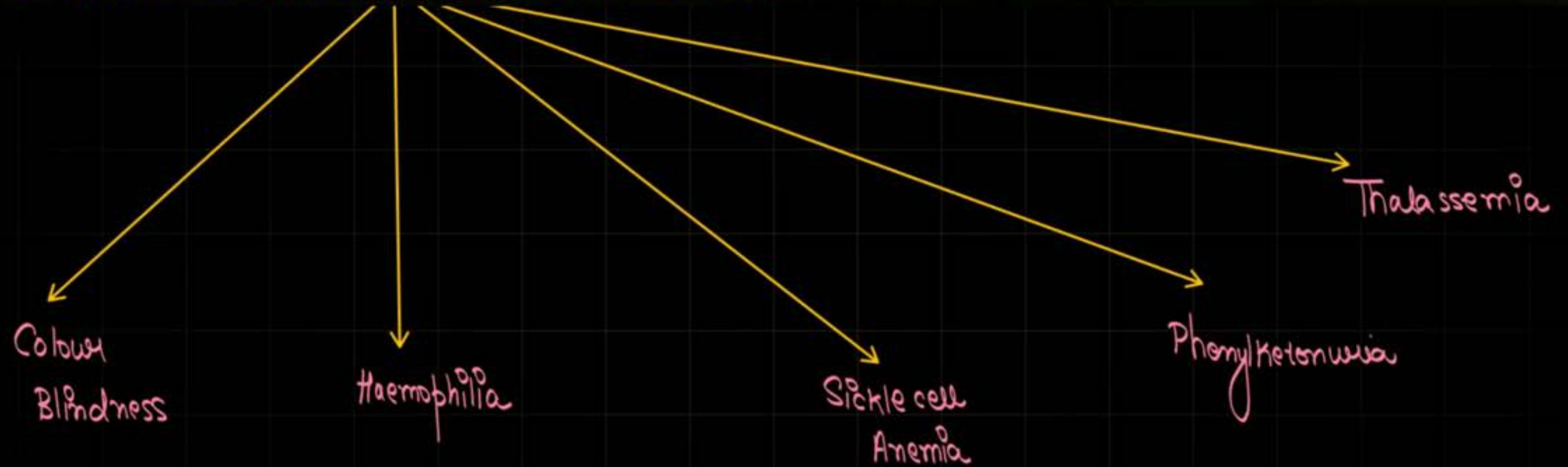
Chromosomal Disorder

Change in chromosome number & Structure.

Pedigree Analysis ✗

Disorders are not transmitted from parents to progeny

MENDELIAN DISORDERS



COLOUR BLINDNESS

→ X linked Recessive Disorder

Parents

male

$X^c Y$

(Affected)

female

$X^c X$

(Carrier)

	X^c	X
X^c	$X^c X^c$ Affected	$X^c X$ Carrier
Y	$X^c Y$ Affected	XY Normal

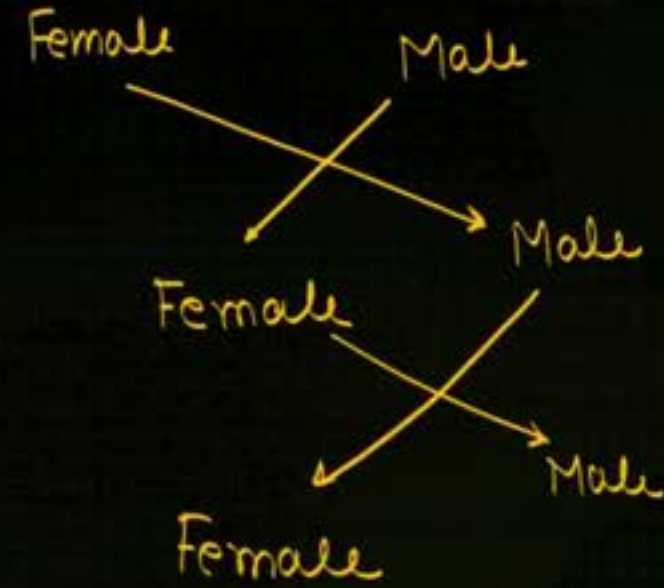
male → 8%

female → 0.4%

- X linked Recessive Disorder.
- Targeting cones (Red or green) cones.
- Dichromasia (Failure of Discrimination ^{between} Red & Green colour)
- Female → colourblind
- Male → Affected
- Female → carrier.
- Criss-cross Inheritance

F_1 generation

	Male $X^c Y$	female XX
	X^c	Y
X	XX^c	XY
X	XX^c	XY



	$X^c X$	XY
	X	Y
X^c	XX^c	XY
X	XX	XY

HAEMOPHILIA

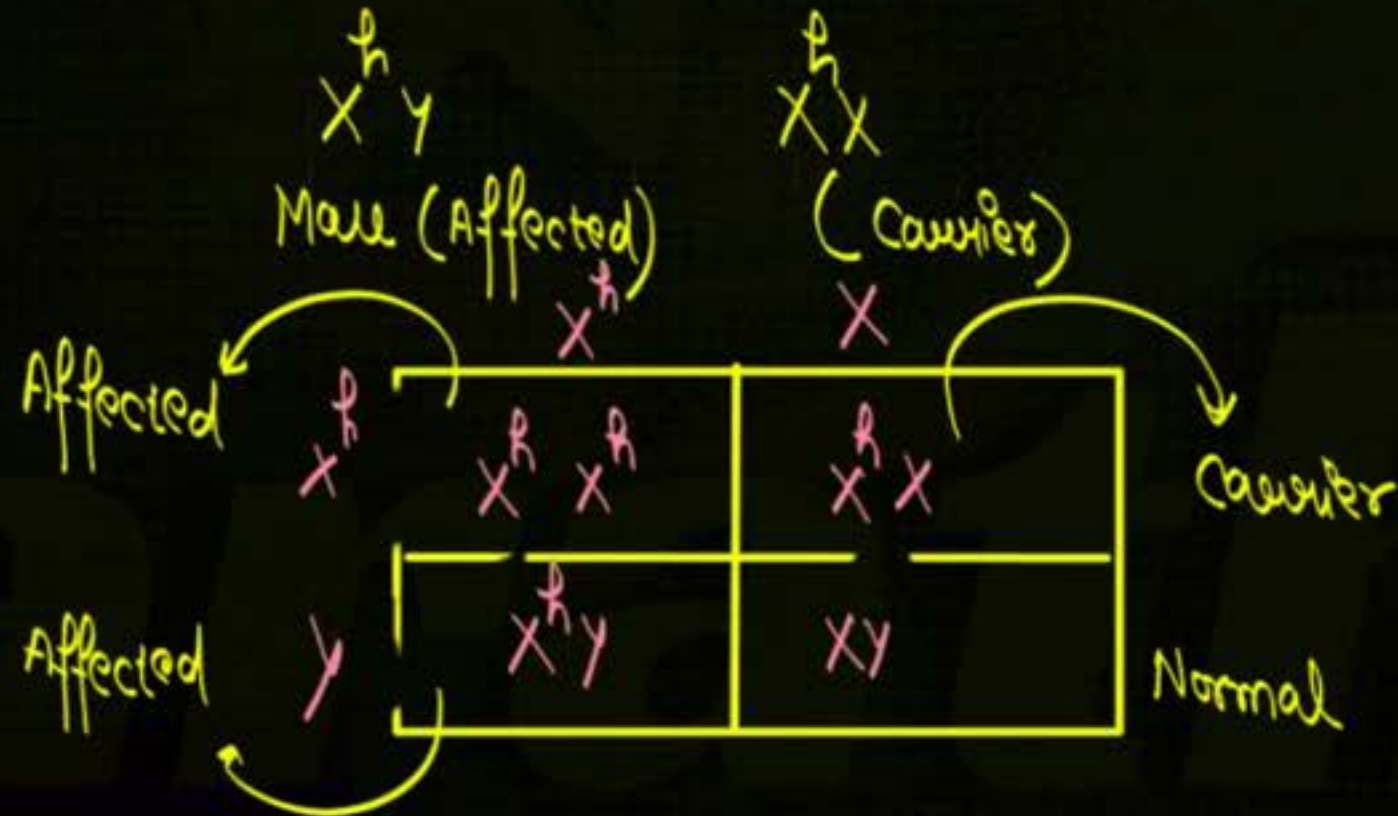
Hemophilia A

Factor VIII Absent (Royal Disease)

Hemophilia B

Factor IX Absent (Christmas Disease)

- X linked Recessive Disorder
- Qualitative (Blood Disorder)
- Problem in clotting



SICKLE CELL ANAEMIA

→ Autosomal linked Recessive Disorder.

Gene → It is present on chromosome number 11
↓
this gene forms β globin chains of Hb

Marathon

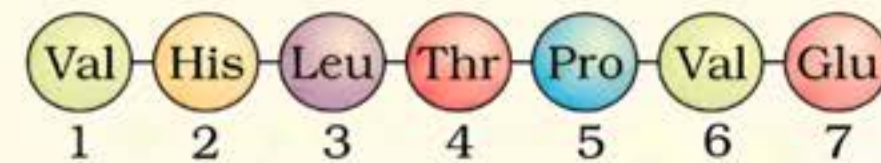
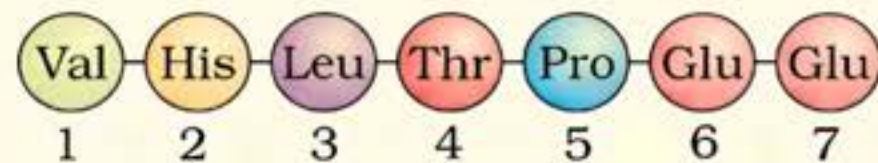


Normal Hb (A) gene ...GAG...
...CTC...

Sickle-cell Hb(S) gene ...GTG...
...CAC...

mRNA ...GAG...
↓

mRNA ...GUG...
↓



HbA peptide

HbS peptide

Parental
Generation

$Hb^A Hb^S$ (male)
(carrier)

$Hb^A Hb^S$ female
(carrier)

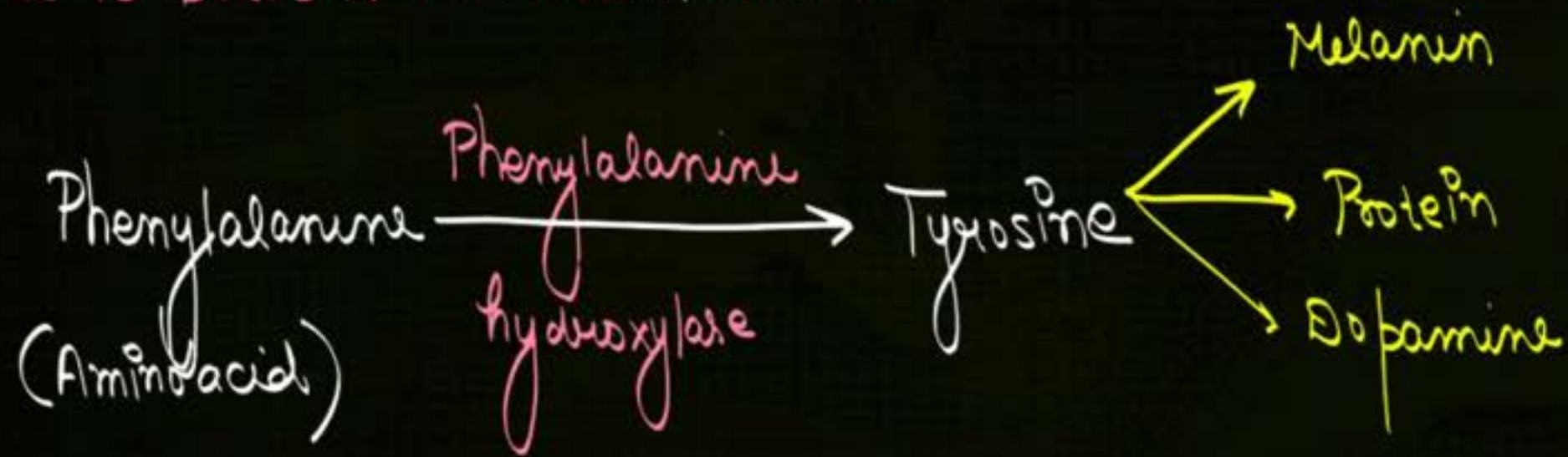
	Hb^A	Hb^S
Hb^A	$Hb^A Hb^A$ (normal)	$Hb^A Hb^S$ (carrier)
Hb^S	$Hb^S Hb^A$ carrier	$Hb^S Hb^S$ Affected

Dead

PHENYLKETONURIA (Good example of pleiotropy)

→ Autosomal Recessive Disorder

→ Gene is present on chromosome -12



In case when gene is affected
↓ convert

Phenyl pyruvic acid & its derivatives. (Keto group in it)

(due to poor absorption of kidney)

(1) ↑ Amount of phenyl
- pyruvic acid is seen in
Urine (Dark-coloured)

(2) Accumulation of phenyl
- pyruvic acid in Brain
leads to mental retardation

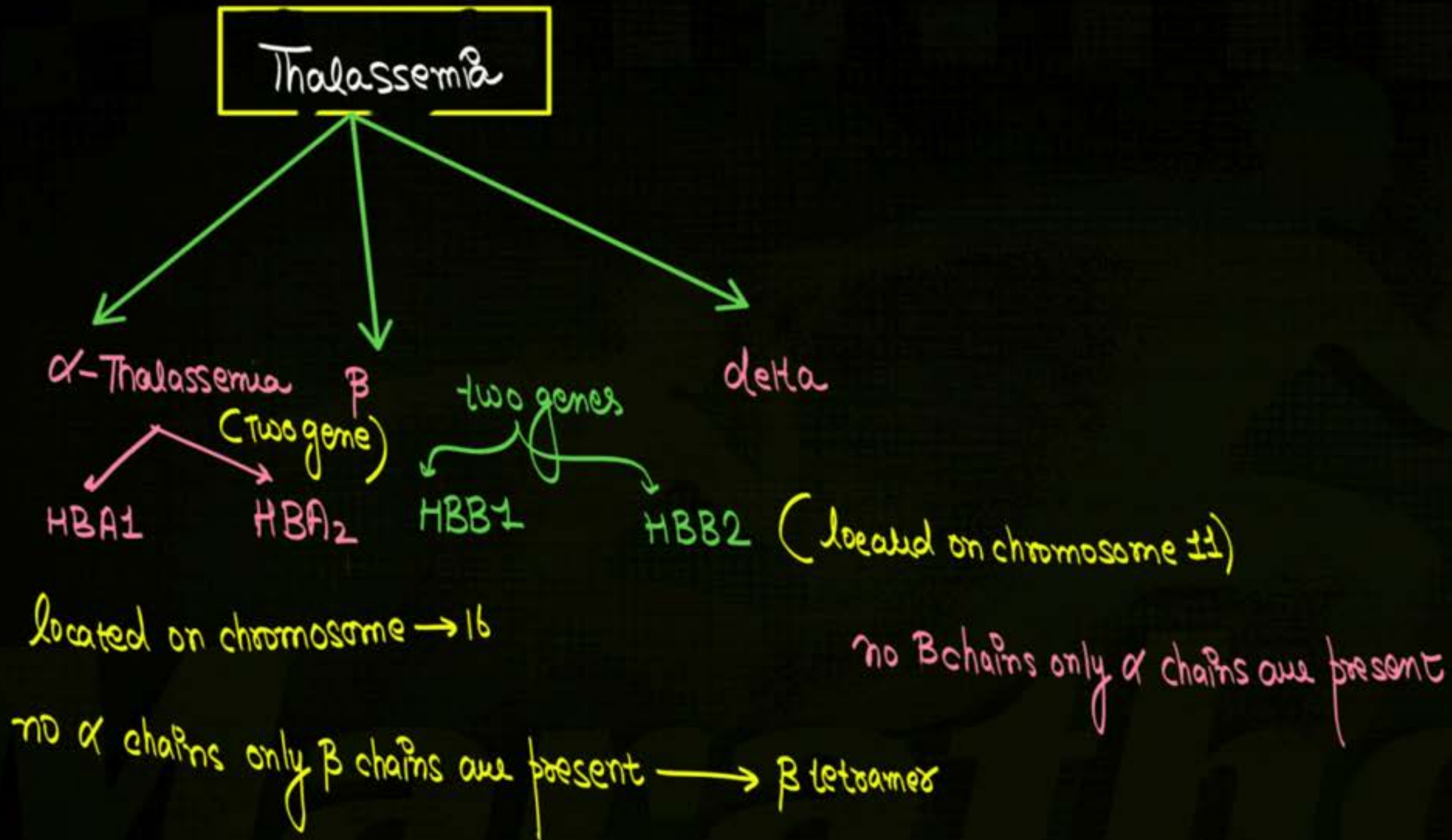
→ light skin & hair

THALASSEMIA

→ Autosomal Recessive Blood Disorder.

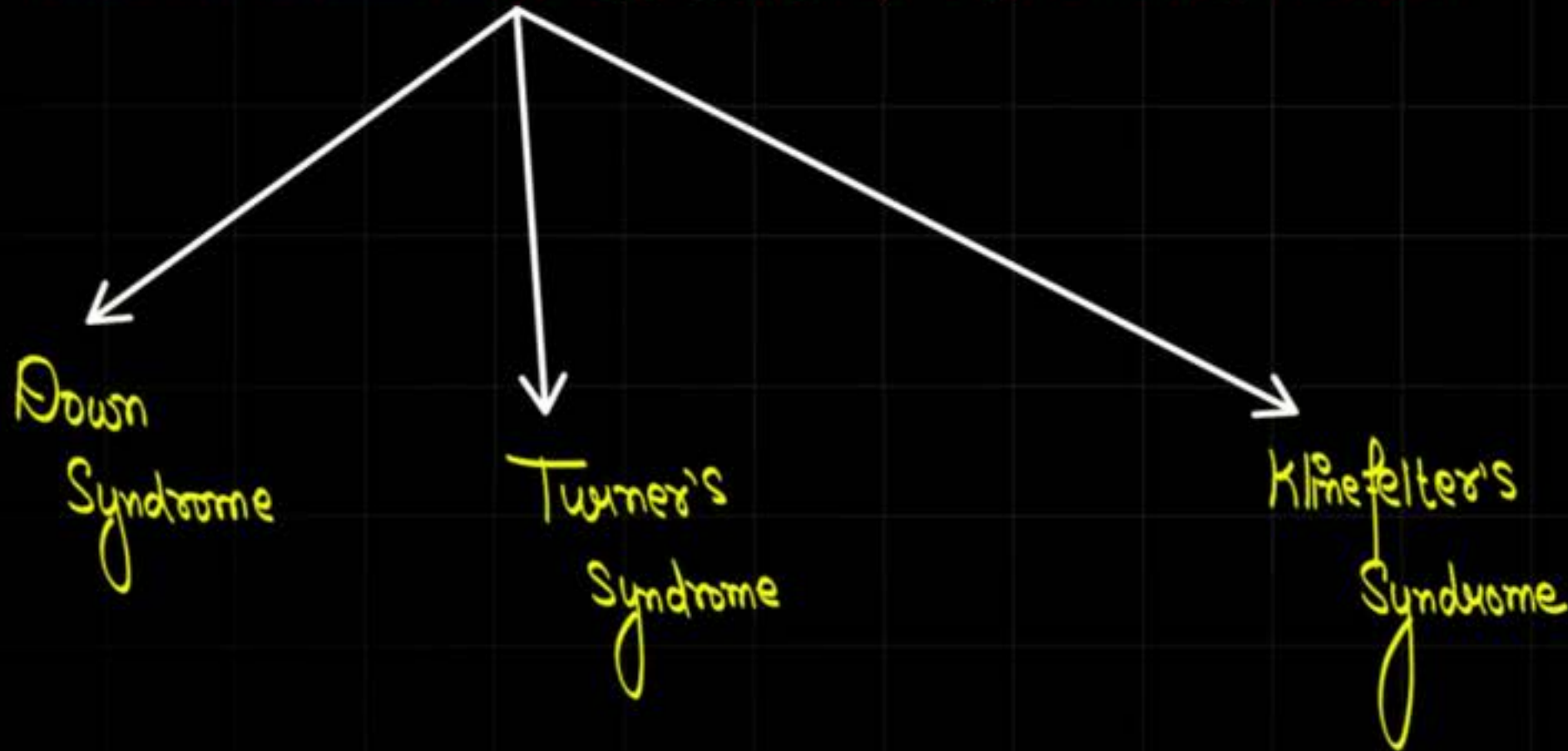
→ Quantitative Disorder

Male	Aa		Aa	Female
	Heterozygous		(Heterozygous)	
		A	a	
	A	AA normal	Aa carrier	
	a	Aa carrier	aa Affected.	→ 25%



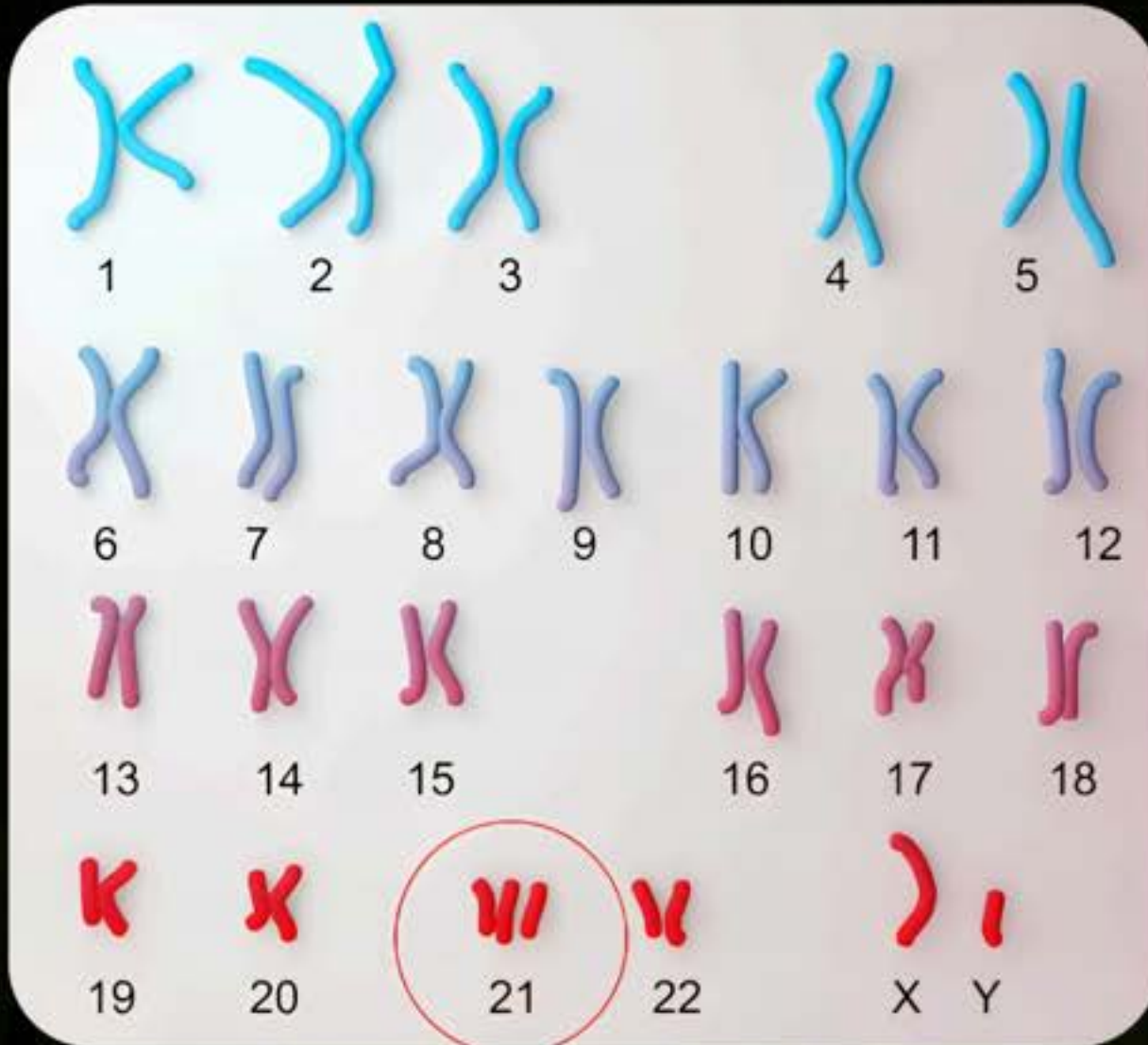
CHROMOSOMAL DISORDERS

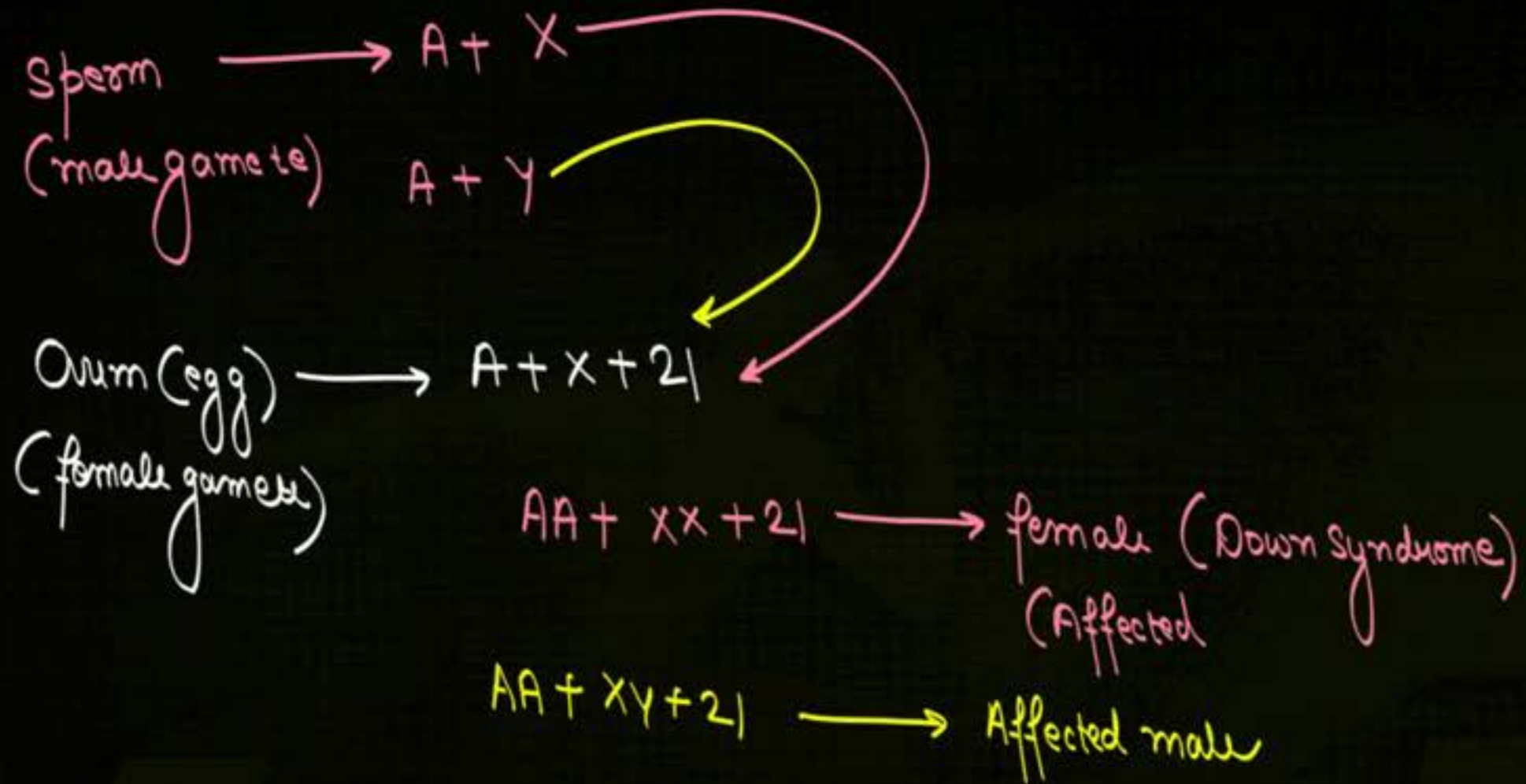
Due to chromosomal Aberration & Genomatic mutation



DOWN'S SYNDROME

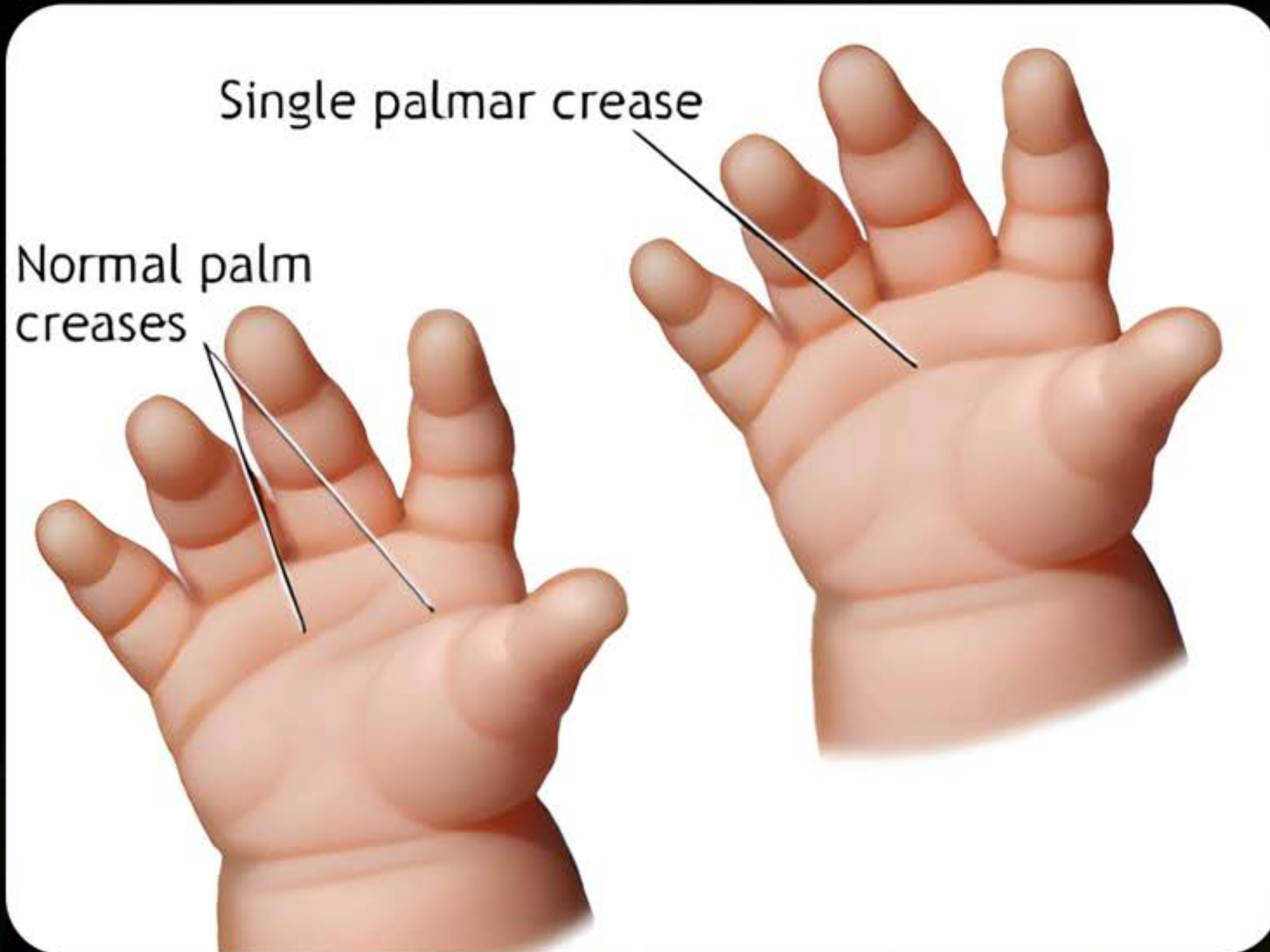
Tripomy of chromosome 21





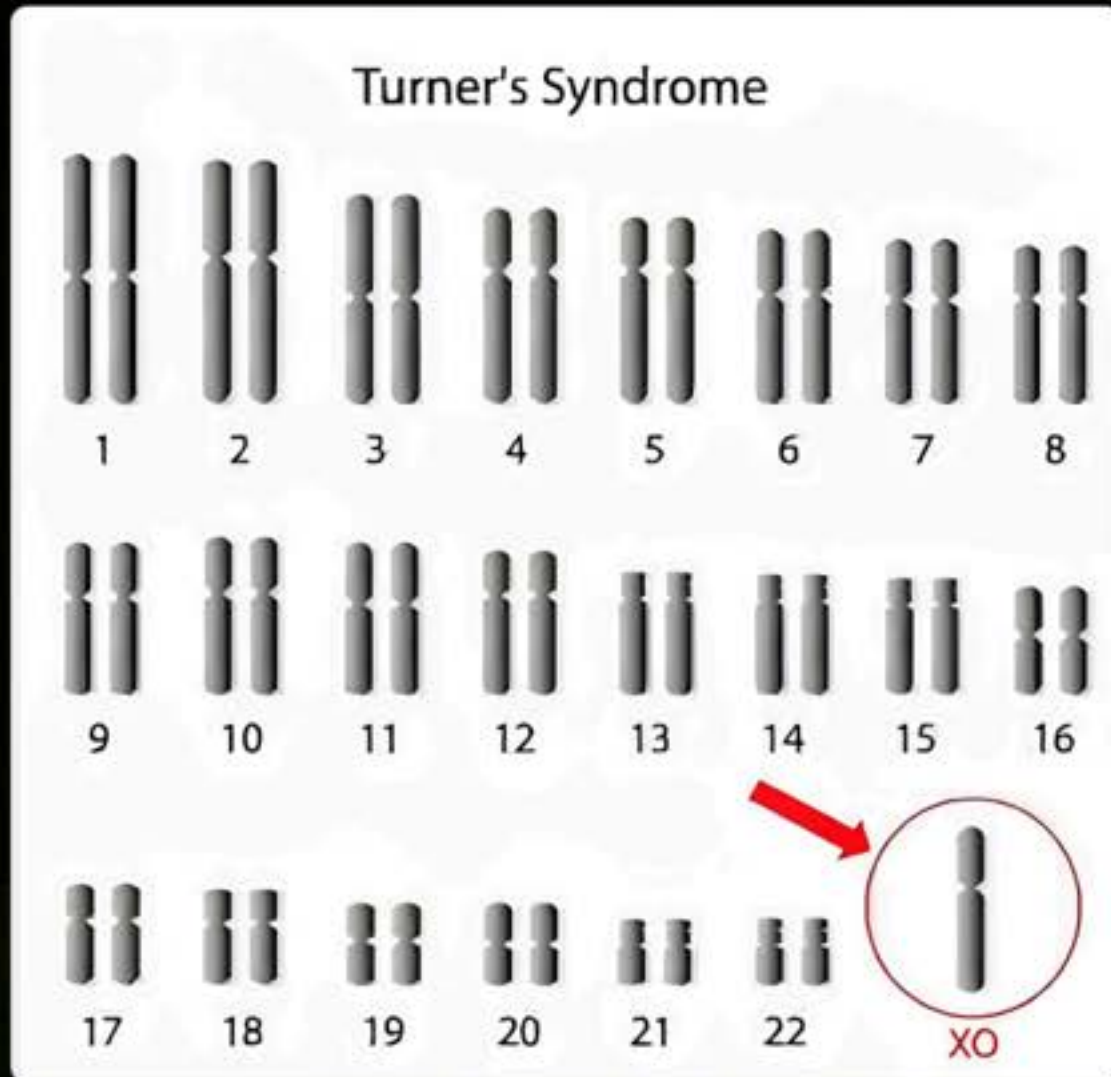
Symptoms

- Broad flat face
- Slant eyes
- Flat back of Head
- Partially open mouth
- Big & wrinkled Tongue
- Palm crease
- Congenital Heart Disease
- Short Stature.



TURNER'S SYNDROME

Absence of X chromosome



Symptoms

- Female is sterile
- Short stature
- Webbed neck
- Low posterior Hairline
- Rudimentary ovaries
- No menstrual cycle
- Heart shaped neck
- Poor Breast Development

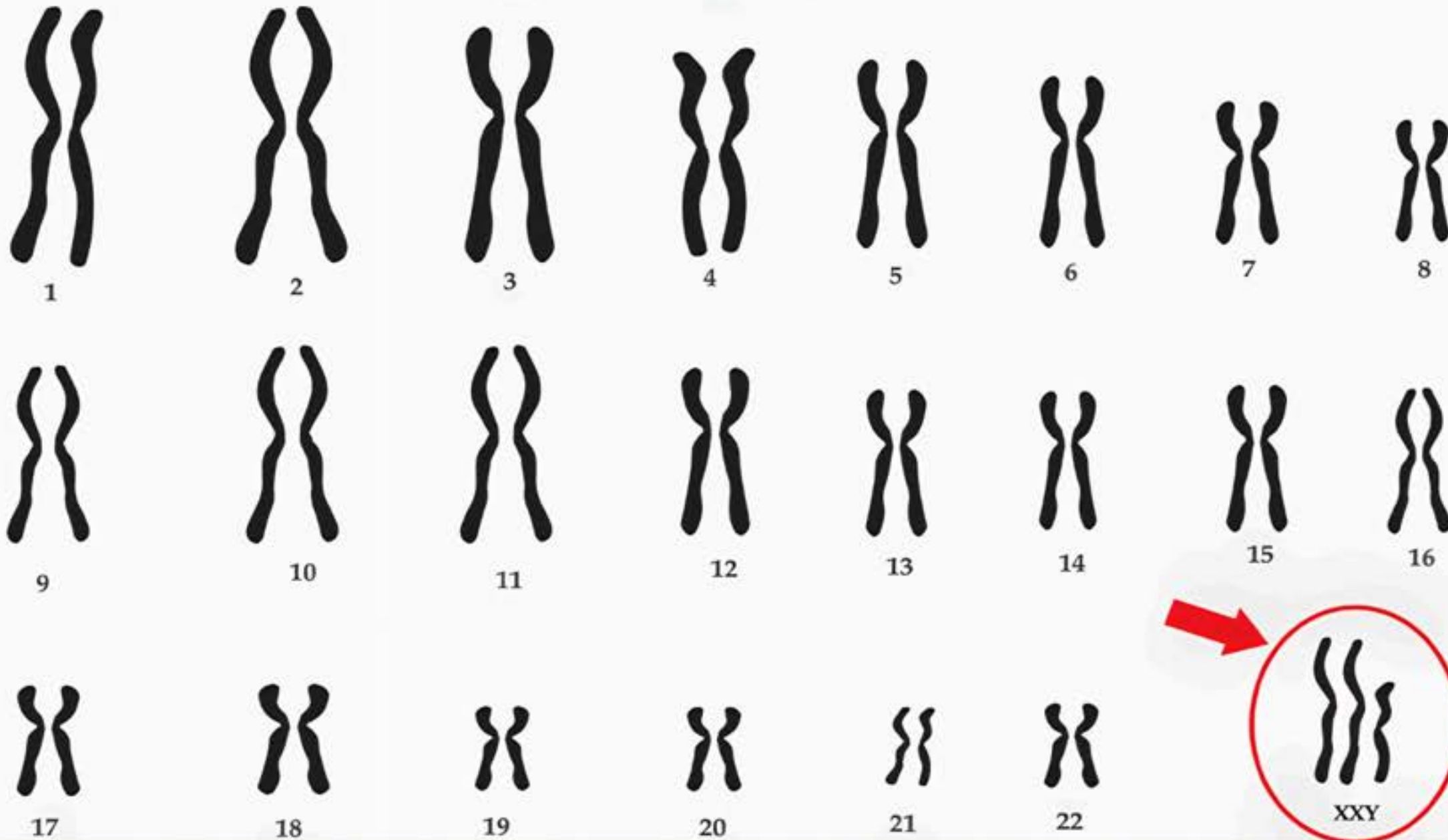
KLINEFELTER'S SYNDROME



Additional copy of X chromosome.
AA + XXY

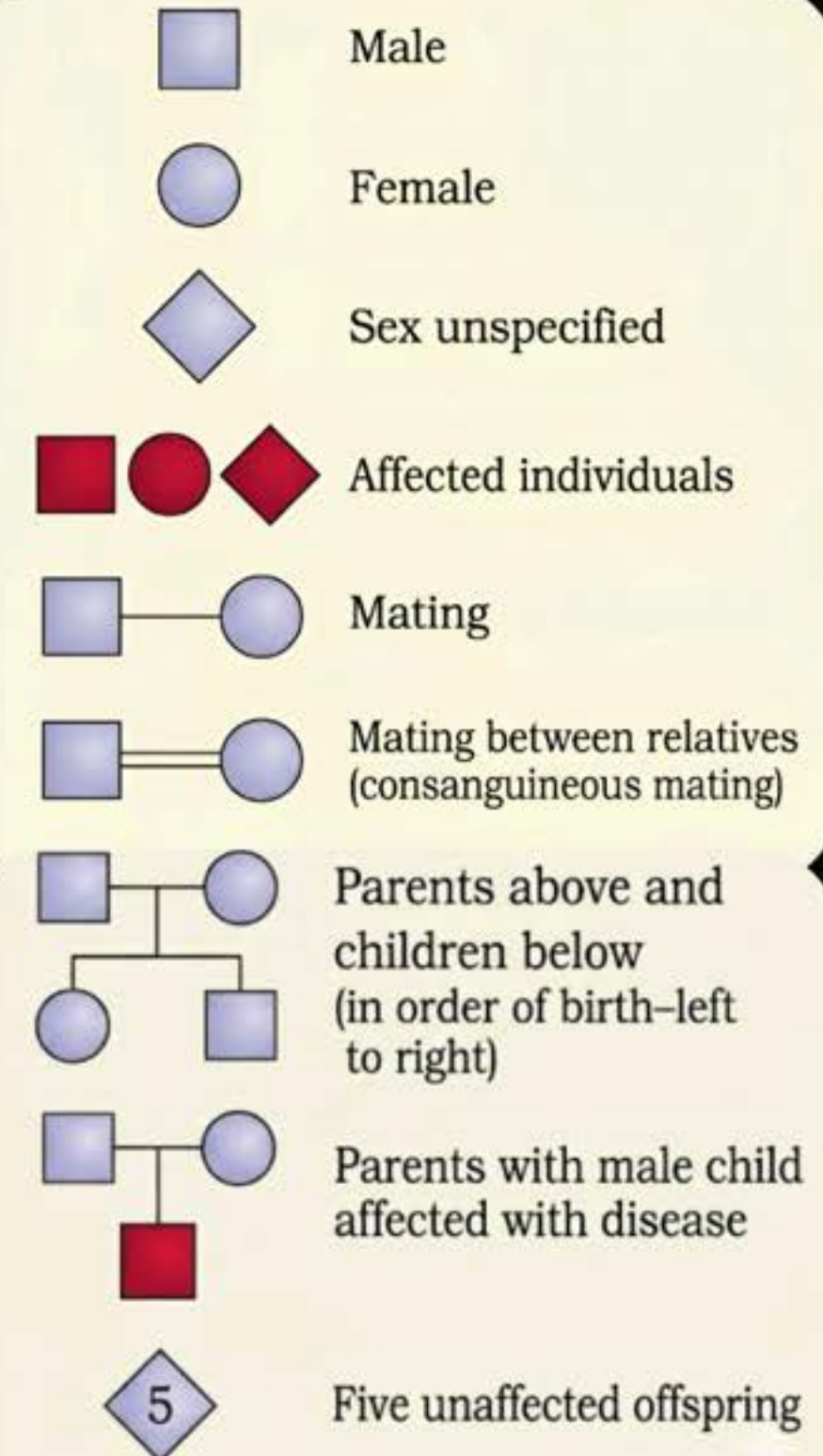
- Tall stature
- Gynecomastia (Breast Development in males)
- Poor Beard.
- Sparse Body Hair.

Klinefelter Syndrome

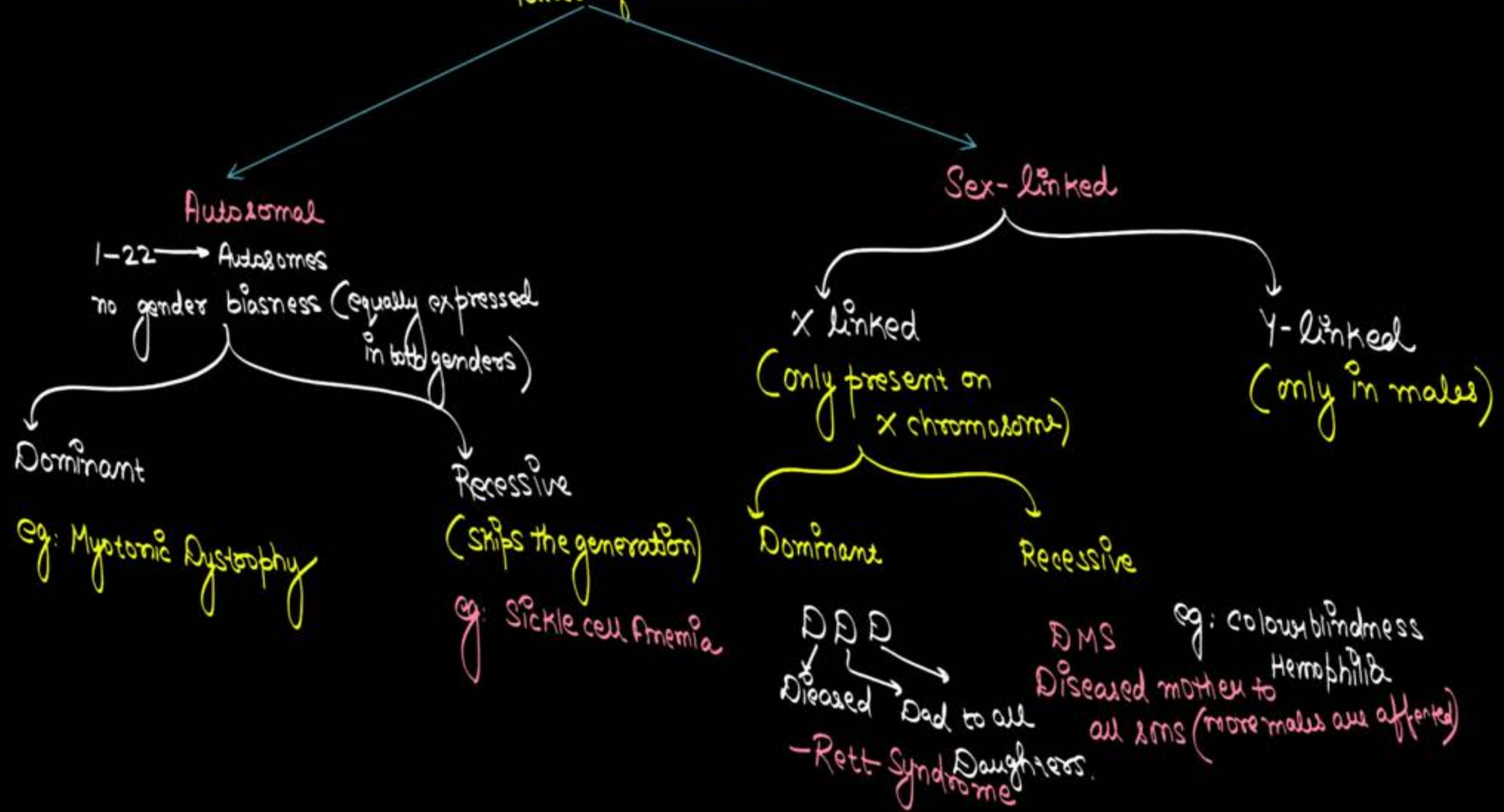


PEDIGREE ANALYSIS

Graphical Representation of traits/ disorder
Inherited in a family.



Pattern of Inheritance



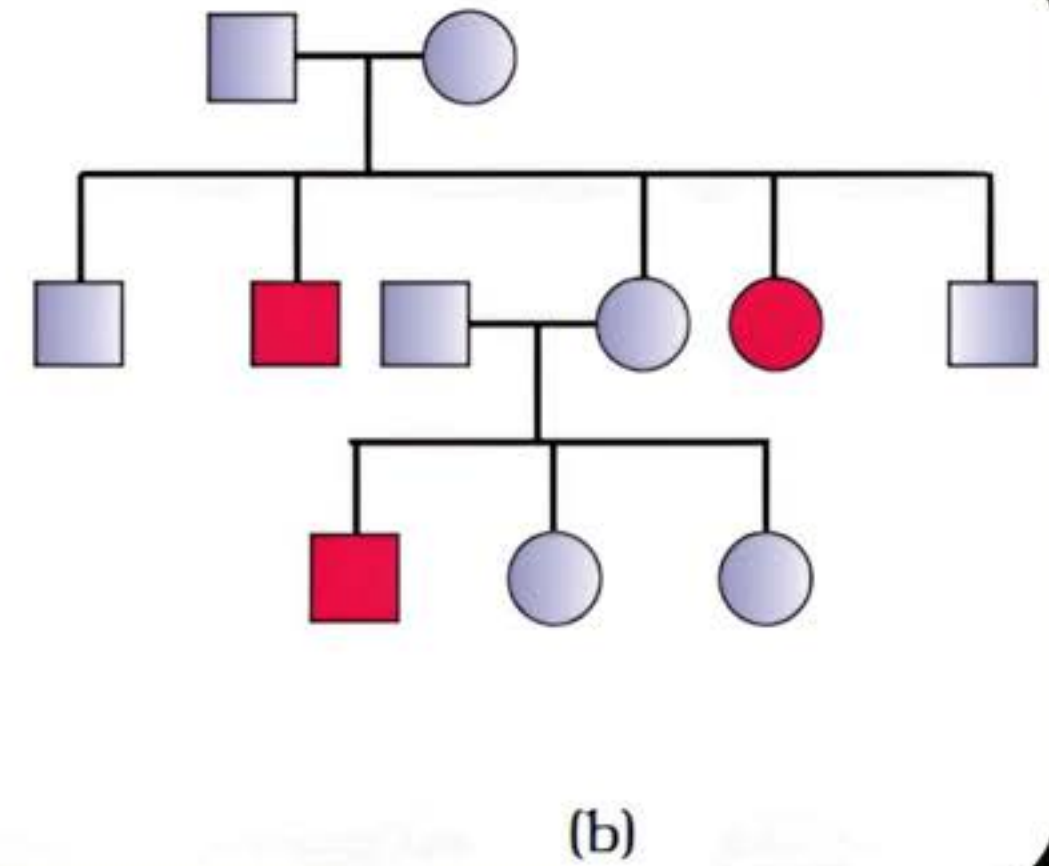
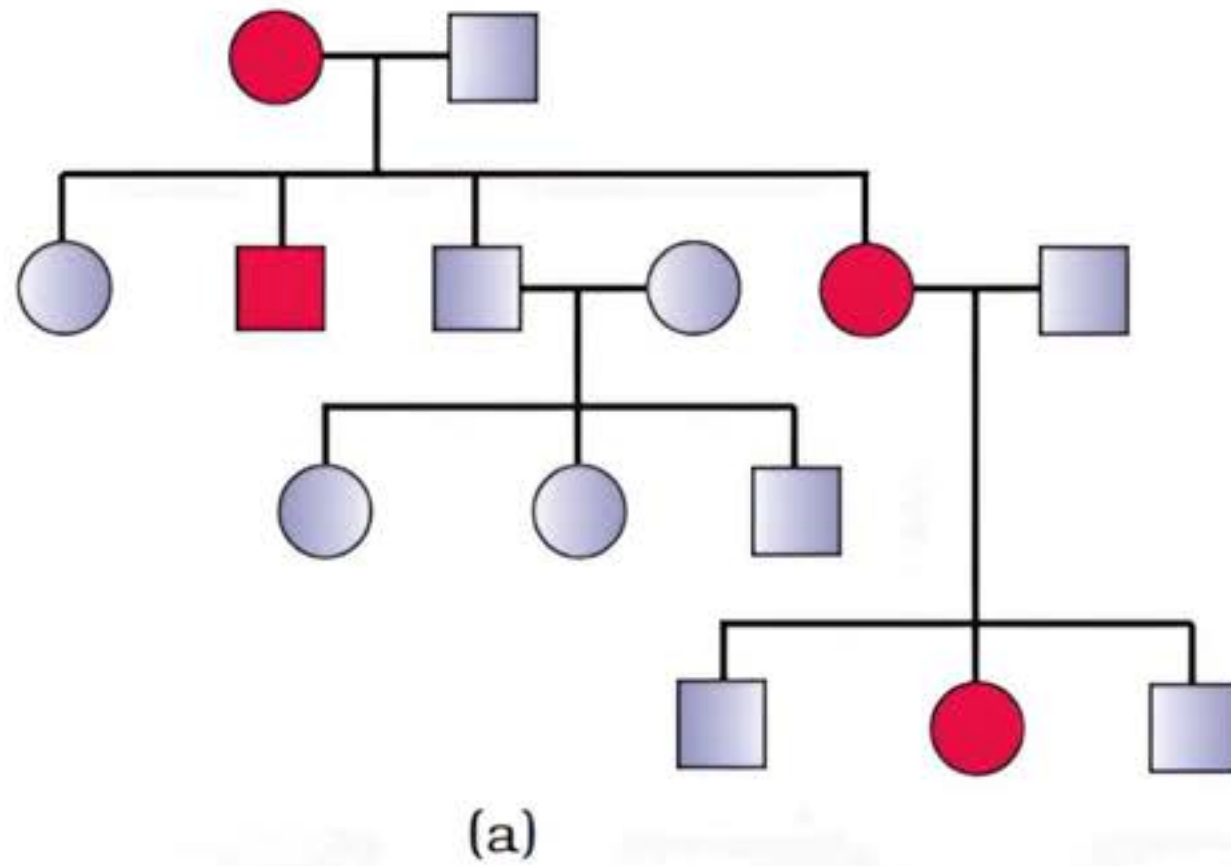


Figure 5.14 Representative pendigree analysis of (a) Autosomal dominant trait (for Example: Myotonic dystrophy) (b) Autosomal recessive trait (for example: Sickle- cell anaemia)

THANK
YOU