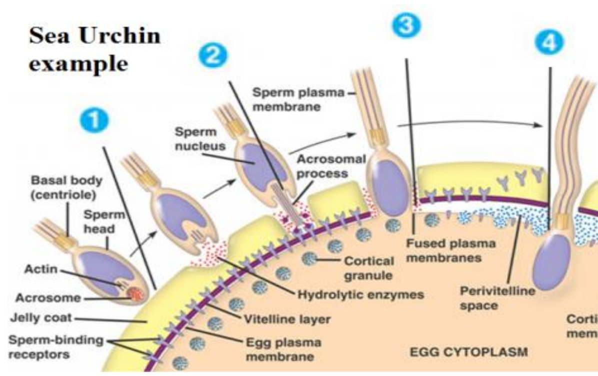
Fertilization to Multicellular Embryo

Fertilization is the successful union of the sperm cell and the egg cell of sexually reproducing organisms. There are two kinds of fertilization: external and internal. **External fertilization** usually happens in aquatic environments like marine invertebrates and vertebrates. This type of fertilization happen when gametes are released through several ways such as spawning. The female organism will spawn or release its eggs to settle in crevices or on top of the substratum of the habitat. There are millions of eggs released. The sperm will also be released or spawned at the vicinity of the egg cells to ensure highest possibility of fertilization. The egg cells release a chemoattractant to further ensure that the sperm cells will find their way to the packs of egg cells. The union is also regulated by the cell membrane proteins for species recognition. This makes certain that the egg and sperm cells that will unite comes from the same species of organism.

Fertilization in Sea Urchin

Sea urchins is one of the first organism observed to understand how fertilization happens. The fertilization is external which requires spawning of millions of gametes. The egg cell after being released secretes species-specific chemical that attracts the sperm. When the sperm reaches the egg, it must be able to penetrate two protective layers – jelly coat and vitelline envelope. The jelly coat is penetrated when the head of the sperm with lysosome-filled acrosome comes in contact with it and triggers acrosomal reaction. This reactions triggers the release of enzymes from the acrosome that will coat at the point of contact. This will create entrance of the sperm.

After the penetration of the jelly coat, vitelline envelope is the next. Protein actin will polymerize and extends out of the head. T from the head is called the **acrosomal process**. specific recognition molecule, will attach on acrosomal process. The bindins will be recogni with the receptors found in the vitelline enve membrane. At the moment the acrosomal process reach the cell membrane of the egg cell, fertilization cone forms and **fast block to polyspermy** will be initiated. Fast block to polyspermy releases calcium ion from the egg cell to the outside which will change the charge of the membrane, and this will trigger the release of cortical granules in the egg cell. The **cortical granules** in the egg cytoplasm will bind with the membrane and the sperm nucleus and centriole will be released. The final recognition will promote the **slow block to polyspermy** which is important to prevent two or more sperms fertilizing one egg. This block will happen when the cortical granules reacts with the vitelline envelop that will separate it from the cell membrane by dissolving of bonds. Proteins of the cortical granules will take up water and swell. After the removal of sperm-binding receptors, the vitelline enve[illegible] preventing entrance of another sperm. This [illegible] **fertilization envelop.**



Internal fertilization is observed in [illegible] and some aquatic animals. This is because these animals cannot spawn their gametes because they will dry out when exposed to air. Further, the sperm needs a medium to swim in towards the egg cell. Animal species that fertilize internally is equipped with accessory sex organs to introduce the sperm in the female reproductive tract such as the penis and vagina in humans. Furthermore, these animals show various sexual behavior to court the opposite sex and have a successful copulation.

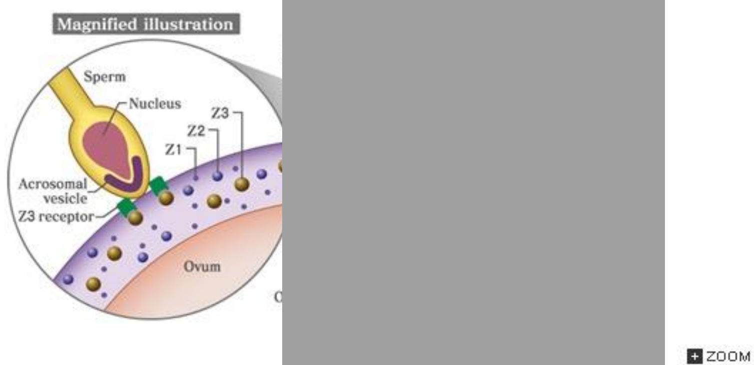
Fertilization in Mammals

Humans are the best example to illustrate internal fertilization. Penis, the accessory sex organ in males, is used to inject millions of sperm into the vagina, the accessory sex

organ in females. The millions of sperm pass
reproductive tract to reach the egg cell in t
fallopian tube. There are many obstacles in t
that significantly reduce the number of sperm
successfully reach the egg cell.

The sperm cell can live and fertilize th
reproductive tract for 4 days. Relatively, a
sperm cell will reach the egg cell but only o
penetrate the egg. The egg is surrounded by a
layer called the cumulus and the zona pelluci
glycoprotein. When the acrosome of the sperm zona pellucida it triggers the acrosomal reaction that releases enzymes to digest the zona in contact with sperm head. After a complete penetration, the sperm head will come in contact with the plasma membrane of the egg and the two will fuse. The zona

pellucida is important because [redacted] sperm comes from the same species as the [redacted]

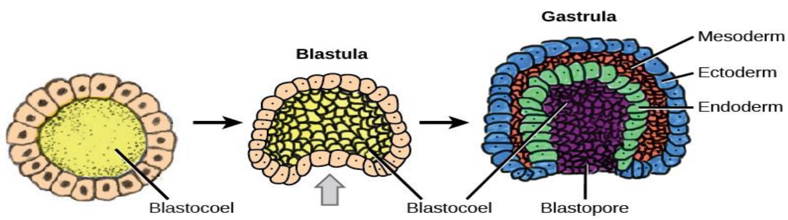


Similar to the sea urchins, [redacted] polyspermy is present in human fertilizati[redacted] enzymes will destroy the sperm-binding [redacted] egg zona pellucida; thus, eliminating the [redacted] can bind to on the egg cell. There is als[redacted] ion which will trigger the egg to complete meiosis II, and set the stage for the fusion of gamete nuclei.

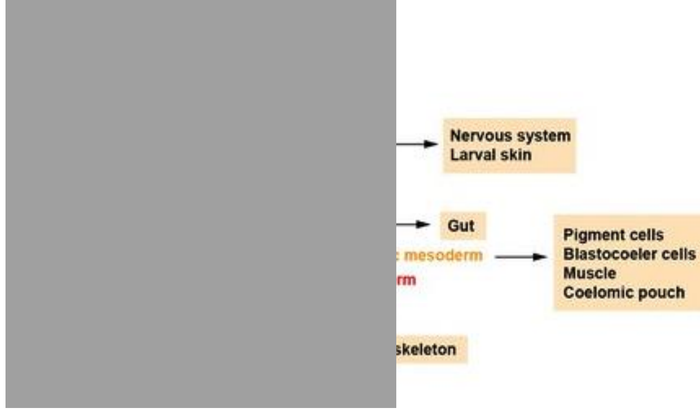
Embryo Development

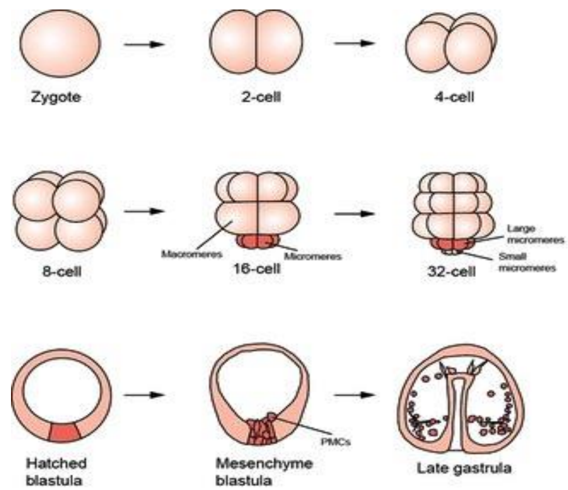
After ovum is fertilized it will proceed to rapid cell division that will produce multiple cells. This is **cleavage stage** of early development. During the cleavage stage, dividing cells completes the S phase and M stages of mitosis. The absence of G1 and G2 phases in the cycle allows division to happen faster than normal. As a consequence of the absence, on the other hand, is the absence of growth of the daughter cells since there is no protein synthesis. Thus, the size of the fertilized ovum will be maintained by the total volume of the daughter cells during the cleavage. The ball of cells after the cleavage is called the morula.

In the process of the fifth to seventh cleavage division, a hollow space is produced in the middle of the ball of cells called the blastocoel. The **blastocoel** is a fluid-filled cavity that is surrounded by blastula cells and together it is called the **blastula**.



The rate of division will slow down once the cleavage process is done. The cells will now start to produce protein and grow. This process will now be the start of **morphogenesis** which is made up of cellular and tissue-based processes that will mold the future body of the animal. Gastrulation will start morphogenesis. The cells on the surface of the blastula will move to the interior of the cell and establish the germ layers and the primitive digestive tract. The gastrula formed from the cellular movement may be 2-layered or 3-layered. Two-layered embryo has the endoderm and ectoderm while the 3-layered embryo will be made up of ectoderm, mesoderm and endoderm. These layers will give rise to respective organs in the body. Furthermore, during gastrulation cells at one end invaginate creating a depression. The depression is shallow initially but as it advances to the opposite pole, it forms a tube from where the depression began to the opposite pole where it will fuse with the endodermal cells and creates another opening. The initial opening is referred to as the **blastopore** while the mound of cells that move nd is called the **archenteron.** The 2 openings the tube that is in between is the embryon fate of the blastopore organisms are **protostome** when the blastopore bec **euterostome** when the blastopore bec are deuterostomes.





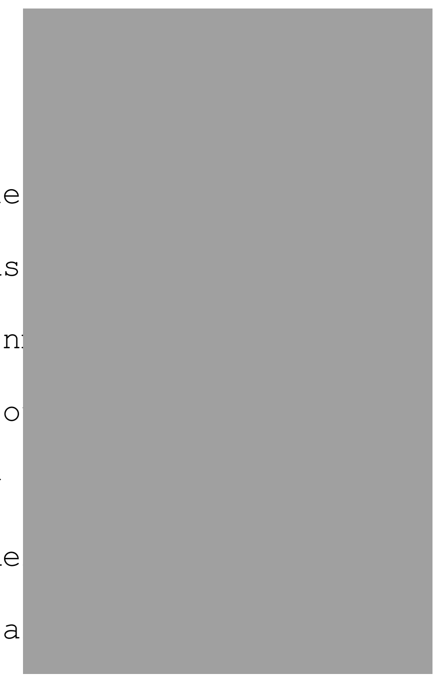
The list below gives some of the organs that will originate from the endoderm, mesoderm and ectoderm, respectively.

Ectoderm	**Mesoderm**	**Endoderm**
• Epidermis of the skin • Germ [redacted] • Pitui[redacted] • Adren[redacted] • Jaws [redacted] • Nervous and sensory system	• Skeletal and muscular [redacted] • Circulatory and lymphatic systems • Adrenal cortex • Dermis of the	• Epithelial lining of the [redacted]ntestina[redacted]piratory, [redacted]ry and [redacted]ctive tracts and ducts • Thymus, thyroid and parathyroid

	skin	

Zygote Development in Other Animals

Development of the fertilized ovum to become the zygote is different for different types of animals. The difference is usually driven by their habitat and the anatomy of the animal. There are 3 types of zygote development namely oviparous, viviparous and ovoviviparous. **Oviparous** is



amphibians, reptiles, bird and one mammal. commonly known as the egg laying animal whe housed in calcium-rich shell that surrounds usually deposited in an appropriate environ period of incubation is expected to hatch o

Viviparous is characterized as having fertilization as well as internal developme development is common in mammals where an a called uterus houses the fertilized ovum after fertilization and throughout its development. The uterus also supports the developing embryo by giving it nutrition and protection against harmful agents external to it. After a period of development, the offspring is delivered as a living young often smaller versions of the parents.

Ovoviviparous is partly oviparous and viviparous development. Initially, internal fertilization will result to the production of eggs within the female uterus but unlike the viviparous animals, the developing embryo is not dependent on the mother for nutrients only for housing. On the end of embryonic development, the egg will hatch internally and a young hatchling will emerge from the mother. This is seen in annelids, arthropods, gastropods, some fishes (sharks) and reptiles (garter snakes)