عملي الفرقة الأولى تربية بيولوجي وجيولوجيا باللغة الإنجليزية

مقرر علم الأجنة

2023/2022

Embryology

Embryology is a branch of science that is related to the fertilization, formation, growth, and development of embryo. In mammals, it deals with the prenatal stage of development beginning from formation of gametes, fertilization, formation of zygote, development of embryo and fetus to the birth of a new individual.

A Brief History of Embryology

- The theory of preformationism
- The theory of epigenesis
- The theory of recaptiulation
- The Cell Theory

Reproduction

Reproduction may be defined as the biological process by which organisms give rise to their own kind. Reproduction may occur in two ways: **Asexual and Sexual reproduction.**

Basic Concepts of embryonic development include:

1. Gametogenesis
2. Fertilization
3. Cleavage
4. Blastulation
5. Gastrulation
6. Organization (Organogenesis)

Gametogenesis

Gametogenesis for the formation of sperms is termed **spermatogenesis**, while that of ova is called **oogenesis**.

- Both spermatogenesis and oogenesis comprise similar phases of sequential changes as: **multiplication phase, growth and maturation phases**.

Spermatogenesis:

The testes structure

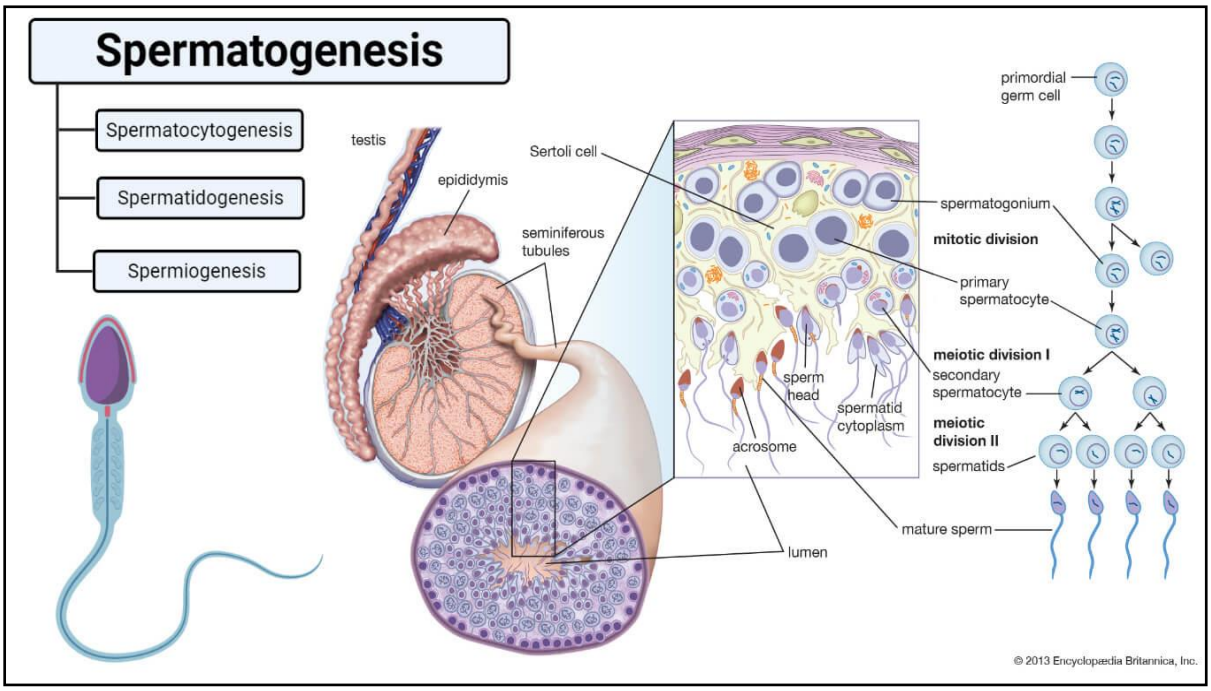
The testicles (testes) are part of a man's reproductive system. A man has 2 testicles.

- ✓ **Spermatogenesis:** includes the following phases:

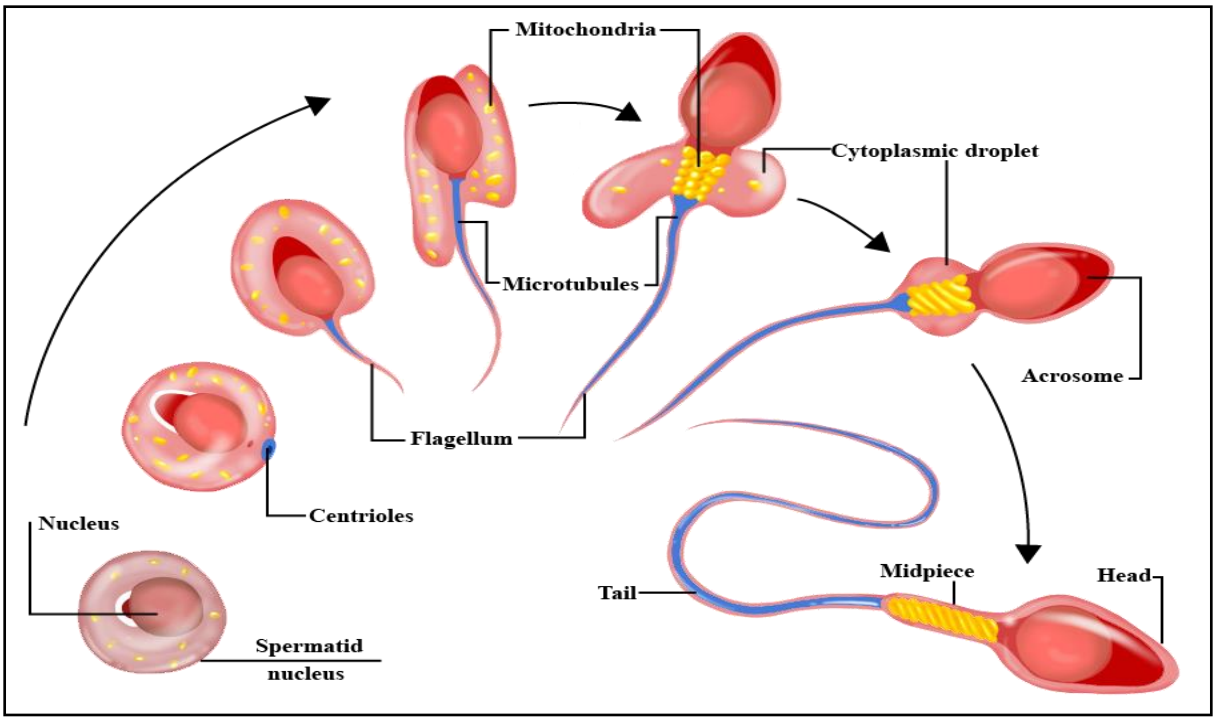
Multiplication Phase

Maturation Phase

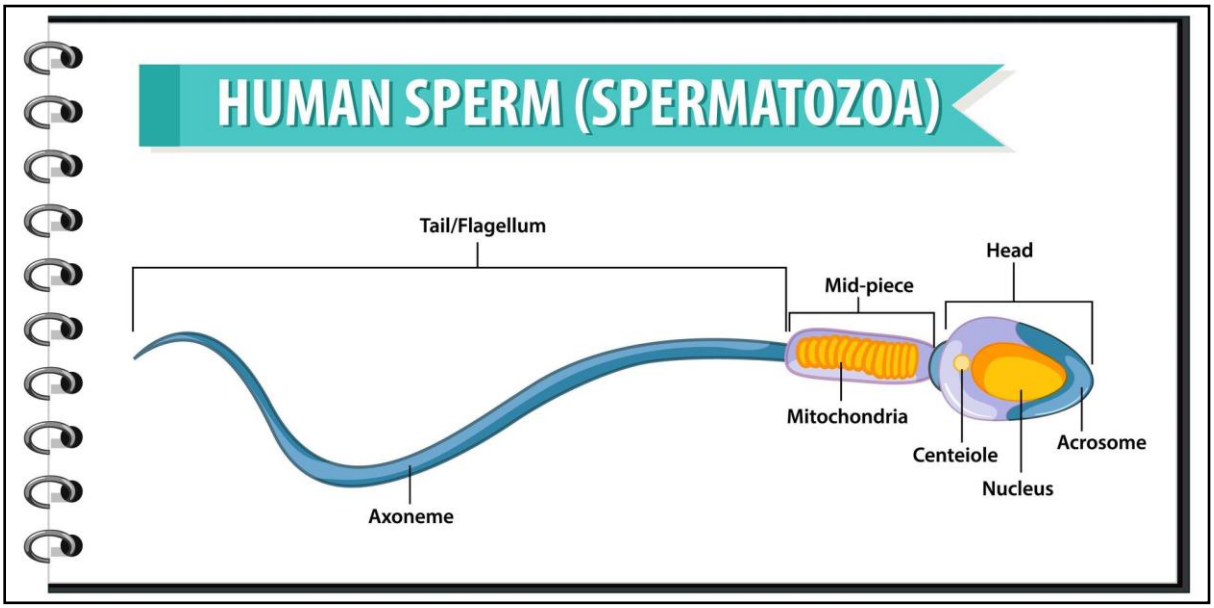
Growth Phase



Formation of Sperms from Spermatids (Spermiogenesis):



Spermatozoon (Sperm):



Different shape and size of sperm

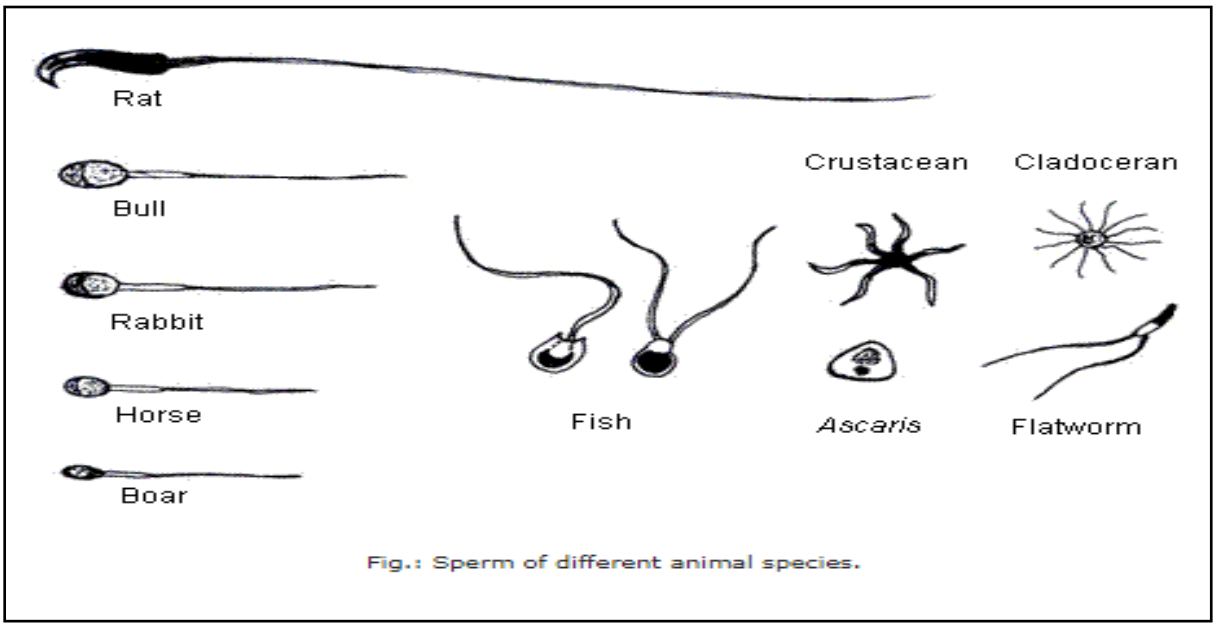


Fig.: Sperm of different animal species.

Oogenesis

Ovum structure:

The ovum is one of the largest cells that measures approximately 120 µm in diameter. The ovum has a large, centrally located nucleus which is covered by cytoplasm. This oocyte nucleus and nucleolus are termed **germinal vesicle** and **germinal disc** respectively. Likewise, the cytoplasm (yolk) of an ovum is termed **ooplasm**. It has less amount of yolk (in humans) and hence it is alecithal. This ooplasm is enclosed by a peripheral layer called the cortex which has many microvilli. These microvilli are tubular projections of the plasmalemma that aids in the transportation of substances in and out of the cytoplasm.

The human ovum is typically covered by 3 layers:

1. Inner thin vitelline membrane
2. Middle zona pellucida
3. Outer corona radiata

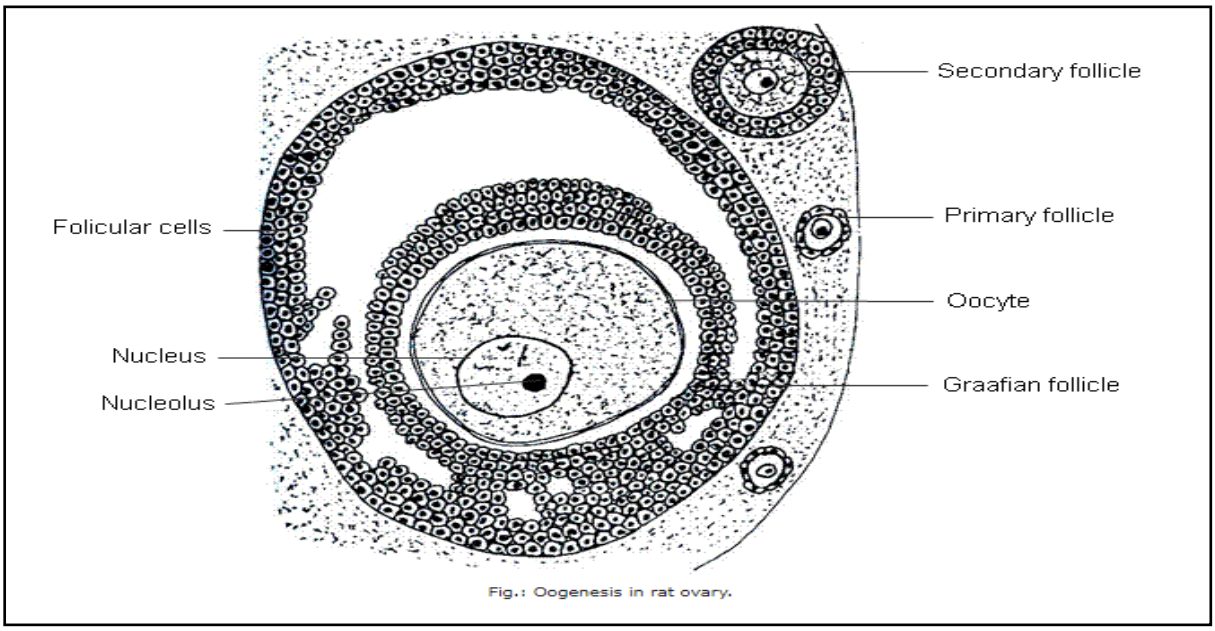
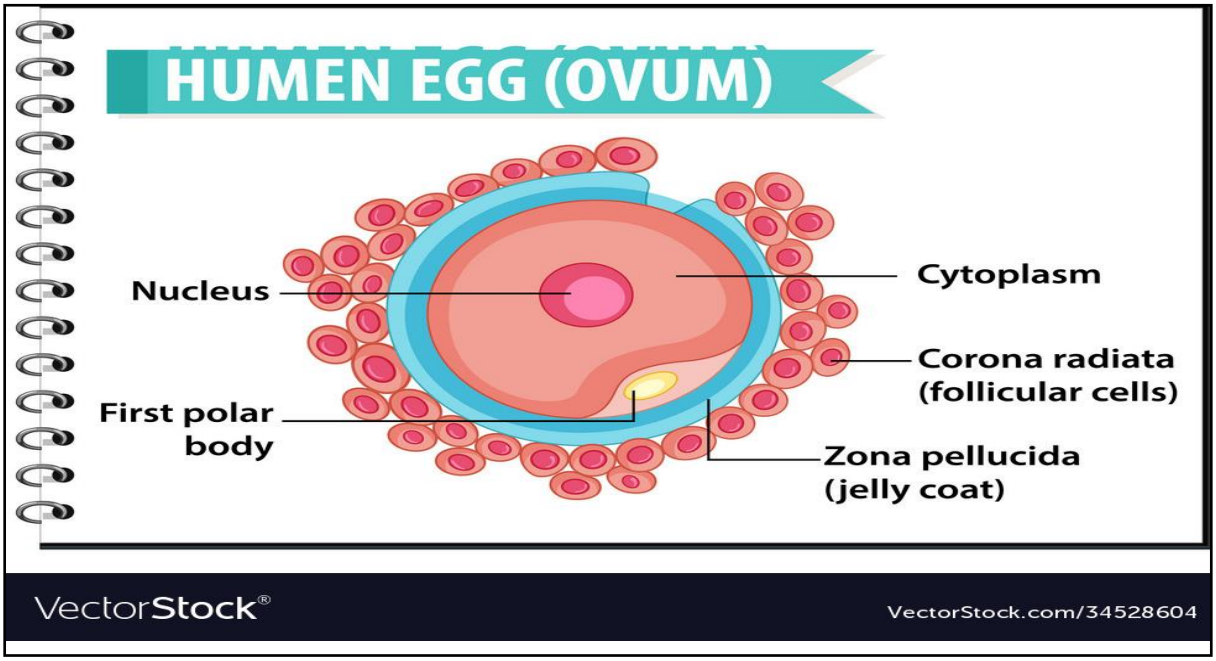


Fig.: Oogenesis in rat ovary.

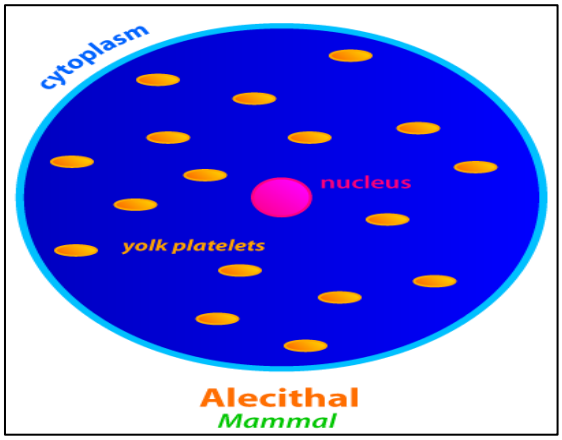


Types of Egg:

According to the proportion of the yolk to the cytoplasm of the ovum there are three types of egg:

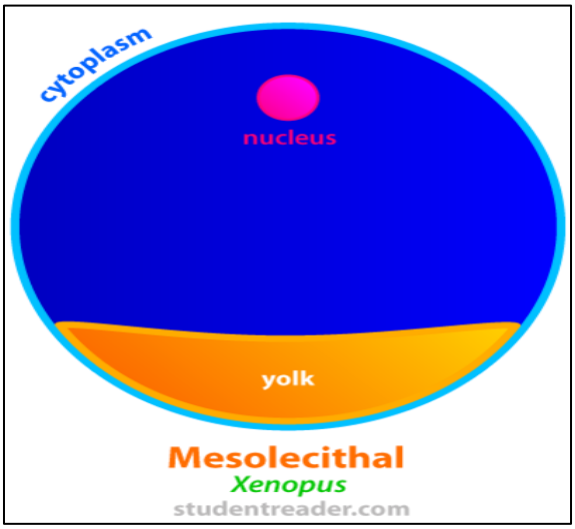
[I] **Microlecithal egg**

- ✓ The eggs of Amphioxus and mammals are of this type.
- ✓ The mammalian eggs contain so little yolk that they are sometimes called alecithal (without yolk) eggs.



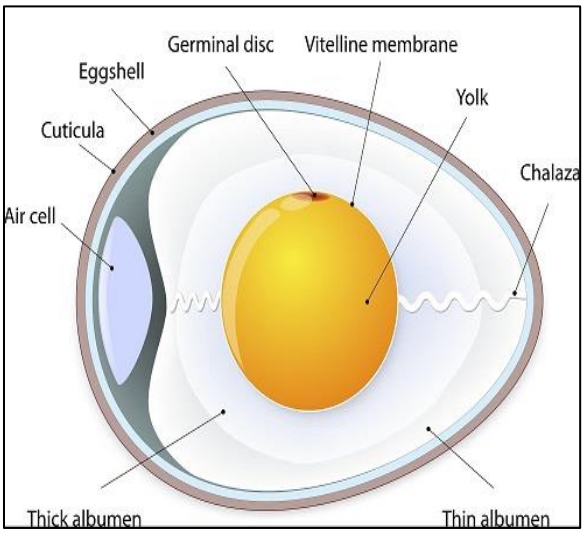
[II] **Mesolecithal eggs**

The eggs of sharks, fishes and many amphibians are of this type.



[III] **Macrolecithal or polylecithal eggs**

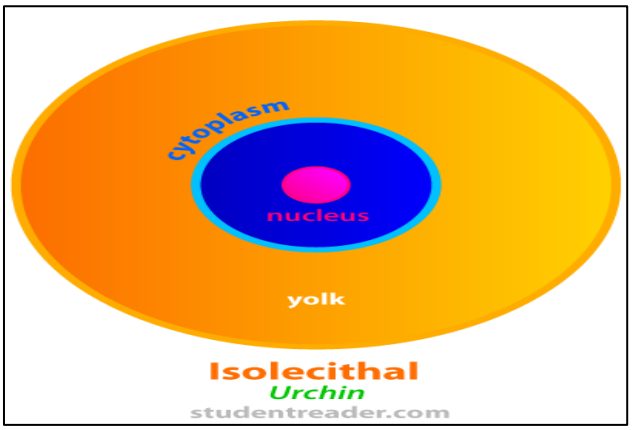
The eggs of teleost fishes, reptiles, birds and monotremates (egg laying mammals) are of this type.



According to distribution of yolk granules or platelets in the cytoplasm of the ova or egg, the eggs are classified as follows:

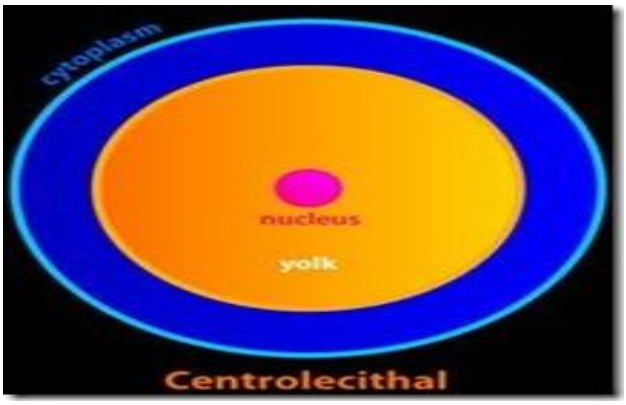
1. Homolecithal/Isolecithal

Examples are of Amphioxus, many invertebrates and mammals including man.



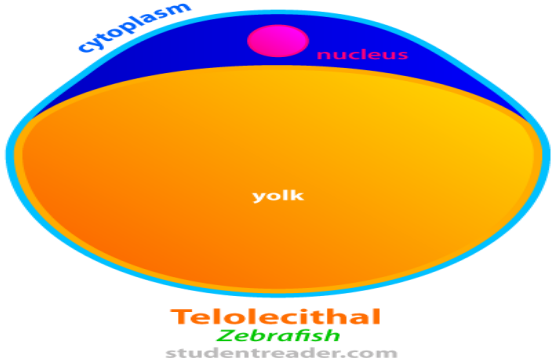
2. Centrolecithal

As in insects and many other arthropodes.

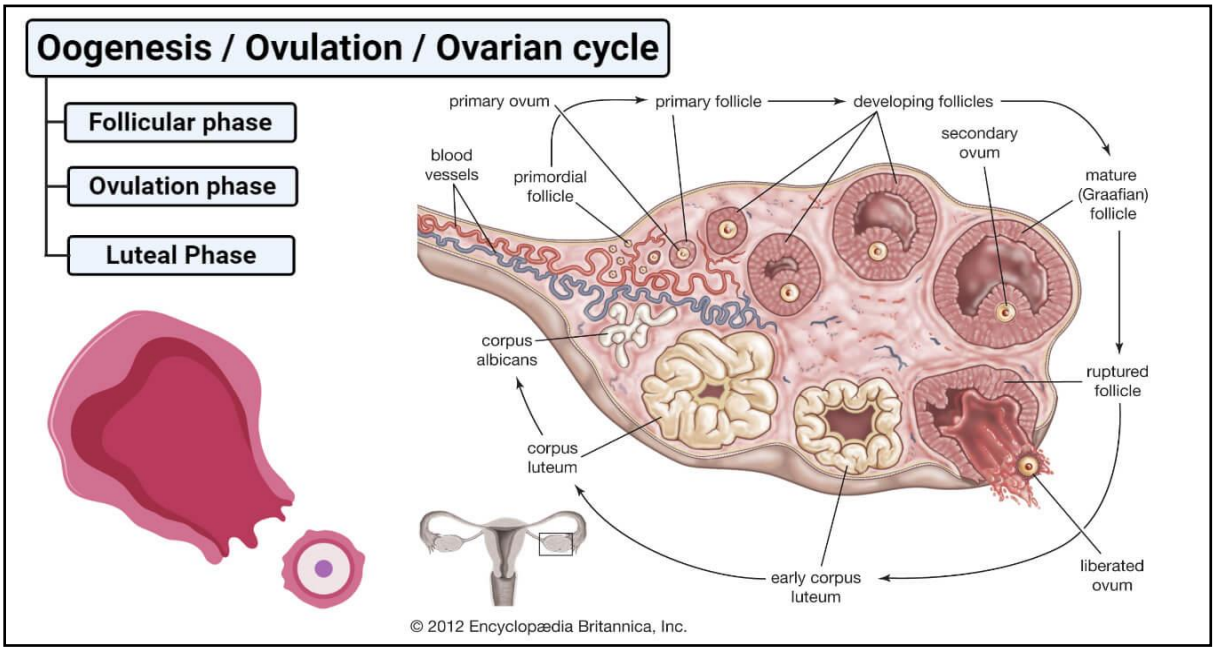


3. Teleolecithal

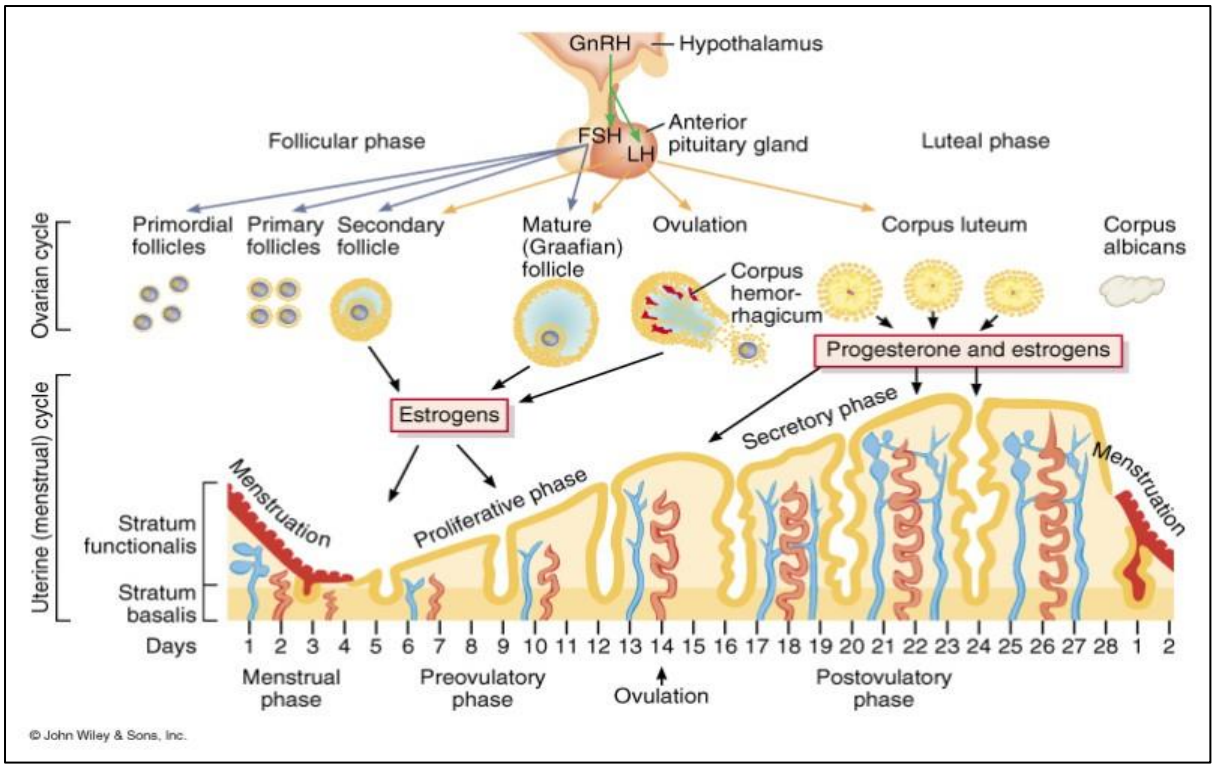
Examples are of fishes, amphibians, and reptiles, birds and monotremes eggs.



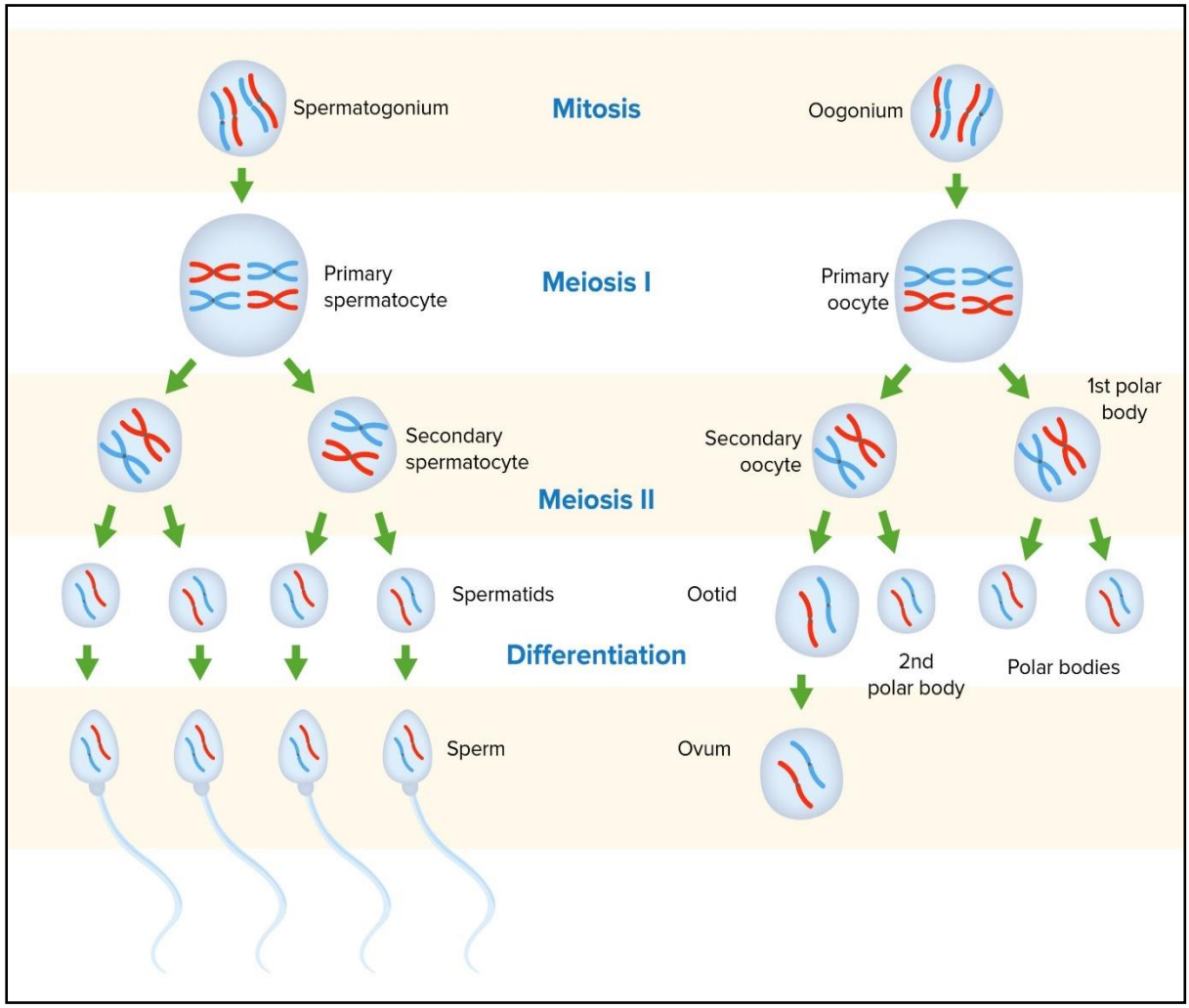
Oogenesis: consists of three phases: multiplication, growth and maturation.



The ovarian cycle

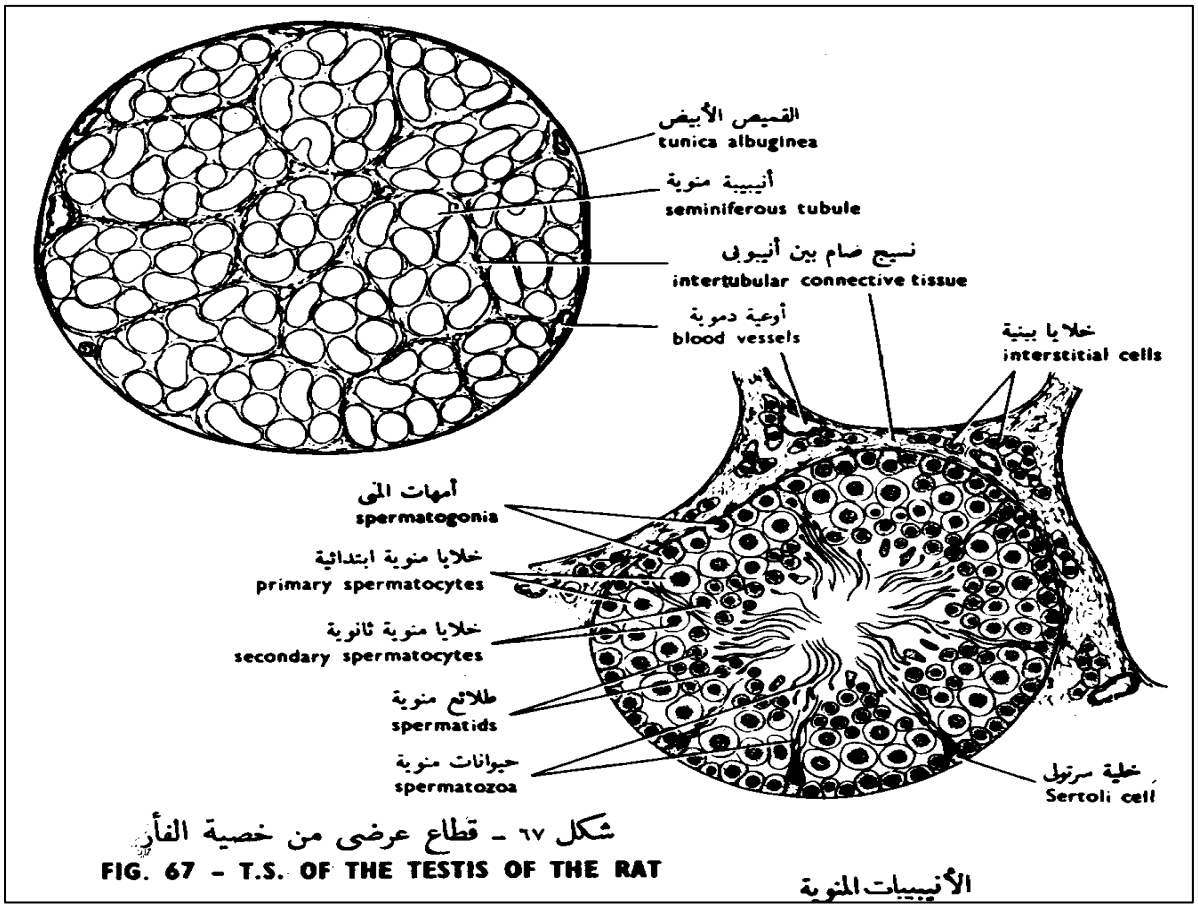


Draw

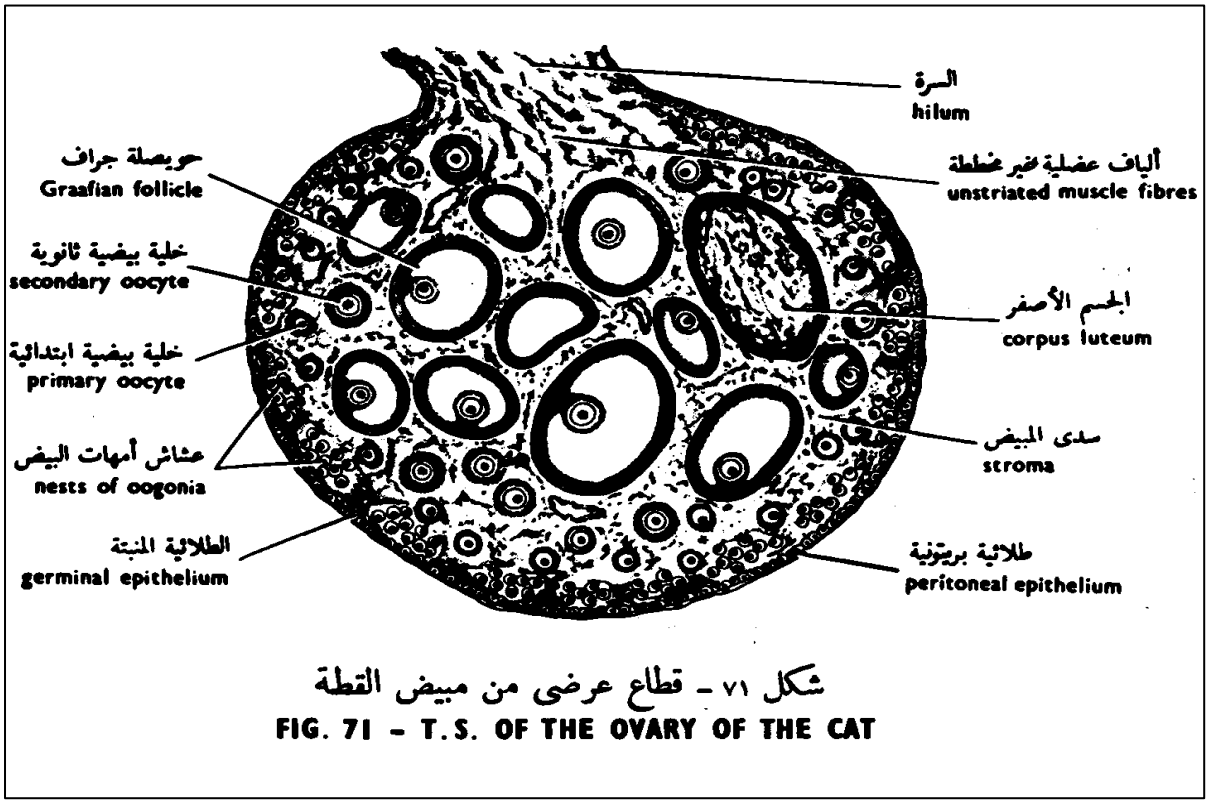


	Spermatogenesis	Oogenesis
Process		
Location	Occurs *entirely* in testes	Occurs *mostly* in ovaries
Meiotic divisions	Equal division of cells	Unequal division of cytoplasm
Germ line epithelium	Is involved in gamete production	Is not involved in gamete production
Gametes		
Number produced	Four	One (plus 2 – 3 polar bodies)
Size of gametes	Sperm smaller than spermatocytes	Ova larger than oocytes
Timing		
Duration	Uninterrupted process	In arrested stages
Onset	Begins at puberty	Begins in foetus (pre-natal)
Release	Continuous	Monthly from puberty (menstrual cycle)
End	Lifelong (but reduces with age)	Terminates with menopause

Draw



شكل ٦٧ ـ قطاع عرضى من خصية الفأر
FIG. 67 – T.S. OF THE TESTIS OF THE RAT



شكل ٧١ ـ قطاع عرضى من مبيض القطة
FIG. 71 – T.S. OF THE OVARY OF THE CAT

Fertilization

Fertilization, the process by which male and female gametes nuclei fuses together to produce diploid zygote.

Types of Fertilization:

1. External:

Eggs are librated in water.

- Occurs outside the female genital system.
- Female laid a large number of eggs, them the male pour its sperms in the same region in water
- e.g. in fish and amphibian.

2. Internal:

- Land-dwellers
- Specialized structures for housing gametes.
- Embryo more protected during development.
- Occurs in animals that have a well-developed reproductive system, animals may be:

a) **Oviparous:** zygote develops in a shell e.g. birds.

b) **Viviparous:** zygote develops inside uterus e.g. mammals.

The intrauterine life is about 21 days in the rat, 70 days in the in the Guinea pig while it's about 280 days in human.

c) **Ovoviviparous:-** e.g. dog fish

It has 4 major steps:

1. Contact and recognition between sperm and egg. (same species)
2. Regulation of sperm entry into the egg. (only one and inhibiting the others)
3. Fusion of the genetic material of sperm and egg.
4. Activation of egg metabolism to start development.

Cleavage and Blastula Formation

Planes of Cleavage:

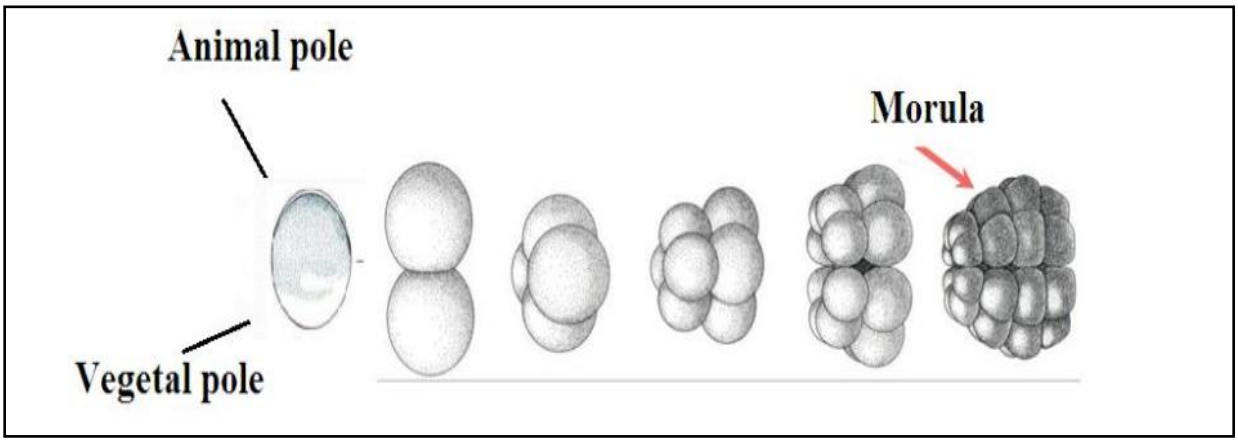
A: Holoblastic or total cleavage:

When the cleavage furrows divide the entire egg.

It may be:

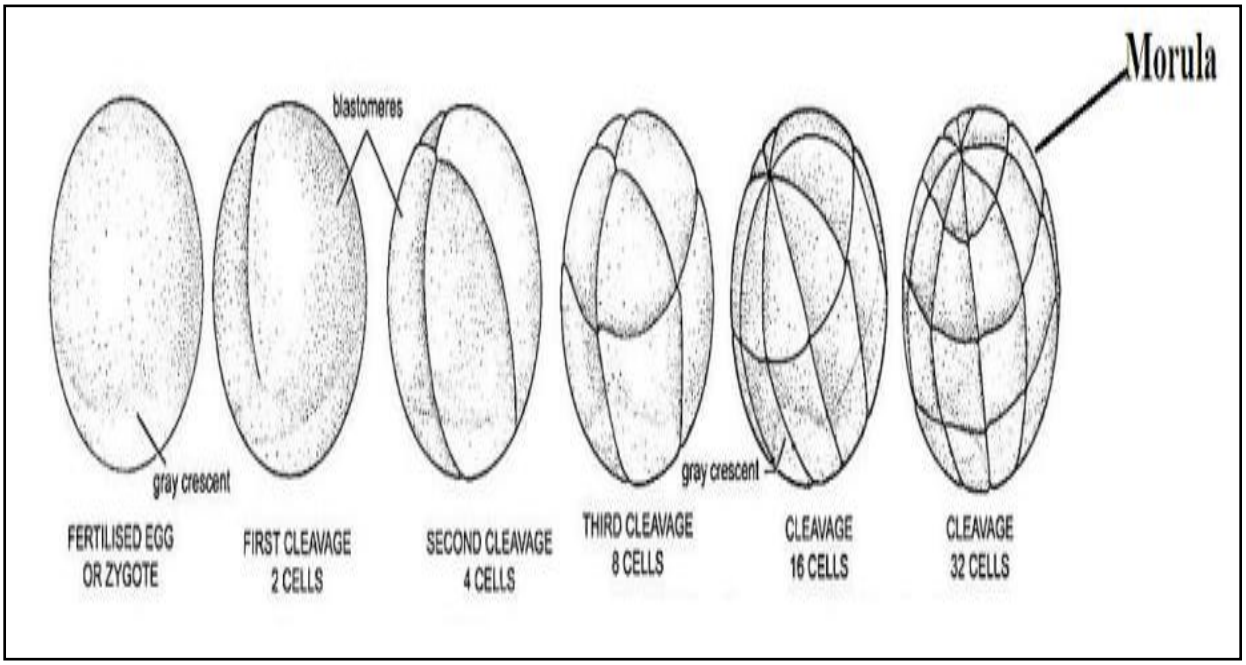
Equal:

When the cleavage furrow cuts the egg into two equal cells. It may be radially symmetrical, bilaterally symmetrical, spirally symmetrical or irregular.



Unequal:

When the resultant blastomeres become unequal in size.



B. Meroblastic cleavage:

When segmentation takes place only in a small portion of the egg resulting in the formation of blastoderm, it is called meroblastic cleavage. Usually the blastoderm is present in the animal pole and the vegetal pole becomes laden with yolk which remains in an uncleaved state, i.e., the plane of division does not reach the periphery of blastoderm or blastodisc.

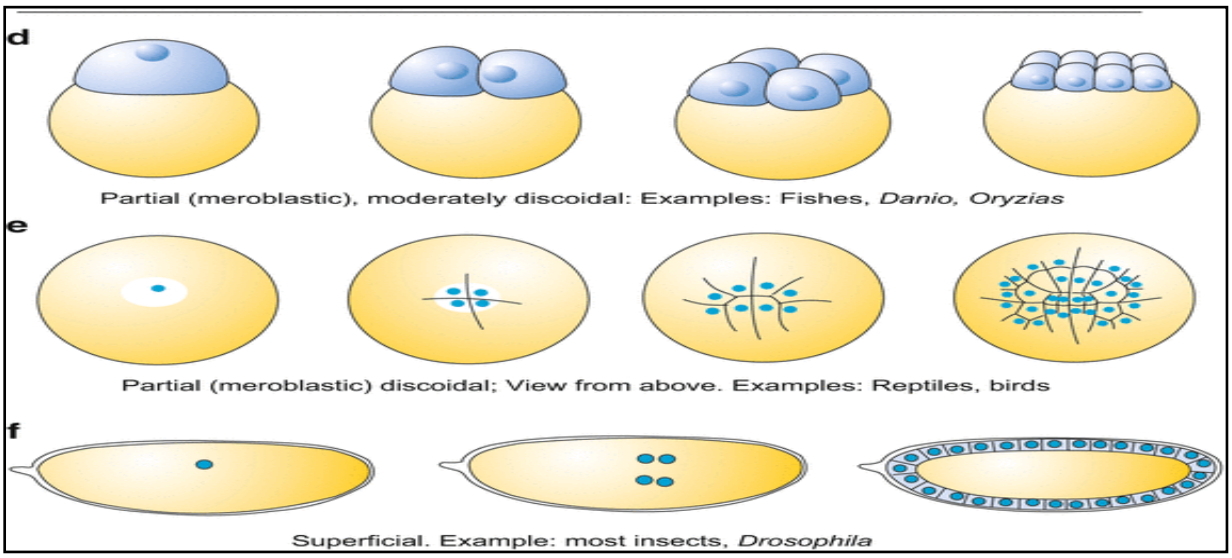
Two major types of meroblastic cleavage are discoidal and superficial:

1- Discoidal

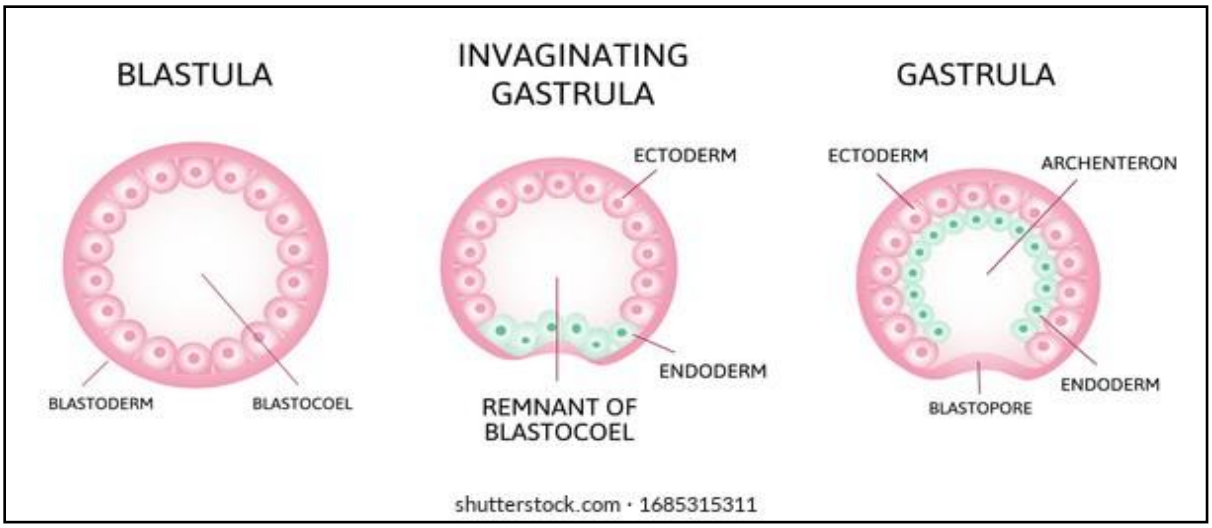
In discoidal cleavage, the cleavage furrows do not penetrate the yolk. The embryo forms a disc of cells, called a blastodisc, on top of the yolk. Discoidal cleavage is commonly found in monotremes, birds, reptiles, and fish that have telolecithal egg cells (egg cells with the yolk concentrated at one end).

2- Superficial

In superficial cleavage, mitosis occurs but not cytokonesis, resulting in a polynuclear cell. With the yolk positioned in the center of the egg cell, the nuclei migrate to the periphery of the egg, and the plasma membrane grows inward, partitioning the cytoplasm into individual cells. Superficial cleavage occurs in arthropods that have centrolecithal eggs.



Gastrulation

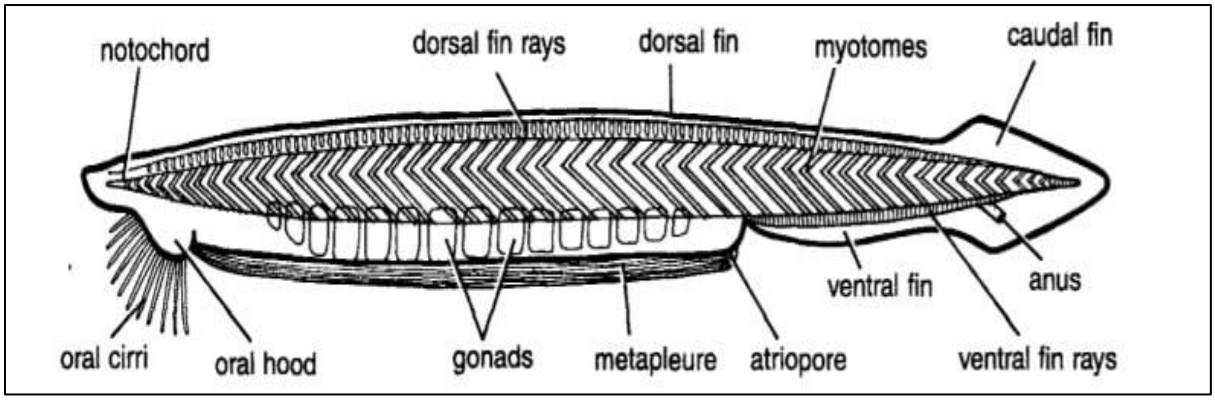


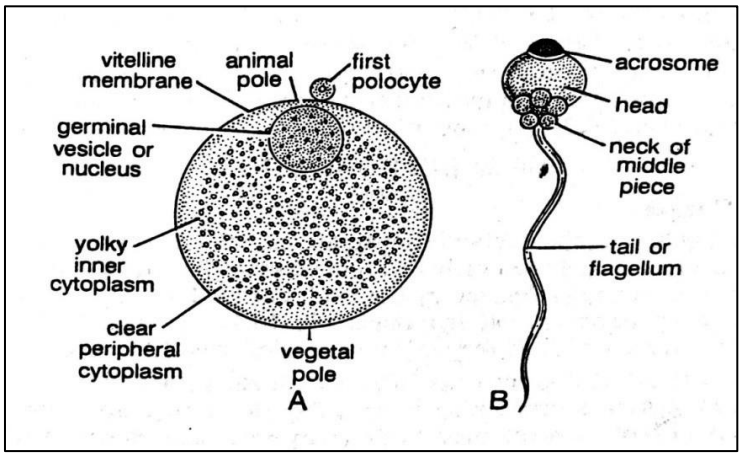
Organogenesis

Germ layers

Embryonic Germ Layer	Vertebrate Adult Structures
Ectoderm (outer layer)	Epidermis of skin; epithelial lining of oral cavity and rectum; nervous system
Mesoderm (middle layer)	Skeleton; muscular system; dermis of skin; cardiovascular system; excretory system; reproductive system—including most epithelial linings; outer layers of respiratory and digestive systems
Endoderm (inner layer)	Epithelial lining of digestive tract and respiratory tract; associated glands of these systems; epithelial lining of urinary bladder

Early embryonic development of Amphioxus





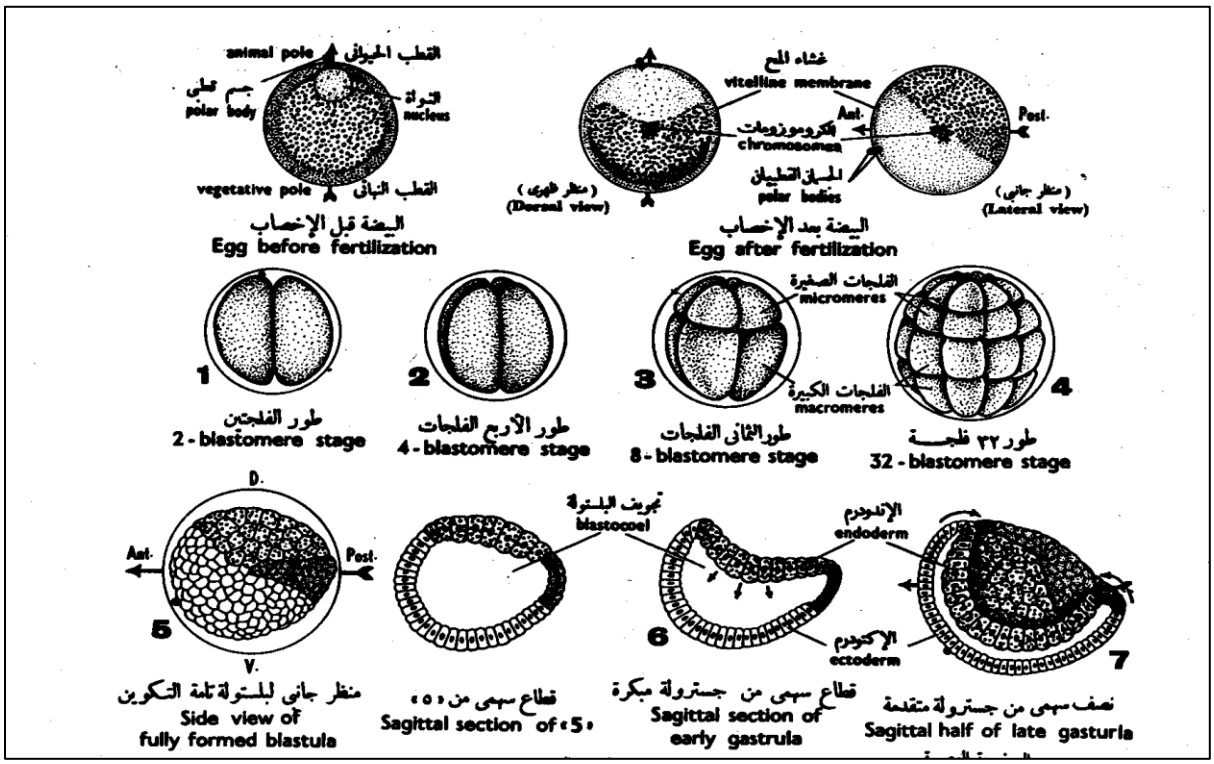
Amphioxus: A. Unfertilized egg. B. Sperm

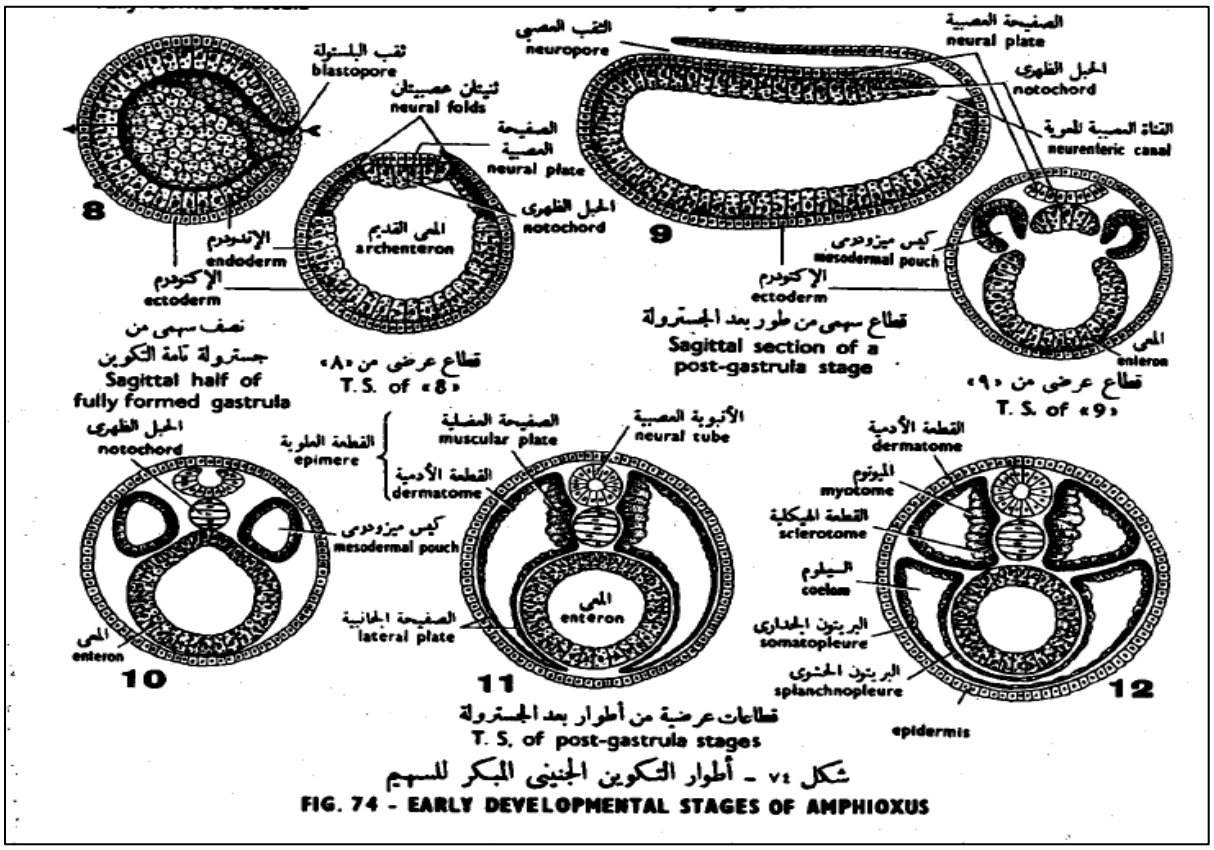
- ✓ Phylum: Chordata – Class: Cephalochordata
- ✓ Sexes are separate
- ✓ The gonads which are in the form of hollow sacs enclosed in coelomic pouches- twenty six in number on each side
  - genital ducts are lacking
- ✓ On maturity of gonads the sperms and ova are liberated into the atrium and from where they are discharged outside through the atriopore in breeding season
- ✓ The spermatozoa contain spherical head, very short mid-piece and tail
- ✓ The ovum of is 0.10 mm to 0.12 mm in diameter
- ✓ Type of Egg: According to amount of yolk oligolecithal or microlecithal

According to distribution of yolk isolecithal

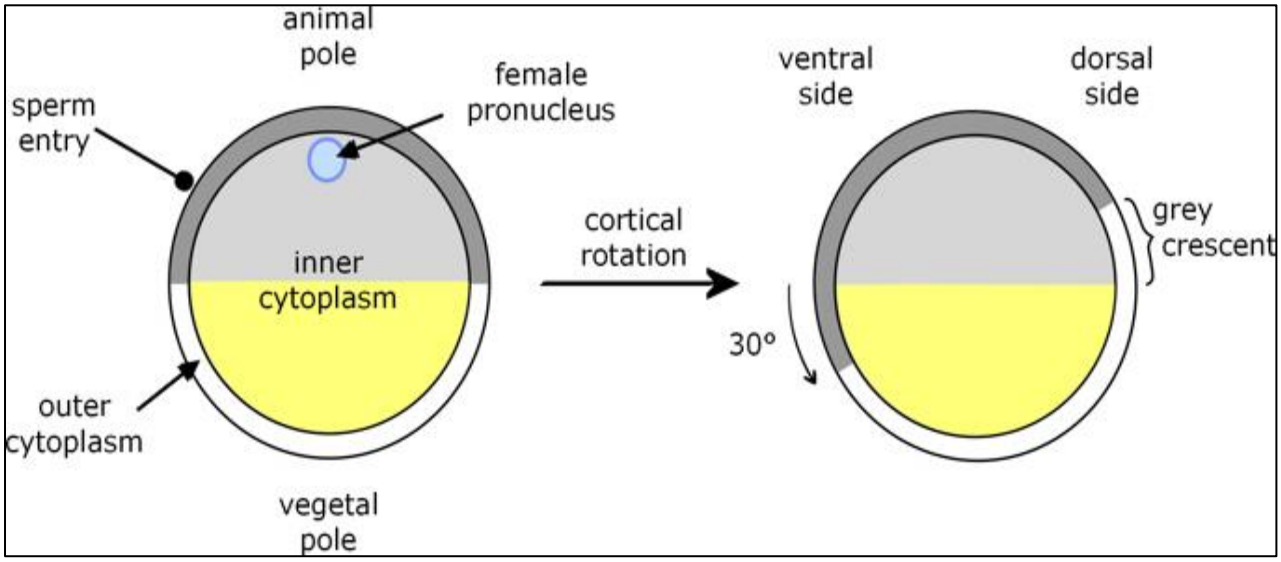
- ✓ Fertilization : External
- ✓ **Type of cleavage:** holoblastic cleavage

Draw

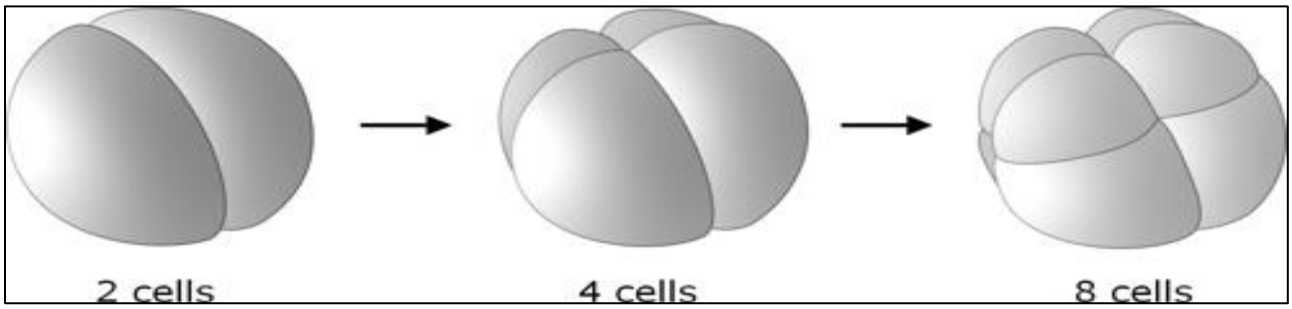




1. Early embryonic development of Frog



Xenopus fertilisation



Xenopus cleavage: the first 3 cell divisions.

✓ Phylum: Chordata – Class: Amphibia

✓ Fertilization: External.

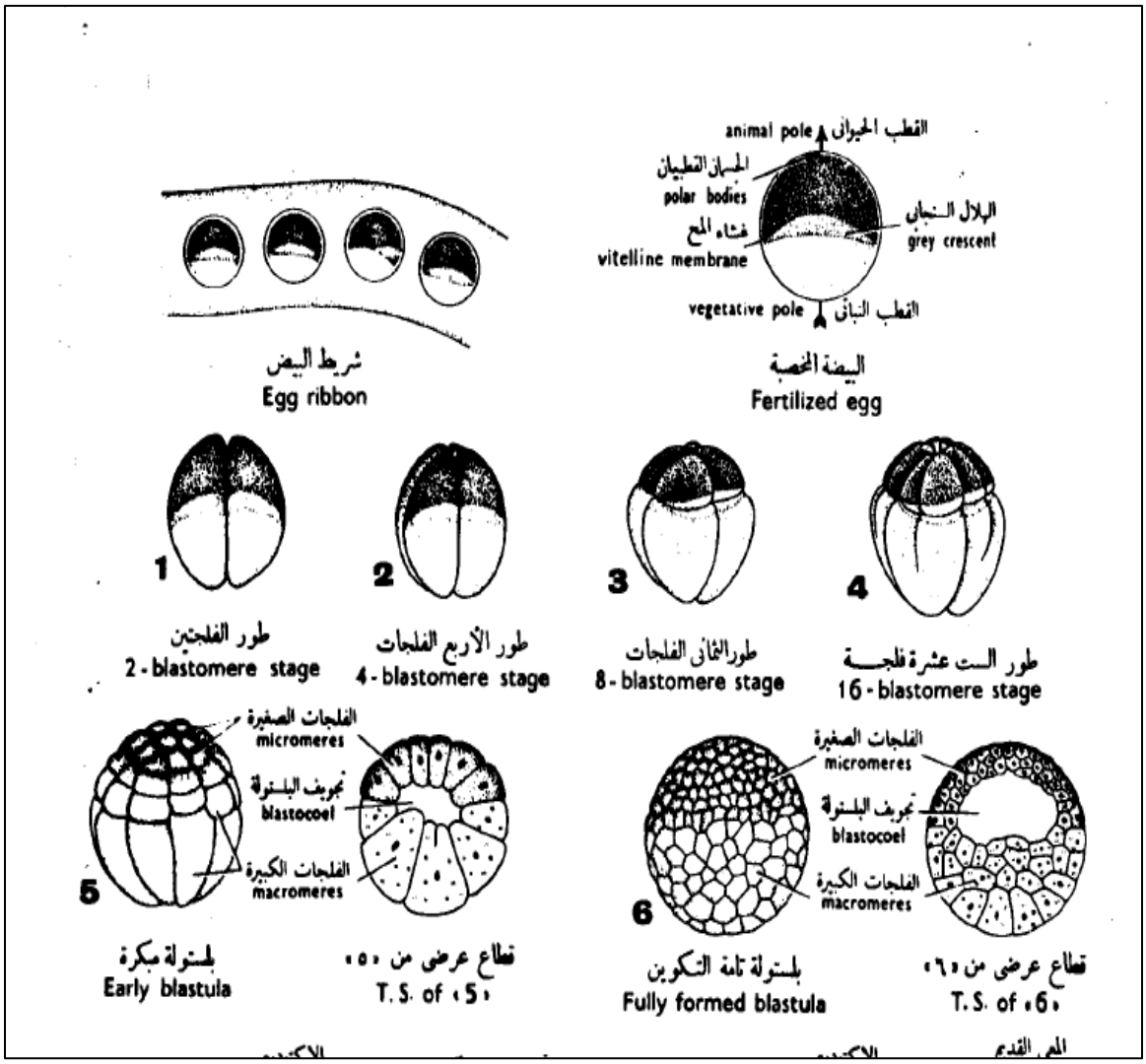
✓ Type of Egg: According to amount of yolk mesolecithal. According to distribution of yolk telolecithal.

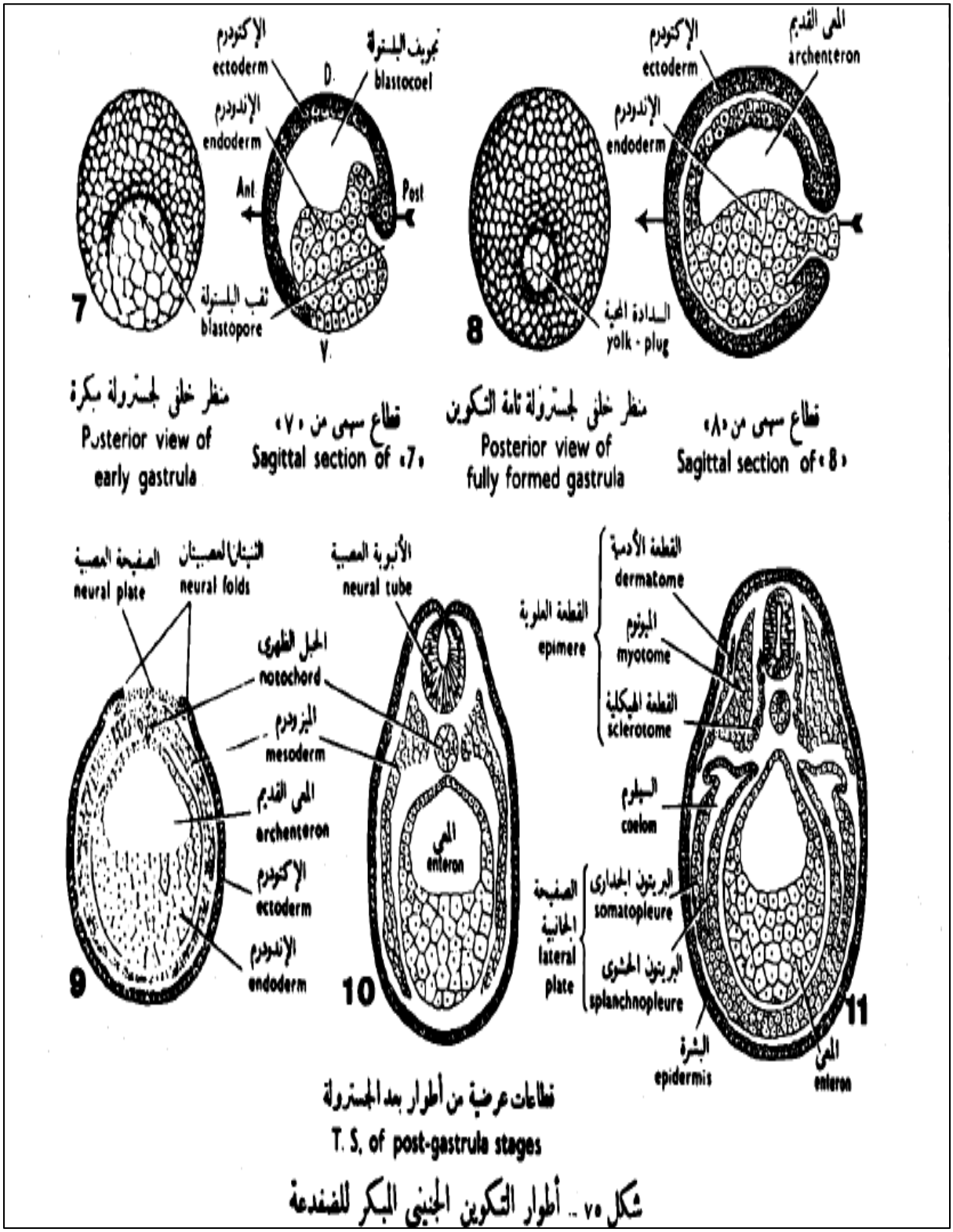
Spawning:

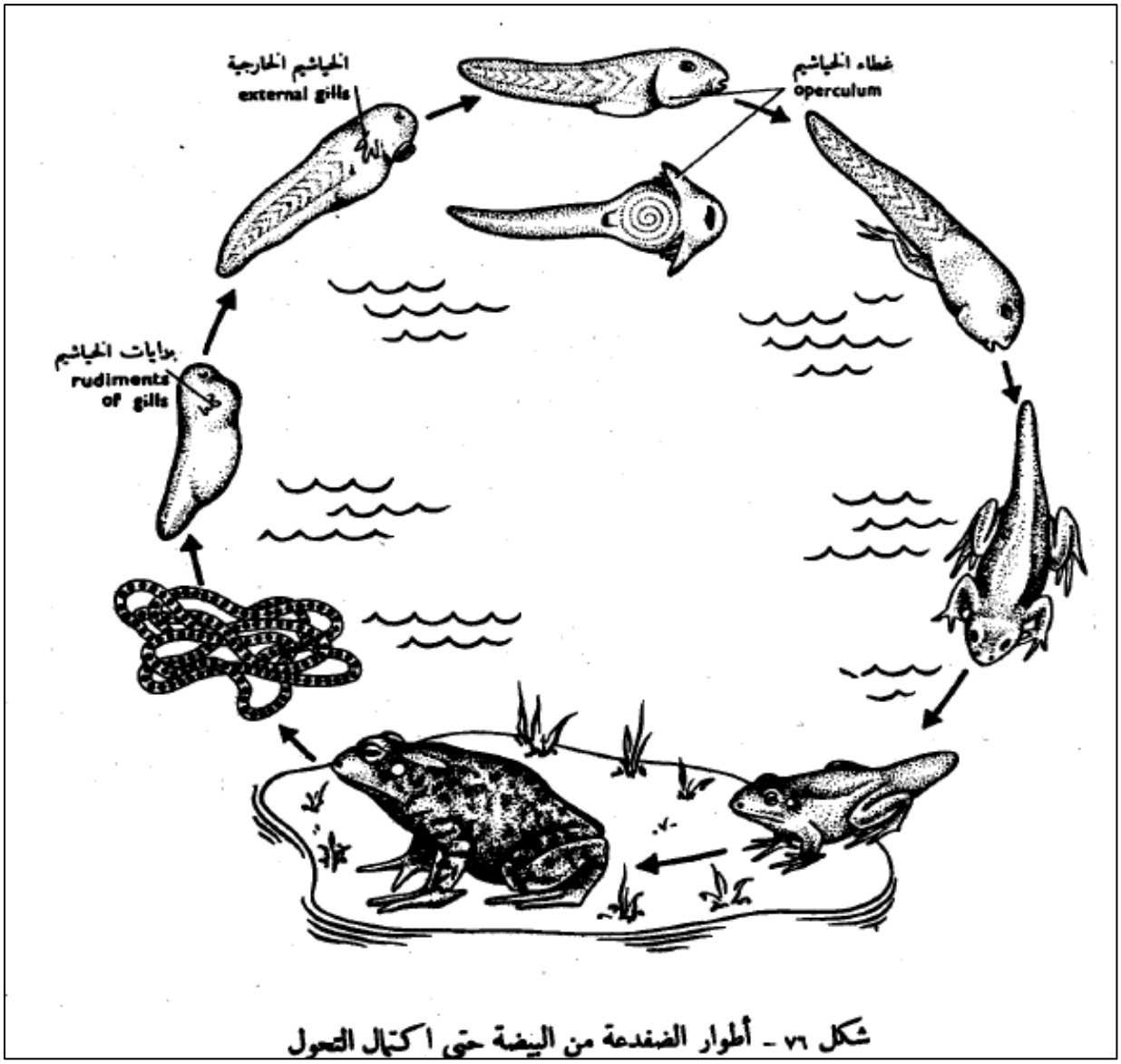
The mesolecithal eggs of frog enclosed in a protective gelatinous albumen are laid in water. The cluster or masses of eggs which remain stick together is called spawn. A spawn of *Rana tigrina* may have 3000 to 4000 ova. The spawn is laid during pseudocopulation or amplexus.

- ✓ Type of cleavage: Unequal holoblastic cleavage.
- ✓ Adult toads live on land most of the time and rely on water for hydration, breeding, and temperature regulation, Mating.
- ✓ Cleavage and blastulation the period of cleavage and blastula formation completed within 24 hours.
- ✓ The cleavage furrow elongates at a rate of about 1mm/minute in the animal hemisphere but slows to 0.03mm/minute in the vegtal pole.

Draw




الإكتودرم
ectoderm
تجويف البلستولة
blastocoel
D.
الإندودرم
endoderm
Ant
Post
ثقب البلستولة
blastopore
V.
7
الإكتودرم
ectoderm
المعى القديم
archenteron
الإندودرم
endoderm
السدادة المحية
yolk - plug
8
منظر خلفى لجسترولة مبكرة
Posterior view of early gastrula
قطاع سهمى من «٧»
Sagittal section of «7»
منظر خلفى لجسترولة تامة التكوين
Posterior view of fully formed gastrula
قطاع سهمى من «٨»
Sagittal section of «8»
الصفيحة العصبية
neural plate
النتوءان العصبيان
neural folds
الأنبوبة العصبية
neural tube
الحبل الظهرى
notochord
الميزودرم
mesoderm
المعى القديم
archenteron
الإكتودرم
ectoderm
الإندودرم
endoderm
9
المعى
enteron
10
القطعة الأدمية
dermatome
القطعة العلوية
epimere
الميوتوم
myotome
القطعة الهيكلية
sclerotome
السيلوم
coelom
الصفيحة الجانبية
lateral plate
البريتون الجدارى
somatopleure
البريتون الحشوى
splanchnopleure
البشرة
epidermis
المعى
enteron
11
قطاعات عرضية من أطوار بعد الجسترولة
T. S. of post-gastrula stages
شكل ٧٥ .. أطوار التكوين الجنينى المبكر للضفدعة



شكل ٧٦ - أطوار الضفدعة من البيضة حتى اكتمال التحول

Early embryonic development of Birds

Egg and fertilization

Testes

The male bird or rooster, possess a pair of testes, each testis is an oval body, cream white in colour and. From its inner border, a vas deferens emerges to run backwards, lateral to the ureter to open into the cloaca. Just before its opening, it dilates forming a small vesicular seminalis.

Ovaries

In the adult of most flying birds only one ovary of the left side, the right one degenerates.

The structure of ovum:

The oocyte grows due to the accumulation of yolk in it, the cytoplasm localized at the animal pole in which the nucleus embedded.

The mature oocyte migrates towards the periphery and finally buldged out from the ovary, connected with the ovary only by means of stalk. The fully formed egg contains a large amount of yolk. The cytoplasm is very little and is in the form of a small disc (the blastodisc or germinal disc).

After fertilization the ovum is surround by various envelopes added to the delicate vitelline membrane.

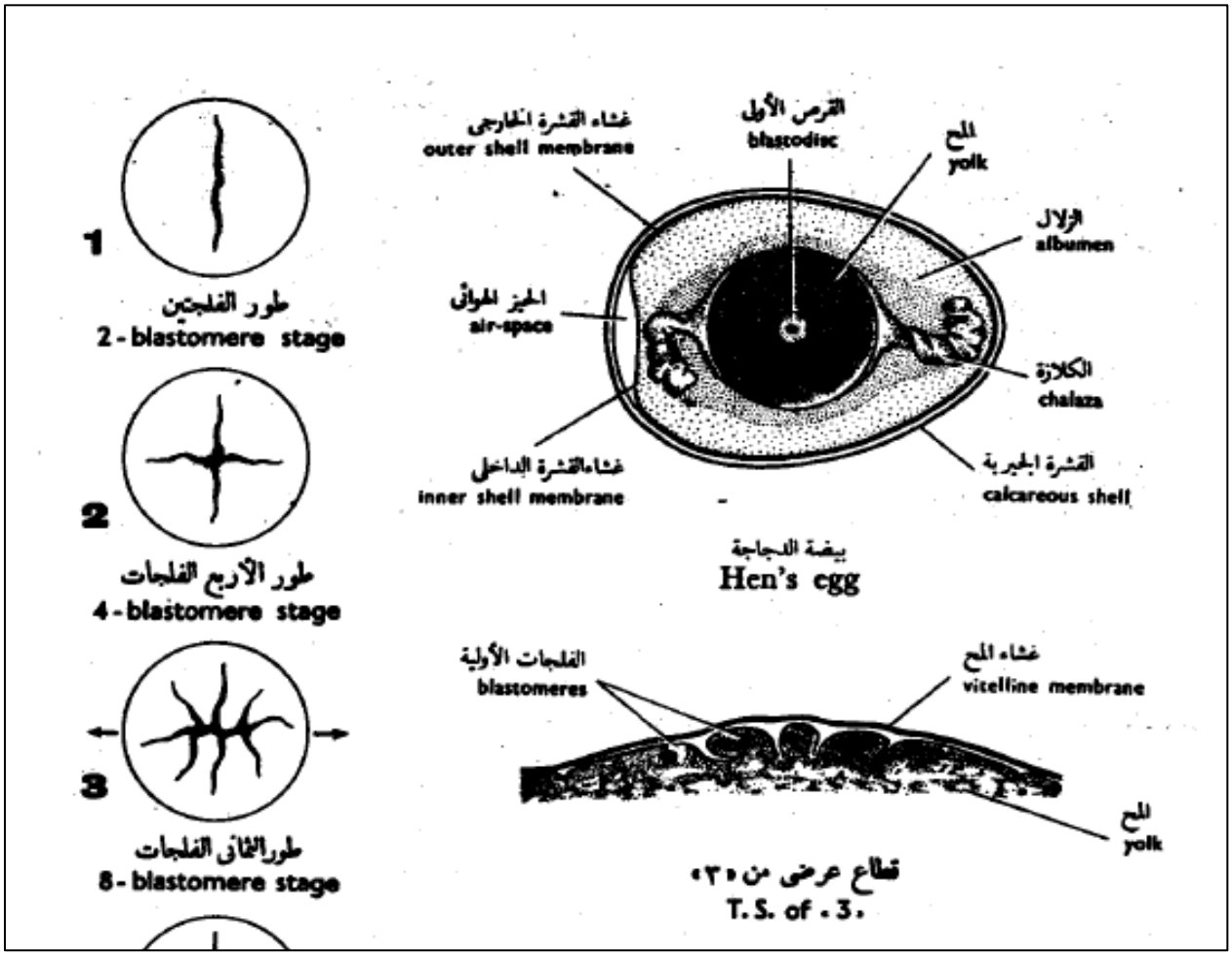
The cleavage starts immediately in the germinal disc. The fully formed and laid egg is surrounded on the outer side by a calcareous shell. The shell consisting chiefly of calcium carbonate.

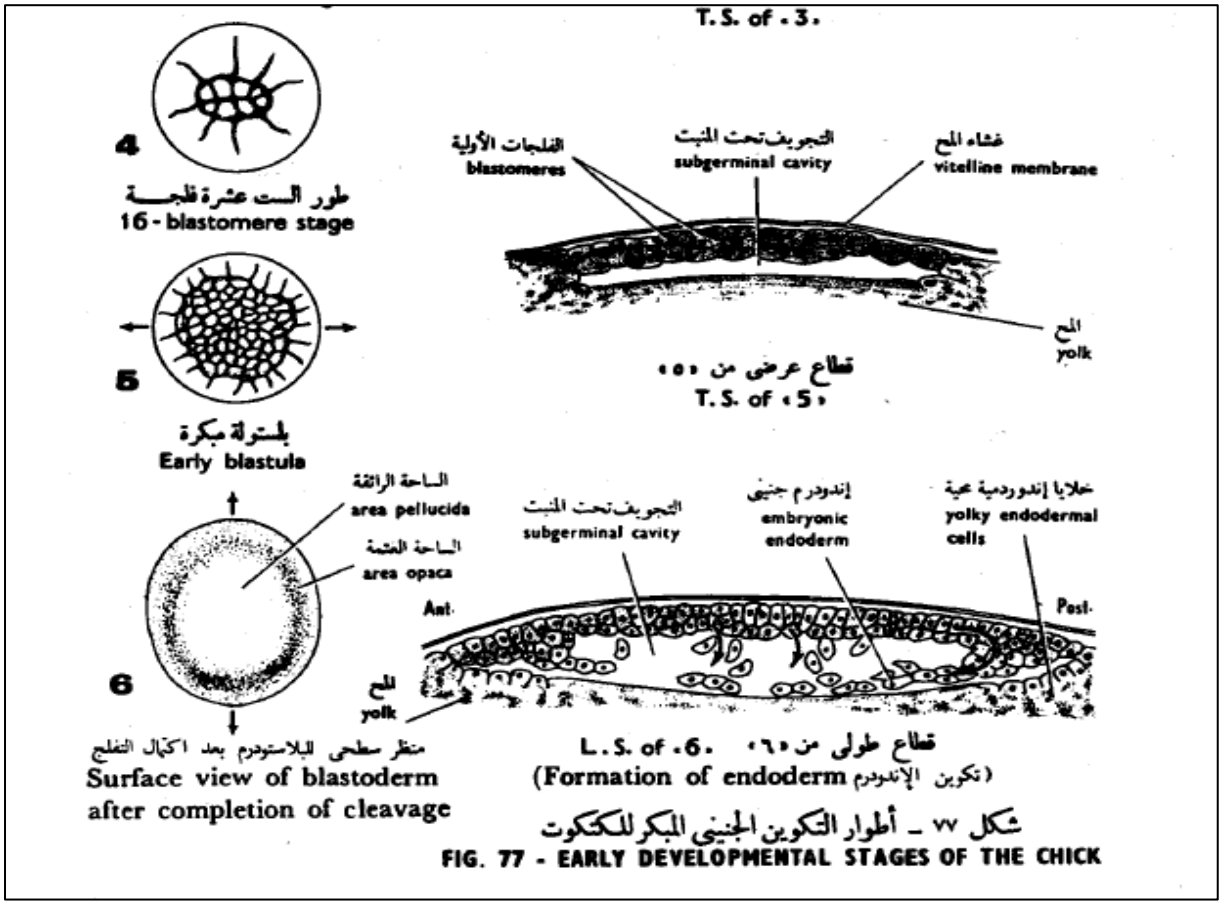
Fertilisation of the egg occurs in the oviduct, before the albumen and shell are added to it. The egg is laid about 24 hours after fertilisation, by which time the development has reached the blastula stage.

Cleavage and blastula

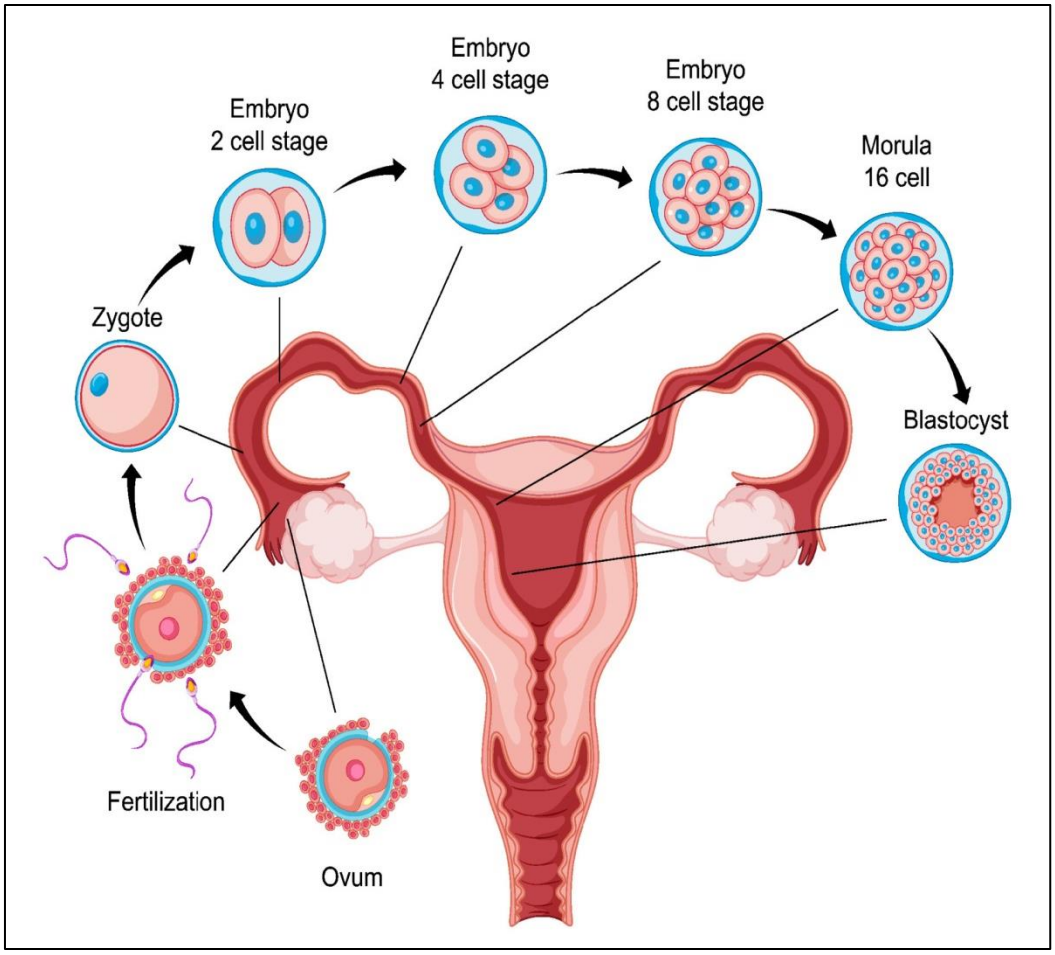
Consistent with having a large yolk, cleavage is meroblastic and is restricted to the germinal disc, and cell divisions do not extend into the yolk at all. The first division passes near the centre of the germinal disc and the next few divisions are at right angles to the preceding one, but then divisions becomes more irregular and asymmetric.

Draw




T. S. of «3»
4
طور الست عشرة فلجة
16 - blastomere stage
الفلجات الأولية
blastomeres
التجويف تحت المنبت
subgerminal cavity
غشاء المح
vitelline membrane
المح
yolk
5
بلستولة مبكرة
Early blastula
قطاع عرضي من «٥»
T. S. of «5»
الساحة الزائفة
area pellucida
الساحة العتمة
area opaca
Ant.
6
المح
yolk
التجويف تحت المنبت
subgerminal cavity
إندودرم جنيني
embryonic endoderm
خلايا إندودرمية محية
yolky endodermal cells
Post.
منظر سطحي للبلاستودرم بعد اكتمال التفلج
Surface view of blastoderm after completion of cleavage
قطاع طولي من «٦» L. S. of «6»
(تكوين الإندودرم (Formation of endoderm
شكل ٧٧ ـ أطوار التكوين الجنيني المبكر للكتكوت
FIG. 77 - EARLY DEVELOPMENTAL STAGES OF THE CHICK

Embryonic development of mammals (humans)



Draw