

# Mona or Monu?

*Author: Rohini Chintha*



Mittu was still asleep when Mom sneaked into his room, placed his gift on the study table, and started singing "Happy birthday to you!" Mittu sat up in bed with a grin, and rubbed his eyes. "Thank you!" he muttered joyously. After a moment, Mittu's eyes opened wide. "Oh! A clownfish! How awesome. I love it. Thank you!"

He hopped off the bed, and hugged her. "Umm...Mom, I know your gifts are always unique - what is special about this clownfish?"

Mom smiled. "Well, this particular clownfish was found abandoned, and I volunteered to care for it. Also, did you know that clownfish groups are headed by a single large, dominant female..."

"Like you, mom?" Mittu winked.

Mom continued "And, clownfish are one of the few species that can change gender. Unique enough?"

"What?" Mittu looked stumped. "But how? Why? I mean...wow!"

"Let's discuss this over breakfast?" Mom suggested.

Mithu got ready in no time. "Tell me now", he pleaded gulping down his favourite hot dosas.



Mom plopped onto an empty chair beside Mittu. "Clownfish live in small schools, among the reefs, hidden away from predators. All the fish in a school are born with inactive sexual organs. Their only function is to compete with each other for food. The one that outcompetes the others, grows faster than them. When this fish reaches a certain size, specific hormones get activated in its body. These hormones lead to the development of male sex organs. And, quite rapidly, the fittest juvenile in the school transforms into a male."

"Does every juvenile turn into a male once it gets big enough?"

"Not really. Once one of them becomes a male, it dominates over the other juveniles in school – they are so stressed that they never grow that big."

"So, the fittest fish in a school becomes a male, and bullies the other fish into remaining juveniles?" Mittu repeated.

"The second fittest. Remember, each school is headed by a female?" said Mom. "She's the fittest, the largest, and the most aggressive. She's also the only female in the school. She uses her much larger size to keep the male in check, and prevent him from growing to her size."

"How?"

"Much like the male keeps the juveniles in check. She controls which parts of the reef the male can visit, and how much he eats. If the male survives her bullying, and can bond with the female, the two stay paired for a lifetime. But the female is always in charge." Mom explained.

"Really?"





Gender neutral clown fish

Fittest juvenile turning male...



Female in-charge



...and caretaker!

Replacing the female in-charge



"Yes. In fact, you can see the male following the female around. But that's not all - after the male fertilizes the eggs that the female lays, he takes care of them till they hatch into the next generation of clownfish."

"Wow!" Mittu exclaimed.

"When the dominant female dies, the male clownfish changes into a female, and takes charge of the school."

"What?" Mittu exclaimed.

"Meanwhile, the largest juvenile transforms into the next male." Mom continued. "This helps ensure that the clownfish can continue reproducing, without leaving the safety of their little reef."

"Can a female change back into a male?"

"No. Once a female, always a female. And since this change in gender happens in sequence - immature to male to female, clownfish are called sequential hermaphrodites."

"How do they do that, Mom?"

"The DNA of every clown fish carries genes for both female and male hormones. While the female fish is around, the male fish expresses only male hormones. But once the female fish dies, the male fish can feed without bullying. Once he reaches a certain size, he stops expressing male hormones, and begins expressing female hormones instead."



These hormones lead to the development of female sex organs, and the male transforms into a female."

Mittu thought for a while "So, clownfish do this to protect themselves from being eaten up by bigger fish? Have other fish also evolved in this way?"

"I know of Wrasses and Guppies."

"What about earthworms?"

"Earthworms are a little different. Each earthworm has both male and female reproductive parts. That's why earthworms are called simultaneous hermaphrodites".

"So, earthworms are both male and female at the same time." Mittu pondered. "Are bacteria also like that, Mom?"

"Bacteria are asexual." Mom replied.

"Please, Mom, can you explain that clearly?"

"Okay. All living things reproduce – this is what ensures the survival of their species, yes? Bacteria, plants, animals, humans..."

Mittu nodded "Fishes too.."

"At first, there were no males or females. No boy or girl plants or animals. Just living beings. Like bacteria".

"Okay."

Earthworms

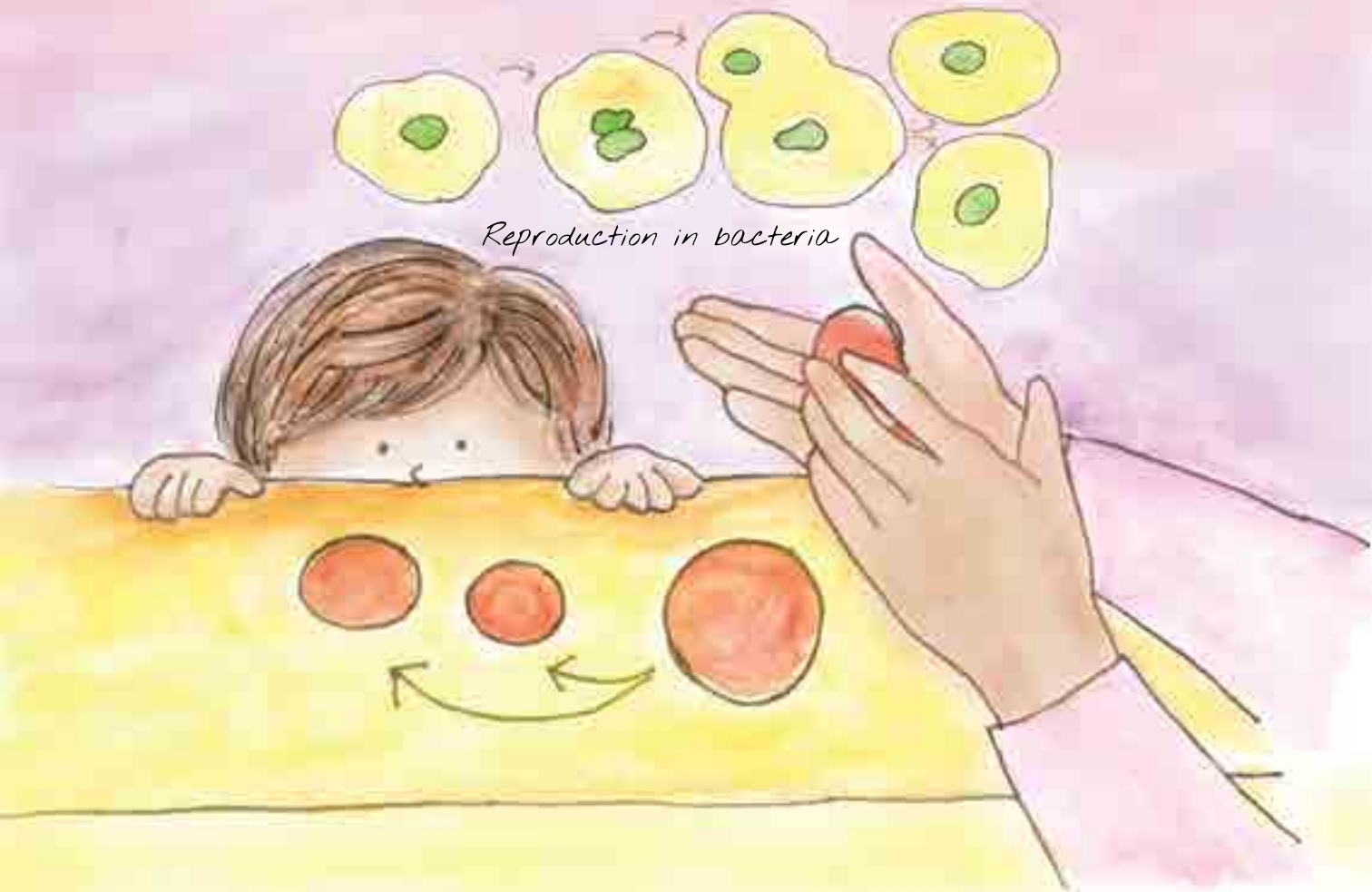


Guppies



Wrasses





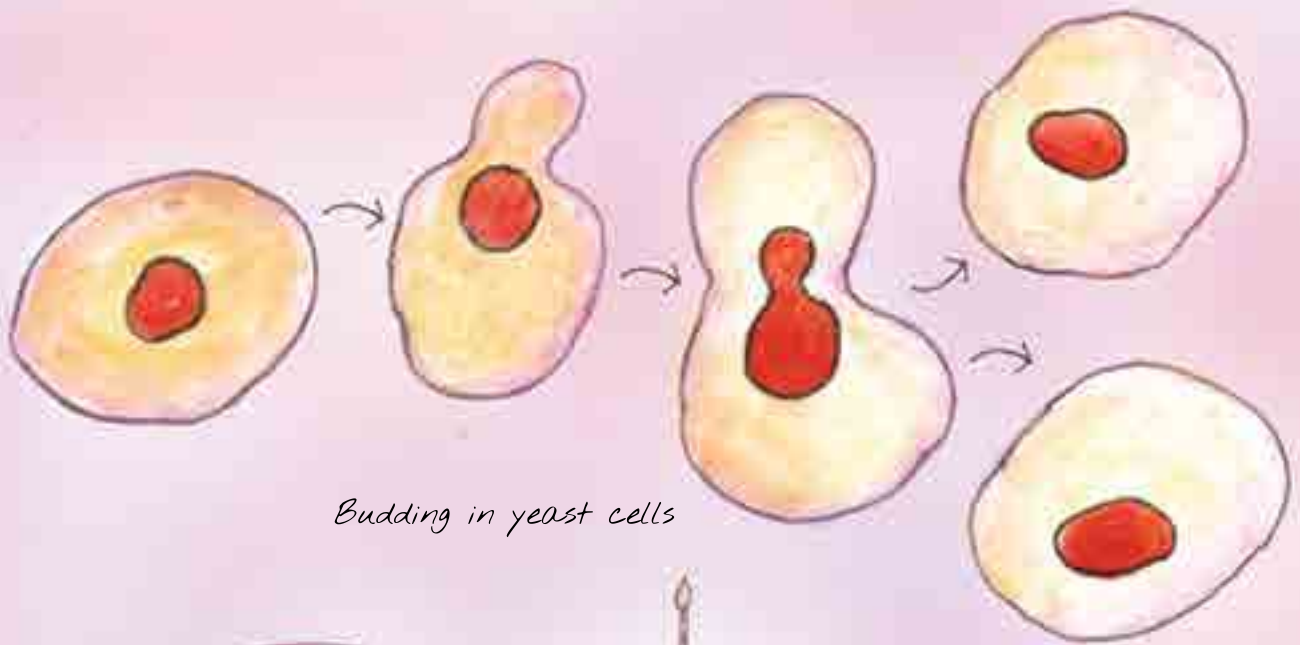
"This bacterium produced daughters asexually. This means that one parent cell divided into two daughter cells. In other words, it just copied itself". Mom took Mittu's pink clay dough, and divided it into two balls of equal size. "Like this. Copies. But first the bacterium needs to grow large enough to divide. So, the daughters in every generation are the same size as the parent, not smaller." Mom demonstrated.

"Got it!" Mittu beamed. "Each of these balls can also divide into two?"

"Excellent!" Mom smiled. "Now, can you see any differences between these four daughters?"

Mittu examined the dough balls carefully. "Yes, Mom. Some of them have more cracks than others. This one is smaller. And that one looks softer."

Mom nodded. "The environment in which bacteria grow is always changing. So, even when a bacterium makes copies of itself, each of its copies is slightly different from the others. Each time a daughter cell divides, it produces cells with more differences. These differences are caused by heritable changes called mutations. Ultimately, mutations result in the evolution of different strains of bacteria. The DNA of each strain is at least slightly different from that of other strains. This is how newer life forms evolved. Clear?"



Budding in yeast cells



"Some of these bacteria happened to mix their DNA. Not consciously though. This intermixing or recombination of genetic material allowed more differences. The more the difference in a population of bacteria, the greater the chance that at least some of the bacteria from that strain survived changing environments. In other words, in each generation, the environment would select for the bacteria with the intermixed DNA to become more in number. This process is called natural selection."

"What kind of intermixed DNA helps bacteria?"

"Many kinds. For example, say a bacterium that grows at very high temperatures mixes its DNA with another bacterium that can resist antibiotics, and produces a daughter with both these traits. See, double advantage because of intermixing? But, sometimes, intermixing also kills bacteria."

"Do other organisms mix their DNA too, Mom?"

"Yes. All eukaryotes do. Like, yeast. It also produces copies of itself by an asexual process called budding. But, unlike bacterial DNA, yeast DNA is coiled inside the nucleus into rod shaped structures called chromosomes."

"So, bacteria intermixes its one strand of DNA, and yeast intermixes a whole bunch of chromosomes?" Mittu interrupted.

"Correct. It is likely that variations in yeast DNA gave rise to two different mating types (strains) called A and alpha. An A strain of yeast can mix only with a cell from the alpha strain, not with another yeast from the A strain." Mom remarked.

"So A and alpha are like male and female?"

"Somewhat similar..." Mom continued.

"So, first there were asexual bacteria. Then there were A and alpha strains of yeast." Mittu added.

"Good!" Mom patted him.

"Then?" Mittu enquired.

"Then, multicellular organisms evolved. And every function in a multicellular organism is carried out by specialized cells or organs.

Sperm & egg

Peacock & peahen





So multicellular organisms had separate reproductive organs and separate reproductive cells to produce offspring."

"What about us?"

"In humans, one type of reproductive cell is large, round, and called the egg. The other type of reproductive cell is small, oval, has a tail, and is called the sperm. We call the organism producing eggs – female. And the organism producing sperms – male. When an egg and sperm fuse, a zygote is formed. In humans, this zygote is the first cell of a baby. This cell divides into the other cells in a baby's body."

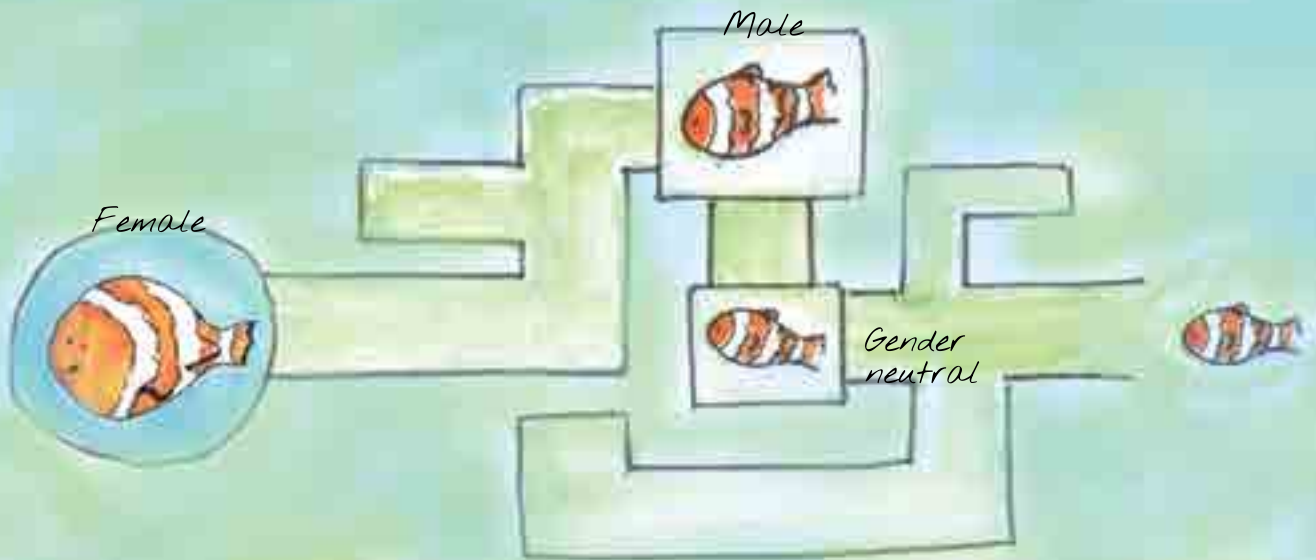
Mittu was thoughtful. "So, are peacocks and lions like us?"

"Yes. Humans, peacocks, and lions all are unisexual organisms. In all three, the males look different from the females. The difference in appearance of males and females of a species is called sexual dimorphism."

Mittu dropped two grains of fish food in the tank. "But you said that when my pet was born, it wasn't male or female?"

Lion & Lioness





"Yes. It could turn into a male and a female." Mom explained. "But, remember, that at any given time in its life, a clownfish can only be one of the three – gender neutral, male, or female. Never all three at the same time."

"Did hermaphrodites evolve after unisexual organisms?"

"Most probably. Different sexes is a more advanced way of mixing traits than the kind of intermixing of DNA seen in bacteria. More intermixing meant more variation in their traits. More variation means a higher chance that at least some organisms of this species will survive and reproduce in new environmental conditions. But, if clownfish remained unisexual, it is likely that they would have to move around more in search of a mate. This would increase their risk of being eaten up by bigger fish. So, clownfish that remained in their corner of the reef would have a better chance of surviving and reproducing. But, if at some point, all the surviving clownfish in a school were male, no new fish would be produced."

"What if all the fish were female?" Mittu asked.

"Again, no new fish. But if some changes in the fish's DNA made it a hermaphrodite, the school would have a higher chance of producing new fish without leaving the safety of their reef homes. In such species, hermaphrodites are more likely to survive and produce offspring, right?"

"Seems so." Mittu was lost in thought.

"So, it would seem that asexual bacteria were the first to evolve. Then,  $\beta$  and  $\alpha$  of yeast, followed by unisexuals. And, hermaphrodites were the last to evolve."

"One last question, mom. Have you planned any activities after the party?"

"Umm...not yet..."

"Then don't. I have a plan for a game that lasts all evening." Mittu said, pointing to his clownfish "Name it - Monu or Mona? Like it?"

Mom laughed. "I love it!"





### *About the Author*

*Rohini Chintla is an Assistant Professor (C) at the Department of Genetics and Biotechnology, University College for Women, Hyderabad. She writes in Telugu and English, is passionate about writing for children, and believes that 'A Happy Childhood builds a Happy Society'. About 75 of her stories for children have been published in various magazines.*

*Illustrations and design: Vidya Kamalesh*