**Mobility, jumps and tails
Zareeena, Mookayi, Mari**

Zareena, Mookayi and Mari had come with Mari’s mother Usha who was attending a biology conference at the Indian Institute of Science Education and Research at Thiruvananthapuram. They were on vacation from college, and liked to visit Kerala so they had jumped at the opportunity.
The three had learnt that Thiruvananthapuram Zoo is one of the large zoos of the country spread over 30 acres of land. So they resolved to spend a day there. The zoo had changed from the usual iron barred, cement floored, dingy animal cages to open moated, spacious, nature immersing enclosures. (The picture shows the Indian Leopard, Rhesus Monkey, Lesser Adjutant, Lion Tailed Macaque, all at the Zoo).They saw several endangered species and came to the much-talked-about *Lion-tailed Macaques* for which the zoo had a Conservation Breeding Programme.
Usha, as promised, met Zar, Mooks and Mari outside the lion-tailed macaques area.
As they were passing through the place where Lion-Tailed Macaques were sitting on the top of the trees and *Nilgiri Langurs* were a bit close to the ground, Mooks pointed towards them and said, "They have such long tails! Why don't humans have tails like monkeys?"
Usha smiled. "That's a great question, Mooks. We humans have diverged from a family called *apes*. This family includes chimpanzees, gorillas, and orangutans. When they diverged from monkeys the apes probably lost their tails millions of years ago.”
"Why?" asked all three in unison.
"It's linked to our evolution," Usha began. "Recently, researchers found that a small change in a gene called **TBXT** might be responsible for tail loss in apes and humans. This gene controls the development of tails in embryos."
"So we all have tails when we're babies?" interrupted Mari.
“Exactly, Mari”, said Usha. "All mammals, including humans, have a tail during early embryonic stages, but in us, it gets absorbed as we develop."
They went to the tiger enclosure. There sat a beautiful tiger, dozing in the shade. Mooks pointed at the tail of the tiger, swishing its tail with ease. "Like the monkeys, the tiger uses its tail for balance. How did apes manage without one?
“Great to hear your observation,” Usha replied. “Losing the tail was probably part of an adaptation which helped *upright walking*. This change was likely helpful for **hominoids**, which includes apes and humans, to move more efficiently on two legs, freeing up their hands for tools and carrying food.”
“Does that mean we’ll never grow tails again?” Zar wondered aloud.
Usha laughed. "Probably not. This mutation happened millions of years ago, and human bodies adapted to life without tails. But studying this helps us understand how small **genetic** changes can lead to big **evolutionary** shifts."

**BOX Evolution**

Evolution refers to the process by which living organisms change over time through changes in the genome. Such evolutionary changes result from *mutations* that produce genomic variation, giving rise to individuals whose biological functions or physical traits are altered.

Evolutionary history is the study of how life on Earth has changed over time. It's based on the idea that all life shares a common ancestor, and that species change over generations. It studies changes in the inheritable characteristics of populations over successive generations.

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Mooks turned to Mari and said, "I think it's cool we don't have tails. We wouldn't be able to sit comfortably in class!"
Mari laughed. "True, but can you imagine using it to hold things like langurs do. We could all be multitasking champions!"
As they moved further into the zoo, they reached the big aviary where they saw many birds. They were glad to see Spoonbills, Rosy Pelican, Grey Pelican, Grey Heron, White Ibis, Adjutant Stork, Painted Stork, Pond heron, Purple Heron, Egrets, Oriental darter and Parrots of course.
Brightly coloured parrots sat on branches, gracefully wagging their long tails as they hopped around. Zar pointed at them and asked, "Even birds have tails! Why did we lose ours while so many other animals kept theirs?"
Usha straightened her specs and replied, "Good question as usual, Zar. Loss of tails in our ancestors was probably due to some combination of genetic changes along with evolutionary needs. Most interestingly, it deals with mobile DNA elements —bits of genetic material which move around in our *genome*.

**BOX Genome**

Genome is the complete set of genes or genetic material present in a cell or organism. For instance, the human genome is the ccomplete set of DNA instructions that make up a human being.

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One of these mobile elements, called **Alu**, played a major role.
Mooks shook her head in bewilderment. "Mobile DNA? Like moving robots?"
Usha smiled. "Well, not really. Mobile DNA elements, like Alu, are sections of DNA that can be copied and inserted into the genome. They are more colloquially called 'jumping genes.' Alu elements are found aplenty in primates and more so in humans. Millions of years of time have passed with Alu in existence.
Mari wrinkled her brow thoughtfully. "So these jumping genes somehow managed to infiltrate our DNA and tail-wagging ability suddenly disappears?"
"It's a bit more complicated than that," Usha said. "One Alu element inserted itself into the TBXT gene—the gene that controls tail development in embryos. This caused something called *alternative splicing*, where a part of the gene, *exon 6* to be exact, was skipped or omitted. This change stopped the development of a long tail."
"What's splicing?" Zar asked.
"It's like editing a movie," Usha said. "Think of having a film reel that runs for many minutes. Cutting and editing scenes is known as splicing. Alu insertion skipped some of the scenes - which are referred to as exons - resulting in TBXT of a shorter size that could not produce tails.
"But, but." Mooks blurted out: "Wouldn't it have an impact on everything? I thought tampering with a gene can be problematic.”
Usha nodded in agreement. "You are absolutely right, Mooks. Genetic modification often has its consequences. In this case, the Alu-created mutation in TBXT did not end only tail growth. This can cause a disorder known to be associated with *neural* *tube defects*, a condition encountered during the early development stage of the embryo's head and spinal cord. Examples of such a defect include an imperfect closure of the spinal cord.
Mari gasped. "So, does that mean that humans can also suffer from these problems?"
"Yes," said Usha gravely. "Neural tube defects, like **spina bifida**, do affect human babies with regional variations. It shows how an evolutionary change, while helpful in some ways, can come with costs."
"So, the tail loss wasn't all good?" Zar asked.
"It's a trade-off," Usha said. "The loss of the tail freed up their hands to grasp tools and hold onto food. But it came with other genetic implications. Sometimes, evolution's payback is a balance of rewards and penalties."
As she watched the parrots clean their feathers, Mari turned to her mother and asked, "So if all this was from the Alu elements, are they still flitting around inside us?
Usha smiled. "Most Alu elements are simply an old part of our inheritance in DNA now. Like fossils. The genome can change in a spectacular manner when they move. Their moving around have been shown to also link with other changes beside this TBXT gene."
Zar's eyes shone mischievously. "Then the jumping genes are rather like tiny researchers testing something inside us?
"Exactly!" said Usha. "Mobile DNA elements have shaped many aspects of evolution. They're like nature's way of randomly introducing new possibilities, some of which may help species adapt."
As the group made its way toward the reptile area Mooks asked, "Could tails come back one day? Like if another Alu jumped into the right place?"
Usha laughed. "Unlikely. This insertion occurred millions of years ago when our tails disappeared and our bodies changed fully. But Alu elements teach us something about the great complexity of evolution and the way small changes may trigger big effects.

Like the stream near the crocodile enclosure, their conversation flowed easily. The three kept marvelling at how something as small as a piece of mobile DNA could shape the story of apes and humans. It showed them how in living organisms, the smallest things may often have a big impact.

Usha smiled to herself. She was glad the zoo visit had sparked such questions and led to a learning about evolutionary history.