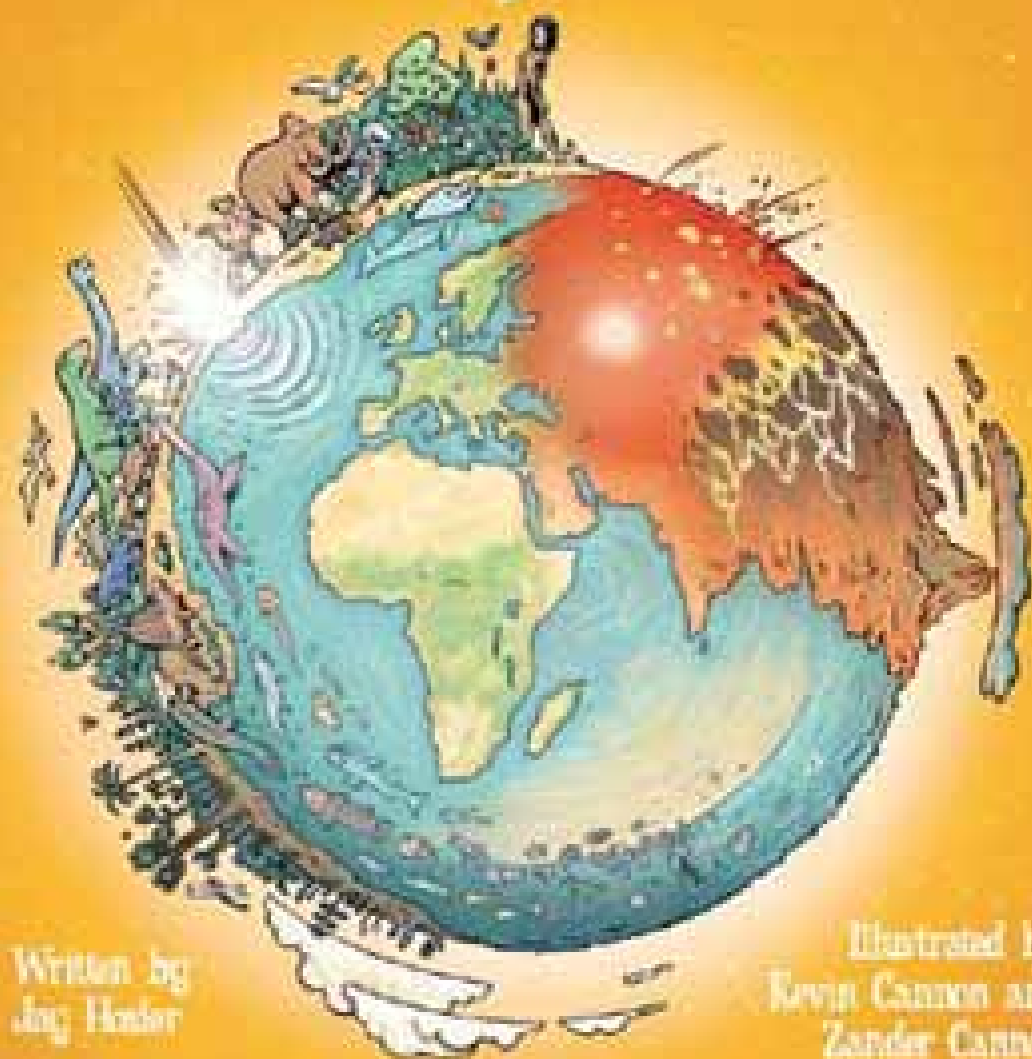


EVOLUTION

The Story of Life on Earth



Written by
Jag Hinder

Illustrated by
Kevin Cannon and
Zander Cannon

EVOLUTION

The Story of Life on Earth

Written by JAY HOSLER

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CHAPTER 1

The Slow Simmer of Life: The First 4 Billion Years

THIS IS THE FIRST 500 MILLION YEARS OF EARTH'S EXISTENCE, BACK WHEN IT WAS PUMMELED BY TONS OF SPACE DEBRIS.

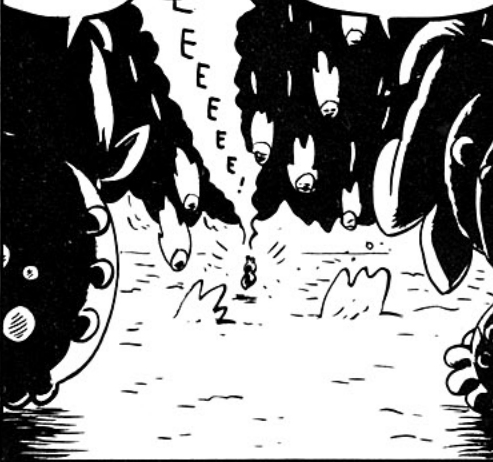
Well, then, perhaps we should skip ahead a bit. And you, young squinch, will stick with me from now on.

Sorry, Dad. I was just excited to see where it all began.



By all that is squincheous! He's caught in a METEOR SHOWER!

IT'S ALL RIGHT, YOUR HIGHNESS. THEY'RE JUST HOLOGRAMS.



It's hard to believe that this place was suitable for life, Bloorr.

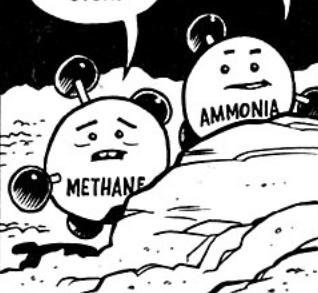
IT IS PRETTY NASTY, BUT, BELIEVE IT OR NOT, CONDITIONS WERE JUST RIGHT FOR SOME VERY CREATIVE CHEMISTRY.



SCIENTISTS SUSPECT THAT THE CHEMICAL PRECURSORS FOR LIFE STARTED TAKING SHAPE ABOUT 500 MILLION YEARS AFTER THE EARTH FORMED.

IS THE BOMBARDMENT OVER?

IT LOOKS CLEAR...



THERE'S NOT MUCH OF A FOSSIL RECORD FROM THAT TIME, SO SCIENTISTS HAVE HAD TO TAKE WHAT THEY KNOW ABOUT THE CURRENT CHEMISTRY OF LIFE AND WORK BACKWARDS.



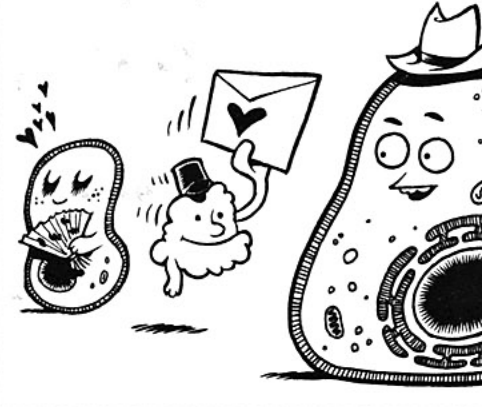
TODAY, ALL LIFE ON EARTH WORKS IN THE SAME BASIC WAY. THE DNA FOUND IN EVERY ORGANISM'S CELLS CONTAINS THE INSTRUCTIONS FOR MAKING PROTEINS. THESE PROTEINS THEN--

Wait, wait, wait. What are PROTEINS?

They're in his first report, that's what they are.



PROTEINS ARE MOLECULES THAT PERFORM THE FUNCTIONS ESSENTIAL FOR LIFE, PRINCE FLOORSH. SOME CARRY MESSAGES WITHIN A CELL OR BETWEEN TWO DIFFERENT CELLS.

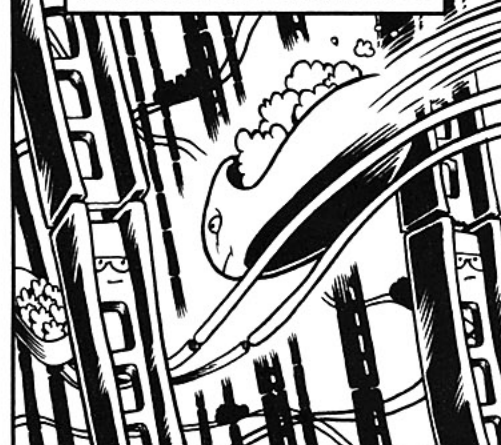


OTHERS ACT AS ANTIBODIES TO DETECT FOREIGN MATERIALS IN AN ORGANISM.

IT'S NO USE HIDING. WE KNOW YOU'RE THERE.



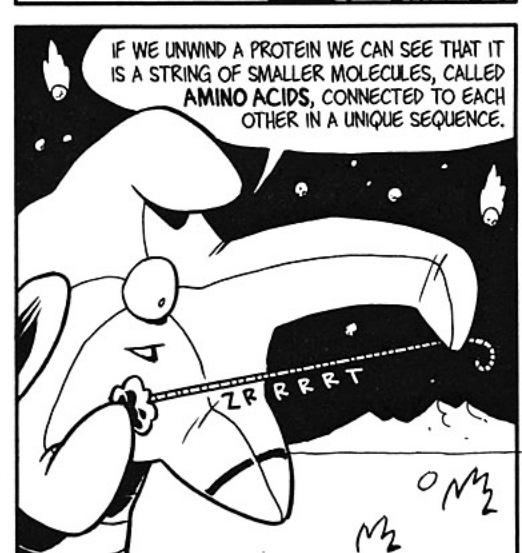
PROTEINS ARE USED TO PROVIDE STRUCTURAL SUPPORT FOR A CELL AS WELL AS TRANSPORTING AND STORING MATERIALS.



ENZYME

ENZYME

BUT PERHAPS THE MOST IMPORTANT FUNCTION OF PROTEINS IS THEIR ABILITY TO ACT AS ENZYMES. ENZYMES ARE PROTEINS THAT RUN THE THOUSANDS OF CHEMICAL REACTIONS THAT TAKE PLACE IN A CELL.



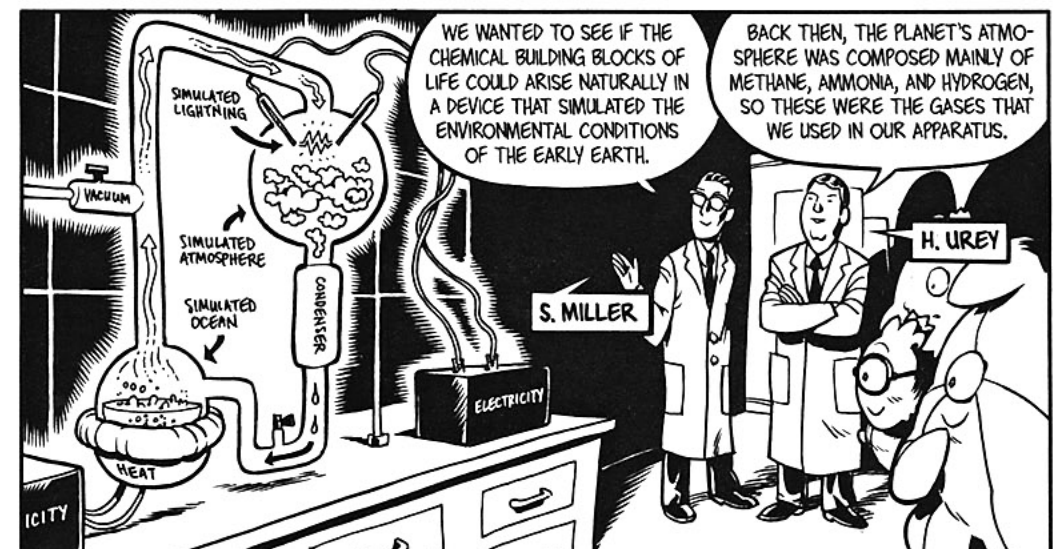
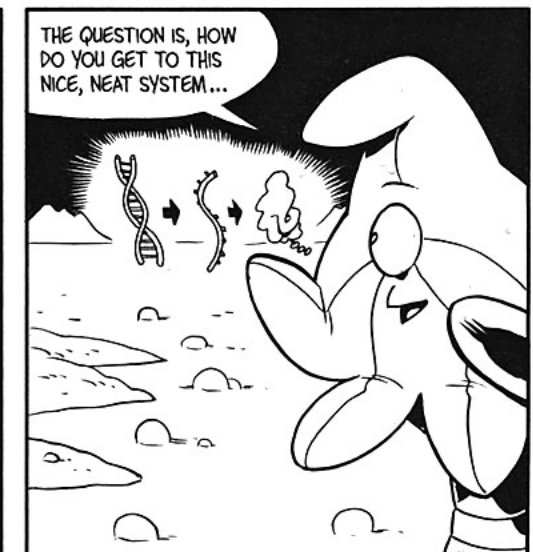
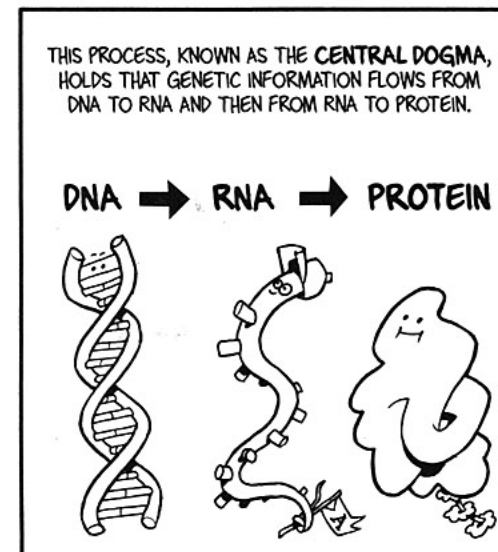
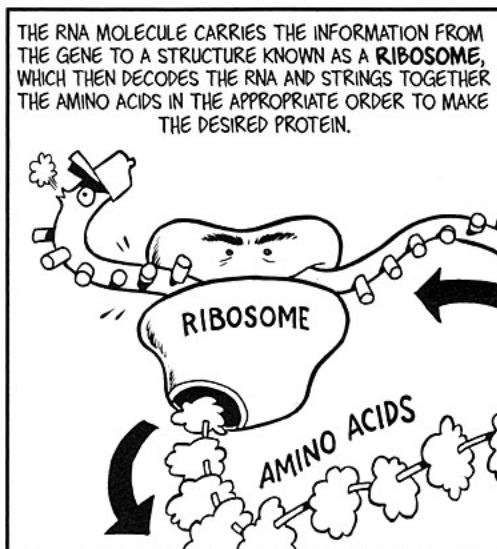
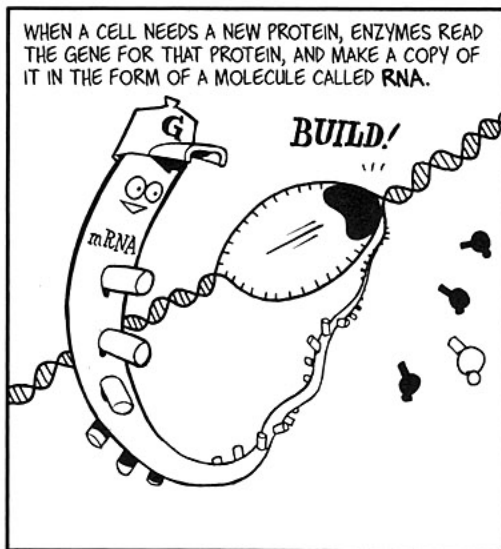
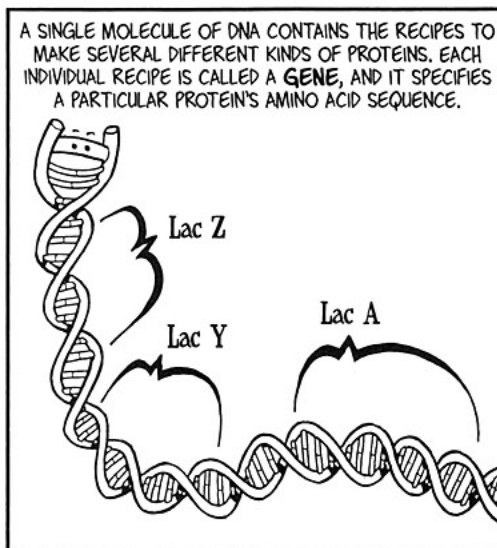
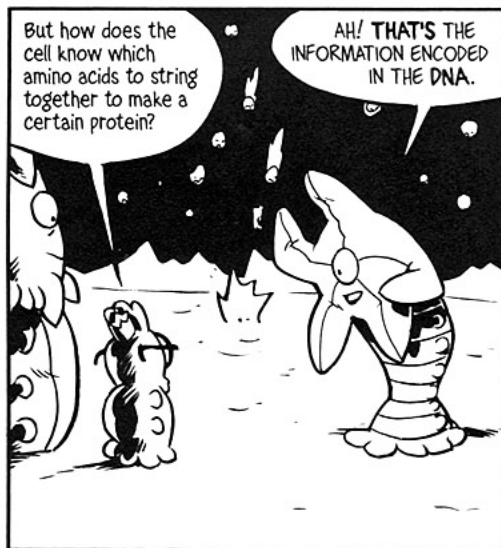
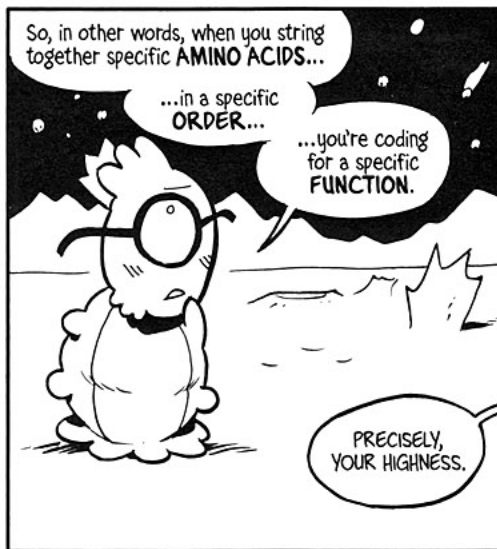
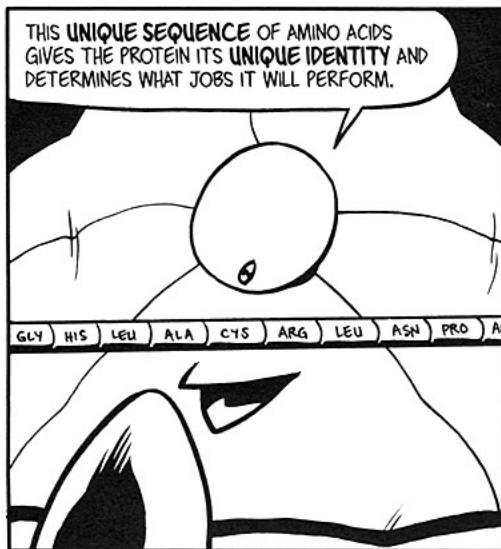
How does a mindless protein know which job it's supposed to do?

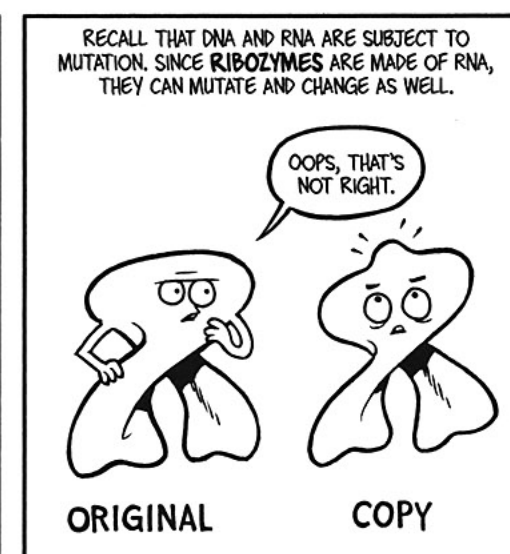
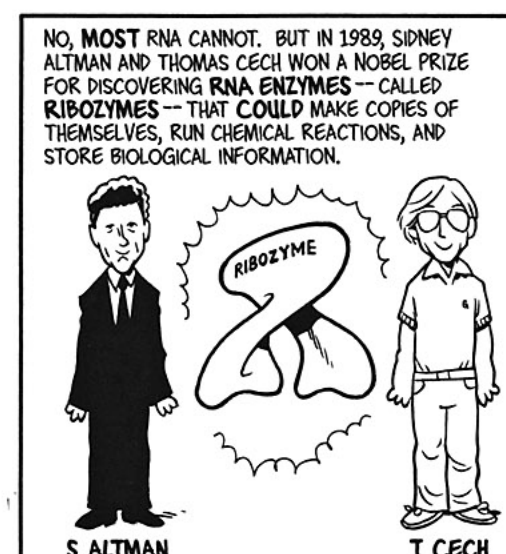
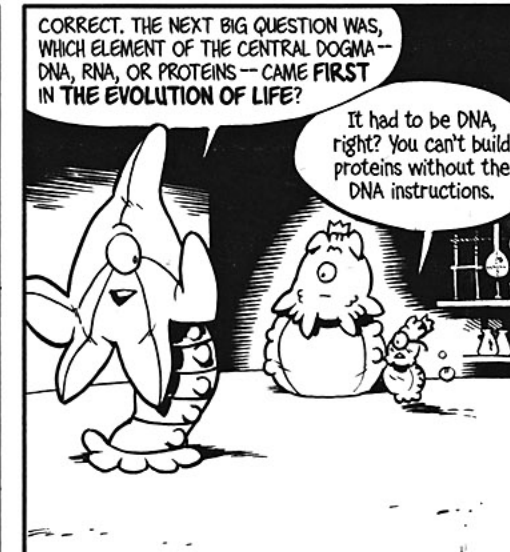
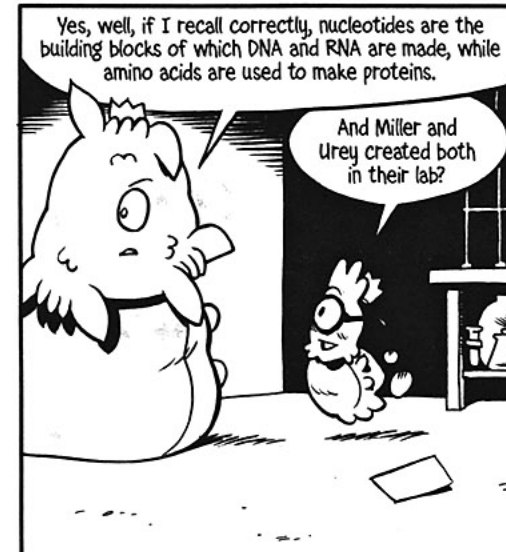
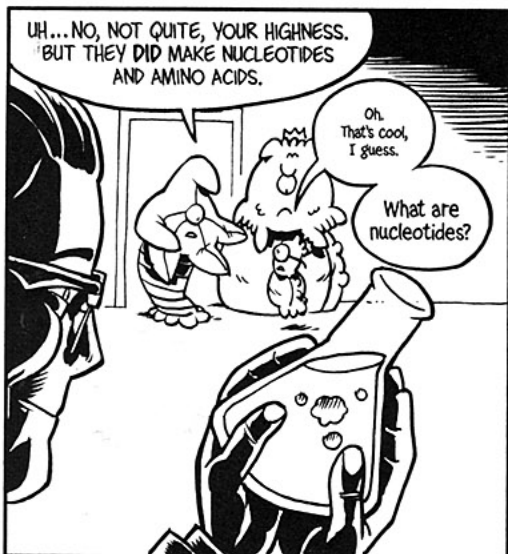
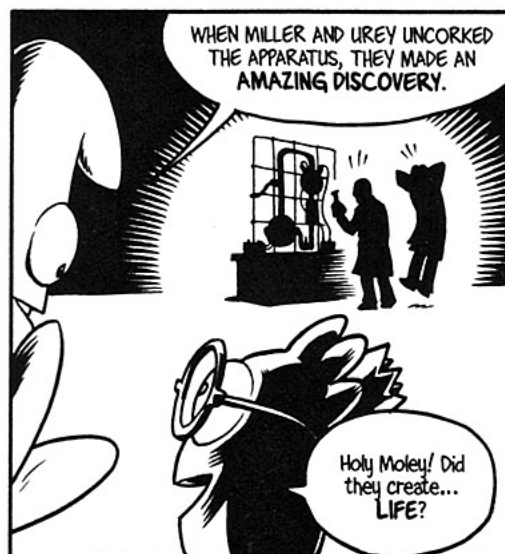
GOOD QUESTION, YOUR PRINCELINESS.



IF WE UNWIND A PROTEIN WE CAN SEE THAT IT IS A STRING OF SMALLER MOLECULES, CALLED AMINO ACIDS, CONNECTED TO EACH OTHER IN A UNIQUE SEQUENCE.





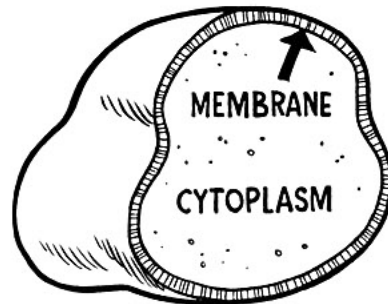


EARTH SCIENTISTS THEORIZE THAT RIBOZYMES COULD EVOLVE IF NATURAL SELECTION FAVORED MUTATIONS THAT ALLOWED SOME TO MAKE FASTER OR MORE STABLE COPIES OF THEMSELVES.



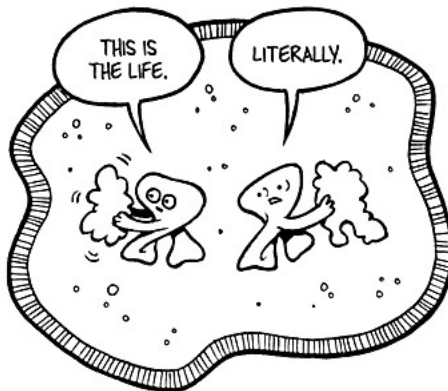
SUCH A MUTATION WOULD ALLOW RIBOZYME MOLECULES TO PRODUCE MORE COPIES OF THEMSELVES THAN THOSE WITHOUT THE MUTATION.

THROUGH A SEQUENCE OF EVENTS STILL NOT CLEAR, SOME RIBOZYMES EVENTUALLY STARTED DOING THEIR COPYING INSIDE OF PRIMITIVE CELL-LIKE STRUCTURES.



THESE EARLY CELLS CONSISTED OF A THIN **MEMBRANE** FILLED WITH A WATERY SUBSTANCE CALLED **CYTOPLASM**. THEY WEREN'T FANCY, BUT THEY TURNED OUT TO BE A BIG EVOLUTIONARY INNOVATION.

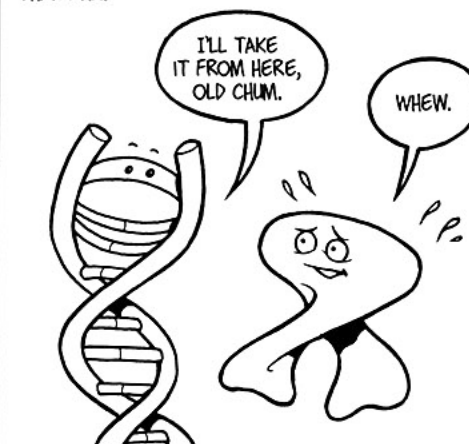
CELLS COMPARTMENTALIZED CHEMICAL REACTIONS AND PROVIDED A STABLE ENVIRONMENT IN WHICH THE RNA COULD FUNCTION.



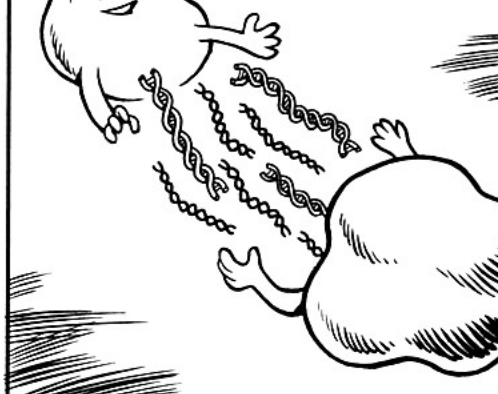
CELLS ARE ALSO TERRIFIC FOR PUMP-ING IN STUFF THAT THE RNA NEEDS AND PUMPING **OUT** WASTE PRODUCTS.



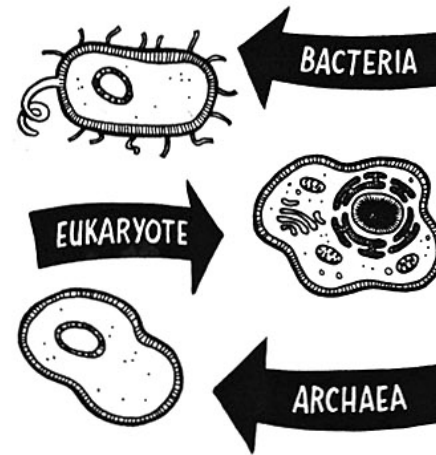
EVENTUALLY, CELLS STARTED STORING GENETIC INFORMATION IN **DNA MOLECULES**, WHOSE DOUBLE-STRANDED STRUCTURE MAKES THEM MORE STABLE THAN RNA.



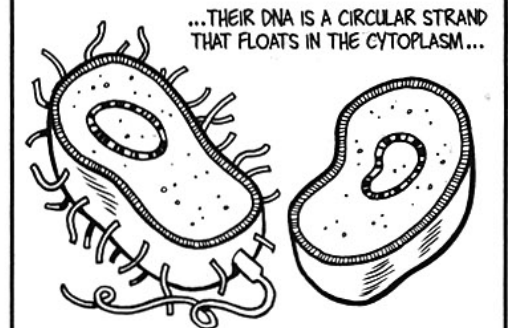
IN THE EARLY STAGES OF THEIR EVOLUTION, CELLS WERE PRETTY SIMILAR AND THEY SWAPPED DNA, RNA, AND PROTEINS FREELY. THESE **LATERAL TRANSFERS** OF GENETIC MATERIAL ADDED VARIATION AND FACILITATED THE SPREAD OF ADAPTIVE TRAITS.



FROM THIS PRIMORDIAL COMMUNITY OF CELLS, THE THREE DOMAINS OF EARTH LIFE EMERGED.



THE BACTERIA AND ARCHAEA ARE COLLECTIVELY CLASSIFIED AS **PROKARYOTES**. PROKARYOTES ARE SINGLE-CELLED ORGANISMS THAT HAVE A CELL WALL SURROUNDING THEIR CELL MEMBRANE...

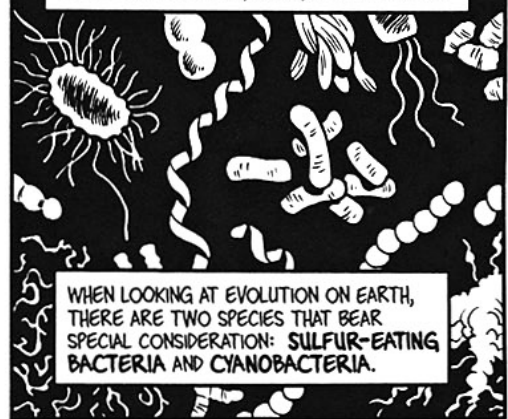


...AND THEY CONTAIN NONE OF THE INTERNAL COMPARTMENTS CALLED ORGANELLES -- WE'LL SEE WHAT ORGANELLES ARE ALL ABOUT SOON ENOUGH.

OF THE THREE DOMAINS, THE FIRST TO HIT IT BIG EVOLUTIONARILY WERE THE **BACTERIA**, WHICH APPEARED ABOUT 3.7 BILLION YEARS AGO.



BACTERIA WERE THE ONLY FORM OF LIFE ON EARTH FOR ABOUT 2 BILLION YEARS. IN THAT TIME THEY DIVERSIFIED INTO A STUNNING ARRAY OF DIFFERENT SHAPES, SIZES, AND FUNCTIONS.



WHEN LOOKING AT EVOLUTION ON EARTH, THERE ARE TWO SPECIES THAT BEAR SPECIAL CONSIDERATION: **SULFUR-EATING BACTERIA** AND **CYANOBACTERIA**.

THOUGH SULFUR-EATERS AND CYANOBACTERIA EXISTED AT THE SAME TIME, THE **SULFUR-EATERS** WERE THE FIRST **DOMINANT** SPECIES OF BACTERIA. THEY THRIVED IN THE NOXIOUS ATMOSPHERE OF THE EARLY EARTH, CONSUMING **HYDROGEN SULFIDE** -- THE CHEMICAL WE ASSOCIATE WITH THE SMELL OF **ROTTEN EGGS**.



BUT, THANKS TO CYANOBACTERIA, THE GLORY DAYS OF THE SULFUR-EATERS WERE NUMBERED.

INSTEAD OF EATING HYDROGEN SULFIDE, **CYANO-BACTERIA** HAD EVOLVED THE ABILITY TO COMBINE SUNLIGHT, WATER, AND CARBON DIOXIDE TO CREATE **SUGARS**, FROM WHICH THEY COULD BUILD NEW CELLS. THIS PROCESS -- CALLED **PHOTOSYNTHESIS** -- PRODUCES A HIGHLY REACTIVE WASTE PRODUCT CALLED...

