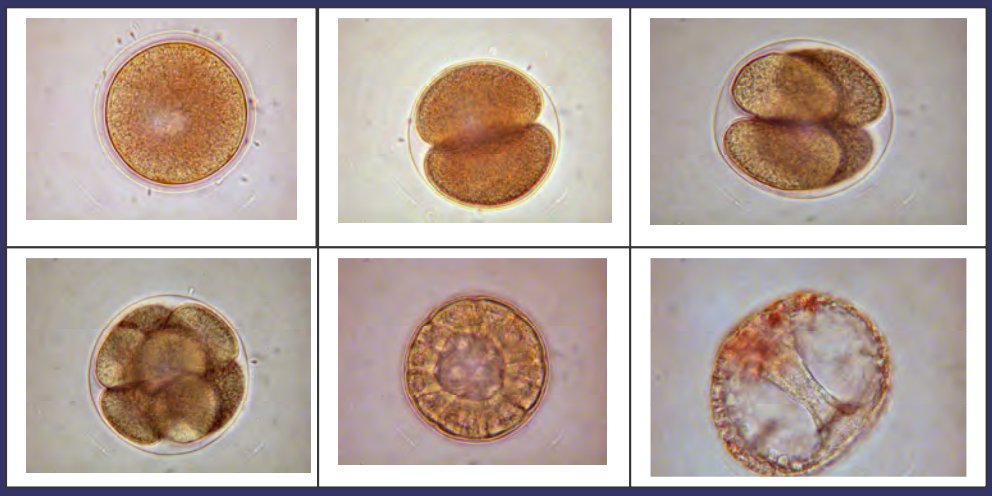
Examining the process of embryonic development of a sea urchin

Case Study: *Tripneustes gratilla*



National Marine Science Centre

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Introduction

Organisms produce new offspring by either asexual or sexual reproduction. **Asexual reproduction** only requires one parent and results in a new daughter organism that is an exact replica of the parent organism. An example of an animal that can reproduce using asexual reproduction is the sea anemone.

Sexual reproduction requires two parents, a male and a female. It involves the fusion of two haploid gamete cells, one from each parent. The male gamete is called **sperm** and female gamete an **ovum**. These cells are produced in a process termed **meiosis** which involves the replication of genetic information and double splitting of single parent diploid cells into four haploid cells which contain half of the parents genetic information. Each gamete possesses a variety of features which assist with ensuring fertilisation occurs. The male gamete possesses a long tail attached to the head of the cell which aids in movement towards a ripe ovum. The head of the cell also contains a variety of enzymes which assist with breaking down the outer layers of the ovum on contact.

The process by which gametes fuse into a single cell is termed **fertilisation**. Following fertilisation the new cell formed is termed a **zygote**. The zygote then develops through a series of stages until it is ready for birth or hatching.

Study Aims

- Objectives:

– Examine the process of fertilisation using compound microscopes.

– Identify key stages within the process of embryonic development.

– Describe the physical features of male and female gametes

Study Equipment

(Per group)

- Small sample of sperm and egg cells
- Pipette
- Petri dish
- Compound Microscope x 10
- Microscope slides & covers
- Identification keys
- Data sheets

Study Methods

1. **Presentation: Reproduction introduction. (15 min)**

2. Obtain your pre-mixed sample of male and female gametes.

3. Using the pipette, immediately transfer a small sample of the mixture to the slide.

4. View slide under Low Power (LP) and then High Power (HP) of your microscope. Avoid exposing eggs to the heat of the microscope lamp for long periods of time.

5. Draw and label a detailed diagram of an egg under HP (Data Sheet 1).

6. Use the HP to observe the sperm surrounding the eggs.

7. Draw and label a detailed diagram of sperm under HP (Data Sheet 2).

8. Leave your slide on the microscope to be observed again later after the following presentation remember to turn off your microscope lamp.

Presentation: Embryonic development. (30min)

9. Turn your microscope back on and draw a diagram of the embryo after 30 minutes (Data sheet 3).

10. Prepare a second concave slide.

11. Now, using the new sample of pre-fertilised gametes supplied by the teacher make a second slide to view under HP.

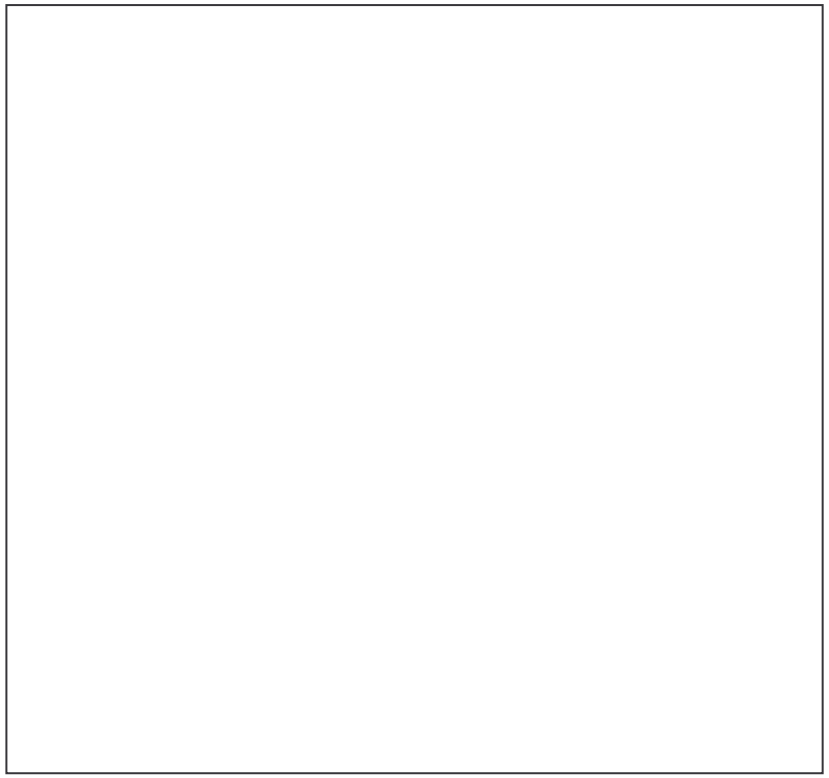
12. Complete Data Sheet 3.

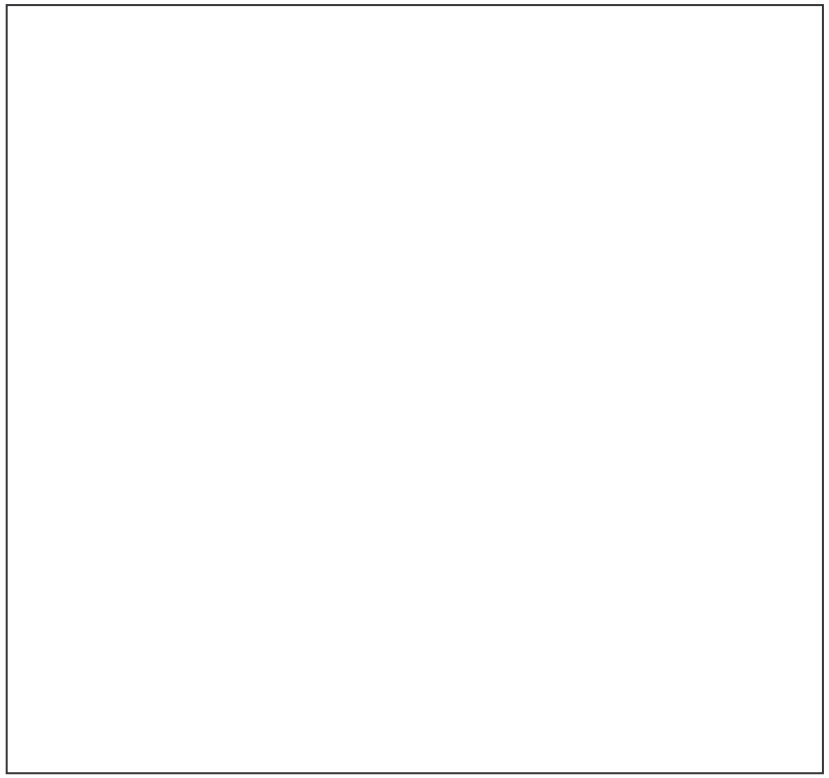
Complete Data sheets 4 and 5.

Work on extension questions.

Diagram 1: Male and Female Gamete

1. Draw and label a detailed diagram of a sperm and an egg under HP.





2. Describe the female gamete:

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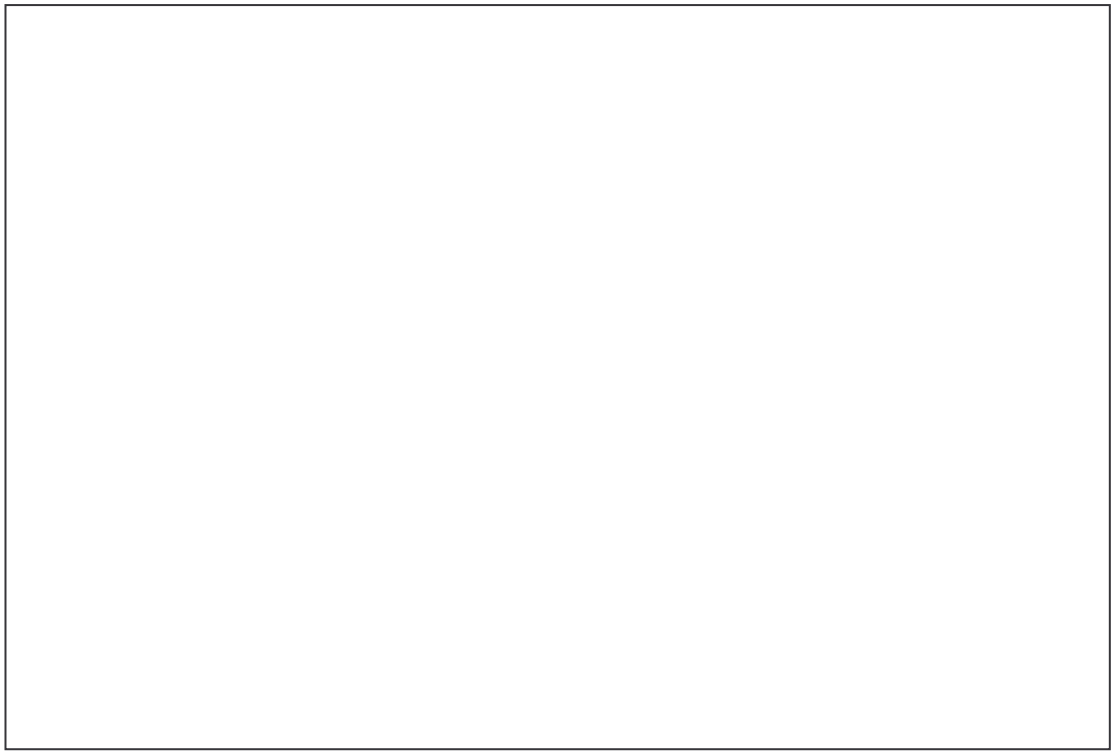
Diagram 2: Fertilised Gamete

1. Draw and label a detailed diagram of a fertilised egg under HP.



2. Describe the fertilised gamete:

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3. In what ways has the cell changed? Explain.

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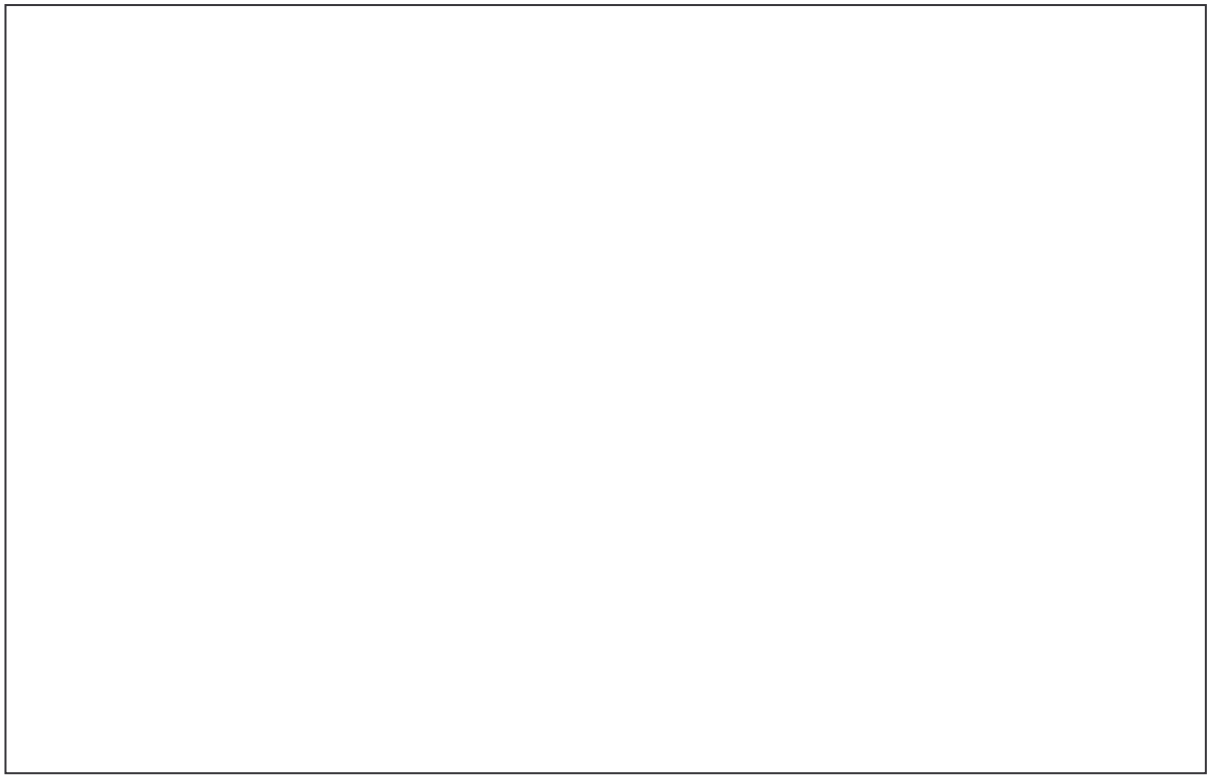
Diagram 3: Embryonic development stage: Multi-celled zygote

1. Draw and label a detailed diagram of a multi-celled zygote under HP.



2. Describe the zygote:

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3. In what ways has the cell changed? Explain.

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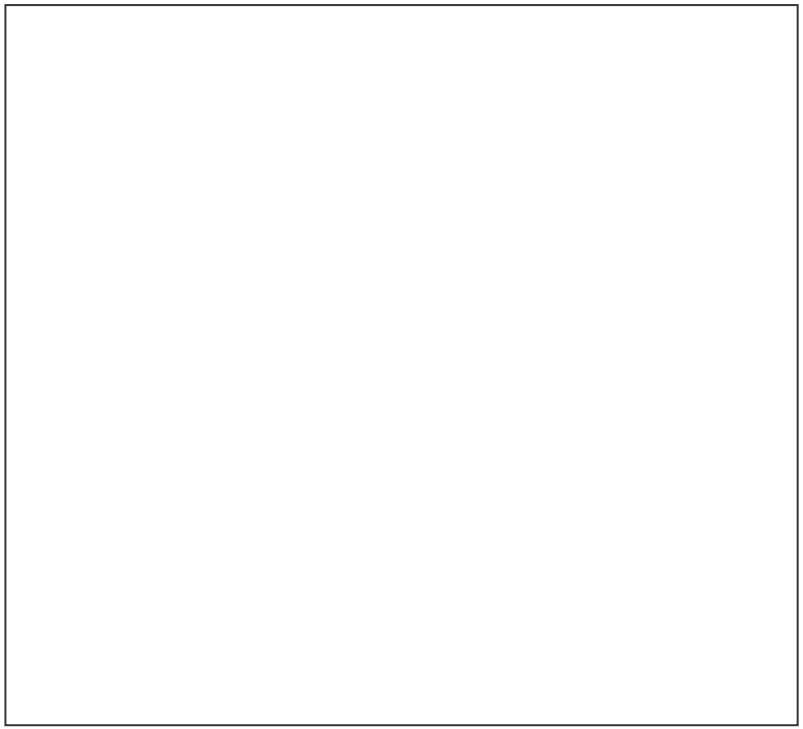
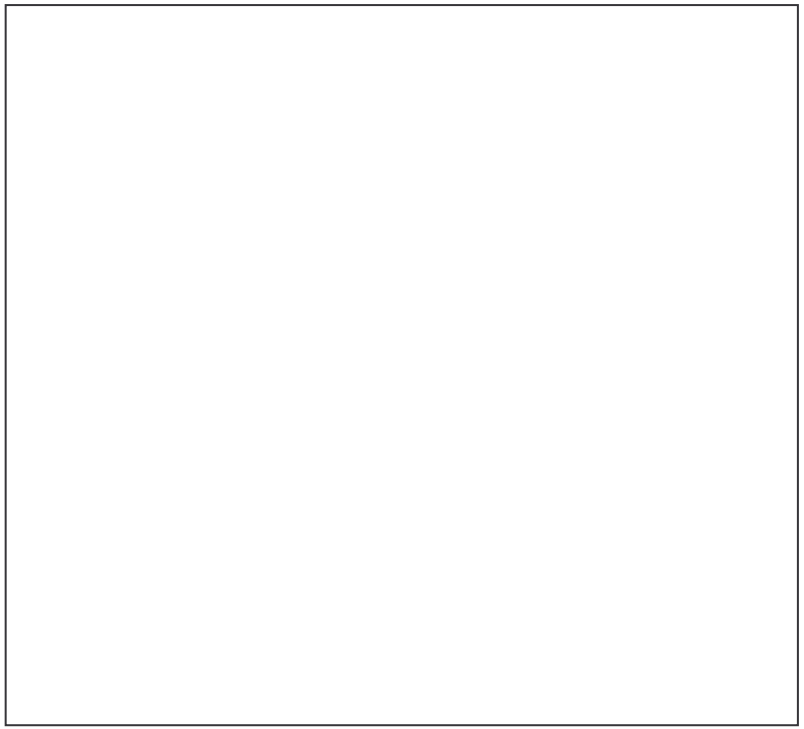
Diagram 4: Embryonic development stage: Blastula & Gastrula

1. Draw and label a detailed diagram of the blastula and gastrula stage.





2. Describe the blastula and gastrula stages:

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3. In what ways is the gastrula stage different from the blastula stage ? Explain.

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Extension Questions

1. How can you tell that the cell drawn in diagram one is a single cell?

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2. What is the main advantage of sexual reproduction as opposed to asexual reproduction?

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3. What is the function of the fertilization membrane of the female ovum?

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4. Why do sea urchins have external fertilization? What are the adaptive advantages of external fertilization? What are the adaptive advantages of internal fertilization?

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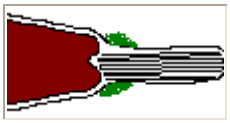
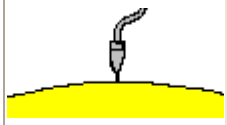
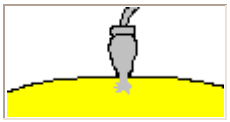
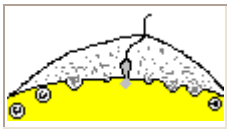
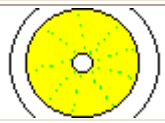
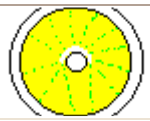
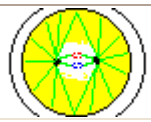
5. Briefly explain the differences between blastula and gastrula stages within embryonic development.

6. How might the reduction in size during cleavage assist with increasing the supply of oxygen available to the cell?

7. In 1902, Boveri caused double fertilization of a sea urchins egg (two sperm in one ovum) the offspring was abnormal. Why would this experiment support the notion that each organism must contain an even number of chromosomes?

EARLY EVENTS

TIME	EVENT	COMMENTS	DRAWING
-30s	Acrosome	The sperm acrosome reacts with the egg jelly causing the acrosome reaction.	
0	Binding	The acrosome reacted sperm binds with the egg. This causes an electrical change in the egg helping prevent other sperm from binding.	
30s	Fusion	The successful sperm's membrane fuses with the egg's plasma membrane	
1-2m	Cortical Rx	The cortical granules release causing the fertilization membrane to rise, also helping to prevent further sperm entry.	
5m	Fertilization Cone	A cone of actin forms around the sperm nucleus, pulling it into the egg.	
10-15m	Nuclei Fuse	The sperm and egg haploid nuclei fuse to become a diploid sea urchin nucleus	
20-30m	Centering	The beginnings of the mitotic spindle force the nucleus into the center of the embryo	
50-60m	Streak	The centrosome replicates causing a spread of microtubules resembling a clear streak.	
80-90m	Metaphase	The chromosomes line up in the center of the embryo ready for cell division.	
90-120m	First Division	Cytokinesis, cell division occurs. The embryo becomes 2 cells.	

http://www.stanford.edu/group/Urchin/fo2.htm

NOTES