**I’m Joe’s Cell**

By J.D. Ratcliff

I am something like a big city. I have dozens of power stations, a transportation system, and a sophisticated communications setup. I import raw materials, manufacture goods, and operate a garbage disposal system. I have an efficient government - a rigid dictatorship, really – and I police my precincts to keep out undesirables.

All this is in something my size? It takes a good microscope to even see me, and a super-microscope to peep inside my metropolis. I am a cell, one of the *60 trillion* inside Joe’s body. (Joe is a typical American man). The cell is often called the basic element of life. Actually, we’re life itself. As a rod cell in Joe’s right eye, I will speak for the vast population of which I am a member.

There is no such thing as a “typical” cell. We are as different in form and function as a giraffe and a mouse. We come in all sizes, the largest of all being an ostrich egg. From there we scale down to a point where a million of us could sit comfortably on the head of a pin. And we come in a variety of shapes – discs, rods, spheres.

We participate in everything Joe does. He lifts a suitcase and thinks his arm is doing the job. Actually, it’s invisible muscle cells, contracting. Let him ponder which necktie to wear; it is brain cells that do the pondering. Or he shaves his face: nerve and muscle cells perform the entire operation. For that matter, the facial hairs he chops off were produced by other cells.

My task as a rod cell in the eye is to catch faint light – say the twinkle of a star – amplify it and change it into an electrical signal, which I then send to Joe’s brain. If enough signals arrive, he “sees” the car.

Since each of us 250 million rod cells in Joe’s eyes contains 30 million molecules of light catching pigment, we naturally use a lot of electricity. To generate it, I have some thousand mitochondria – super-minute, sausage shaped power stations that burn fuel (sugar), produce electricity and leave “ash” (water and carbon dioxide) behind. In this complex chemical process they synthesize a substance called adenosine triphosphate – ATP for short. It is the universal power source for every living thing, from rhubarb to clams to man.

When there is need for energy – to make the heartbeat, to expand the chest in breathing, to blink an eyelid – ATP breaks down into simpler substances, releasing power as it does. As long as Joe lives, there will be this call for energy and ATP. Even in deepest sleep there is a torrent of activity –cellular furnaces burning to keep the body warm, brain cells discharging electricity to make dreams, heart cells pulsing to keep blood flowing. The breakdown (and building up) of ATP is constant.

 All of us cells have mitochondria, with one notable exception: red blood cells. Since they do no manufacturing and are swept along by the bloodstream, they have no need for power.

Perhaps the ultimate wonder among cells is the female egg, as in the body of Joe’s mother. Once fertilized, this single cell divides over and over until there are the two trillion cells of a baby. Phenomenal as such multiplication is in itself, the truly striking thing is the enormous amount of information stored within the fertilized egg. That tiny fragment of life contains the blueprint for building that complex chemical plant, the liver. It stores enough coded information on hair color, skin texture, body size. It knows just when to shut off growth of a little finger. Even at the outset, it knows approximately how bright Joe may be years later, what diseases he might be susceptible to, and his general appearance.

How does one tiny egg (they are all about the same size in the mammalian world) know how to make a whale, another rabbit, another Joe? This gets us to that miracle stuff of creation, DNA –deoxyribonucleic acid. The dictator of all us cells, it tells our cellular components how to behave, what to manufacture, what to seek, what to avoid.

My DNA can be compared to an architect whose job is to draw up the grand design for living. But it hands the work over to contractors – RNA, ribonucleic acid. In the form of molecules, all information is printed on the interlocking twin spirals of DNA. “Messenger” RNA snuggles up to DNA spirals, gets a blueprint of what is wanted. Then it passes the word along to another form of RNA, “transfer” RNA. And the latter starts to work according to the instructions – most likely building one of the hundreds of proteins in Joe’s body. It takes the 20-odd amino acids that proteins are made of, and strings them together like beads in a specified pattern. The result may be a pulsating muscle cell for Joe’s heart, a contractile leg muscle that permits him to walk, or whatever the DNA ordered.

Surprisingly, the DNA in the rod cells of Joe’s eyes contains all the information needed to produce a complete baby! The DNA in an ear cell could theoretically construct a foot. We don’t do these nonsensical things because in each of us, large portions of the DNA template are blocked out. My DNA makes rod cells, nothing else.

The cellular division that created Joe continues throughout life. Each second, millions of cells die – and millions are born, by the process of old cells pulling apart, each to make two new ones, exact duplicates. Fat cells, large storage bins, reproduce slowly. But skin cells reproduce every ten hours. One notable exception to this constant replacement is the brain. The moment Joe was born he had his lifetime maximum number of brain cells. Worn -out, damaged ones keep dying; they are never replaced. Yet Joe’s initial surplus was so great that he scarcely notices the loss.

We cells manufacture upward of 600 enzymes – most remarkable substances. On orders from RNA, these master chemists instantly and effortlessly synthesize proteins – taking protein from a piece of fish, breaking it down into its components and rearrange the amino acids to make the human proteins needed for, say, Joe’s thumbnail. Cellular enzymes also build bafflingly complex hormones and disease fighting antibodies, and perform many tasks beyond the capabilities of the world’s most gifted chemists.

Just as remarkable as our internal structure is our external wall. My membrane is a bare 0.0000001 millimeter thick. Until very recently, scientists thought of this gossamer covering as little more than a kind of tight cellophane bag. Thanks to the electron microscope, they now realize that it is one of the most important components. Acting as a gatekeeper, the cellular membrane decides what shall be admitted, what excluded. It controls the cell’s internal environment – keeping in exact balance salts, organic materials, water and other substances. Life is absolutely dependent on this.

Which raw materials are wanted for protein manufacture? The membrane admits the right one, excludes others. Obviously it has a sophisticated recognition system.

Each of us carries an identification tag, recognized by other cell membranes. Any foreigner or intruder is simply chased away

from our individual colonies. Imagine what would happen if we tolerated strangers. A hair cell might wander into my area and hair would soon sprout from Joe’s eyes. Warts might grow in his kidneys, liver cells on his eyelids.

The membrane also seems to have a communications system to talk to other cells. How it functions I don’t know – enzymes again, maybe? Anyway, if you take heart apart, separating it into individual cells, those cells will pulse at random. But soon they will be beating in unison again. Somehow how the word gets around.

Hormones are also part of the communications system, acting as chemical messengers. For example: Joe’s blood sugar starts rising. His pancreas steps up production of insulin, the hormone that says, “Speed up burning of sugar”. The bloodstream carries this work order around and the cells respond. Or, Joe may decide to chop some wood. He will need extra energy. In this case, his thyroid sends the hormonal work order to cells: “Speed up production of ATP”.

Our great enemies are the viruses. These pesky little parasites have no mitochondria – they are unable to produce their own power for living. From time to time, our membrane guardians fall down on the job and a virus penetrates a cell. With power now available, these terrors start reproducing. Overwhelmed by virus particles, the unfortunate cell perishes. Then the released virus attacks other cells. In even the mildest virus infections, millions of cells perish. If it were not for a variety of body defenses, the viruses would take over, and Joe wouldn’t be long for this world.

Perhaps the story of cells can best be summed up by saying that we are where it all takes place –everything from Joe’s beginning to his end. How 60 trillion of us can live in harmony – each minding his own business, efficiently performing his own tasks – is something to contemplate. It is a wonder. Maybe it is the supreme wonder.