

## NITROGEN CYCLE MOVIE TRANSCRIPT

Text reads: The Mysteries of Life with Tim & Moby.

The video shows Tim, a man, and Moby, a robot, at a picnic. Birds are chirping. Tim is wearing sunglasses and a shirt that has a big N on it with arrows going around it counterclockwise. Moby is wearing a hat.

Moby picks up the picnic basket and takes out a sandwich on a plate.

TIM: Lunch! Tim takes off his sunglasses.

TIM: What would you pack for me?

Moby puts down the sandwich and holds up a bowl of something green with red dots in it.

MOBY: Beep. Moby's lights blink.

TIM: Look, for the last time, I am getting plenty of fiber. Tim holds up a letter and reads from it.

TIM: Dear Tim & Moby, I thought that air was mostly made up of oxygen, but my brother just told me that it's mostly nitrogen. Who's right? Sincerely, Eloise.

The video shows four circles, two are red and have the letter Upper O in them, and the other two are blue and have the letter Upper N in them.

TIM: Well, you can definitely find both elements in the atmosphere.

The video zooms out to show that there are many more blue circles with an Upper N in them than there are with an Upper O in them.

TIM: But oxygen makes up only 21 percent of it, while nitrogen accounts for a whopping 78 percent!

MOBY: Beep. The video shows Tim and Moby back at the picnic.

TIM: Hey, we need nitrogen just as much as oxygen!

TIM: It's a key component of DNA, the body's genetic program for life and of all proteins, the building blocks of cells.

Text reads: Upper D Upper N Upper A.

Text reads: proteins.

MOBY: Beep? Moby's lights blink.

TIM: Well, unlike oxygen, we cannot just breathe in nitrogen and put it straight to work in our bodies.

The video shows a zoomed-in view of a skin cell wall. There is a little blue sphere with a smiley face outside of the cell wall.

The blue dot bounces off the cell wall and off the screen. Several more blue dots bounce off of the cell wall and off the screen.

The video shows Tim and Moby. Moby is holding his sandwich and Tim is holding a bowl of greens.

TIM: We need nitrogen in a different form—and we get it from food.

MOBY: Beep? Moby moves the sandwich up to his mouth and pauses. Tim looks at Moby.

An animation shows a rabbit and plants. The ground is in cross section so the roots of the plants can be seen. There are round nodes on the roots. Arrows are circling the scene in a counterclockwise direction.

TIM: Well, it's all part of a process called the nitrogen cycle.

**Text reads: nitrogen cycle.**

TIM: See, nitrogen is constantly moving in a big circle, from the air to the ground to plants, animals, and humans—and back again.

An animation shows rain coming down.

TIM: First, nitrogen from the atmosphere falls to the ground, thanks to precipitation—snow, rain, hail, that sort of thing.

An enlarged inset shows a water droplet. One of the blue dots with a smiley face is hanging onto it. This droplet disappears into the bottom of the inset. (Wheeee!) The video shows Tim.

TIM: Once it's in the soil, the nitrogen crosses paths with a special type of bacteria.

TIM: These bacteria often live on the roots of plants in a mutually beneficial relationship.

The video shows Tim and Moby.

TIM: The plants give the bacteria a cozy home, and the bacteria give the plants—well, let's take a closer look!

Tim picks up a plant and Moby picks up a magnifying glass.

The video zooms in on the plant, showing many little blue circles with smiley faces and bacteria.

TIM: The bacteria latch onto a nitrogen molecule, break it into two separate atoms, and combine each with hydrogen to form a compound called ammonia.

An animation shows a grey bacterium grabbing a nitrogen molecule, consisting of two nitrogen atoms. The bacterium splits the nitrogen molecule into two nitrogen atoms. Then six hydrogen atoms enter the screen. Three enter from the left of the screen and three enter from the right of the screen. Three hydrogen atoms stick to each of the nitrogen atoms.

Text reads: ammonia. The video shows Tim.

TIM: Just like that, the gaseous nitrogen has been "fixed," or attached to other elements to form compounds that cells can use.

The video shows Tim and Moby.

MOBY: Beep? Moby's lights blink.

TIM: Right. That process is called nitrogen fixation.

**Text reads: nitrogen fixation.**

MOBY: Beep? Moby's lights blink.

TIM: Well actually, ammonia itself is pretty toxic, so before it can be used it needs to be turned into something else.

An animation shows a yellow bacterium with hands grabbing onto the two ammonia molecules, one in each hand.

TIM: For this, a different type of bacteria grabs onto each ammonia molecule and combines it with oxygen.

Six red spheres, representing oxygen, enter the screen. Three enter the screen from the left and three enter the screen from the right. Three attach to each of the two ammonia molecules. The hydrogen is replaced by the oxygen, which is now attached to the nitrogen atoms.

TIM: This step is called nitrification, and it creates a compound that plants can safely absorb through their roots.

**Text reads: nitrification.**

TIM: Plants use these compounds to build proteins.

The video shows a plant. The ground is in cross section so that the roots are visible. An enlarged inset of the roots is shown. These compounds are traveling through the roots.

The video shows Moby at the picnic next to a cow that is eating plants.

TIM: Animals, in turn, get these nitrogen-based goodies by eating plants . . . and other animals!

MOBY: Beep? Moby's lights blink.

The video zooms in on Tim's face.

TIM: Well, no, this stuff doesn't stay with us forever, since all living things have to—er, emit waste.

The video shows cow poop on the ground by the cow's feet.

TIM: And when plants and animals die, their bodies decay.

TIM: The proteins and other nitrogen compounds inside them return to the soil.

The video shows a scene in the forest with a dead animal and a decaying log with mushrooms growing all over them.

TIM: A third type of bacteria breaks these substances back down to ammonia.

The video shows an orange bacterium with hands breaking the ammonia off of the compound.

TIM: This process is called ammonification.

**Text reads: ammonification.**

The video shows Tim and Moby at the picnic.

TIM: This new ammonia can go right back into the nitrification step.

MOBY: Beep? Moby's lights blink.

TIM: Well, plants don't absorb all of the substances created at that step.

TIM: Some of it is snagged by a fourth kind of bacteria.

The video shows a purple bacterium with hands and a burglar's mask. Ammonia molecules are floating around.

TIM: These guys steal the oxygen atoms from those compounds, leaving plain old nitrogen gas as a byproduct.

The bacterium grabs the oxygen atoms separating them from the nitrogen atoms. The nitrogen atoms float off screen.

TIM: This has the opposite effect of nitrification, so we call this process denitrification.

**Text reads: denitrification.**

The video shows the nitrogen atoms rising up into the air.

TIM: The leftover nitrogen is free to return to the atmosphere, completing the nitrogen cycle!

There is a voice saying Woo-hoo!

The video shows Tim and Moby back at the picnic.

MOBY: Beep! Moby's lights blink.

TIM: Yeah, human activity can have a huge impact on the nitrogen cycle.

TIM: Fertilizers, smoke, and sewage from factories—not to mention the wastes of farm animals—all add millions of tons of extra nitrogen to the environment.

The video shows the screen divided into four sections. In the top left are bags of fertilizer. In the top right is a factory building emitting black clouds of smoke. In the bottom left is a sewage plant dumping sewage into a body of water, and on the bottom right is a pile of animal manure.

TIM: That throws the nitrogen cycle out of balance leading to the loss of oxygen in lakes & rivers; soil that won't grow anything; and polluted, or "acid," rain.

The video shows the screen divided into three parts. On the left there is a polluted lake with dead fish. In the middle is dark brown soil with no plant life. On the right is acid rain falling from the sky.

The video shows Tim and Moby.

TIM: If we want to keep the delicate cycle of nitrogen moving, we have to take steps to protect our environment.

The video then zooms in on Tim.

TIM: Using alternative energy sources instead of burning fossil fuels is a big help.

TIM: So is cutting back on the use of artificial fertilizers and properly cleaning up after our livestock.

The video shows Moby with a shovel next to a dumpster filled to the brim with cow manure.

The label on the dumpster reads: WARNING: COW POO! KEEP BACK!

MOBY: Beep! Moby's lights blink.

The video shows Tim holding his nose.

TIM: Yeah, I guess that is a start . . .