Hemo the Magnificent

“FOR THE LIFE OF THE FLESH IS IN THE BLOOD.”
LEVITICUS 17

HEMO THE MAGNIFICENT

STARRING
RICHARD CARLSON AND DR. FRANK BAXTER

PRODUCED BY
FRANK CAPRA

“Oh, Doctor, I know you keep explaining to me that this is a picture of a heart, but how...

- Hey Jim! Jim! Come on now, let’s get cracking with this. Look.
- You know…
- This is the film for my science screen. Take care of it and keep it in focus, will you?
- Yes, okey dokey, Doc, but I wanna ask one little…
- All right, guys; let’s get set for a rehearsal.
- Yes. One…
- Everything works this time boys: science screen, magic screen, music effects. My magic screen film all set up, Jim?
- Well, the screen is ready.
- And so is the imagination so, get lost.
- Fiction and science, that’s a pretty good team. Say, what’s the big show about today?
- Hemo the Magnificent.
- Who-mo?
- Hemo. That’s Greek for blood.
- Oh, blood! Blood? Well, don’t get any on you.”

“Doc, I think we’re just about all set. So I’ll open the show on the magic screen. Wait till you see what I’ve got dreamed up.

Come on, magic screen!”

“Hey! What’s going on here? Hey! You guys, there’s people.
Fellows, everybody, we got people!

- Er, two-legged people?
- Yeah, yeah!

- Have they got guns?
- I don't know.
- Are you… you guys, hunters?
- No, no, television show. We're gonna do the story of Hemo the Magnificent.
- A show about Hemo?
- Well, Hemo is our king.
- Hemo, come! Hemo! Hemo! Hemo!
- Oh, here he comes!
- Hi Hemo!
- Hi, gang! *Shalom aleichem*!
- *Aleichem shalom.*
- Hey, Hemo!
- Humans!
- Yeah, they're doing a show about your life.
- Oh, th…this is Doctor Research, a scientist and I'm a writer and, and…
- You can't tell my story. Humans think blood means disease, wounds, pain. These friends, they know me for what I really am: health, life. I'm the song of the lark, the flesh on the cheek, the spring of the lamb. I am the precious sacrifice ancient man offered up to his Gods. I am the sacred wine in the silver chalice. Down through the ages, I am the price men pay for freedom. But to you, scientists, I'm a smear on a slide, a stain, a specimen, a sickness. My story is a song only poets should sing, not disease lovers. Come on, gang.
- Okay, yeah, let's go.
- Yeah! Come on, let's go.
- No, just a gosh, darn minute, you, you Hemo hot-stuff.
- Hmm.
- Men like Doctor Research don't study disease because they love it. Tens of thousands of doctors and scientists, nurses, technicians work night and day to create health. They've saved millions of lives: mending bodies, relieving pain, fighting disease, not by witchcraft, and instinct or, or poetry, but by experiment, observation, knowledge about you, picked up piece by piece the hard way, with their smears and their stains and their microscope. You, you… drip!
- Well, bless his little blood pressure. The writer man made a speech.
- What am I doing blowing my top to a cartoon?
- You invented him.
- Well, I, I goofed! All right, back to the woods, comics! We need you like a bloody nose.
- One moment, boy. What's the purpose in telling my story?
- Mister Hemo, the spirit of man seeks truth through many avenues. The artist seeks it through creative expression, through beauty, music, form, the laws of harmony. The religious, through spiritual revelation, through the power of prayer, love, mercy, moral laws. And in science, we seek it through the study of nature and its physical laws.
- Yeah, and to us, it's as fascinating as any poetry.
- Hmm. I may listen.

- Roll 1.
- If I can stay awake.
- Man's fascination with you, Mister Hemo, goes way, way back into our dim past. Probably back to prehistoric times, when man discovered he could defend himself better with a club than with his hands.
  Or, that he could kill certain foods he couldn't catch on foot by throwing rocks.
- That's men, all right.
- Yeah, yeah, it's men.
- Death, food and blood, the primitive imagination began to stir. Blood was life. Some early genius even discovered that blood would make his sick vegetables lush and green again, not knowing it was a fine natural fertilizer.
- No wonder ancient medicine men attributed magical powers to blood, and cooked up weird mixtures of it for curing the sick."

BARBER AND SURGEON
BLOODE-LETTING

"Matter of fact, as recently as Shakespeare's time, blood and its circulation continued to be a, a dark and fearful mystery.

- Then came the first great light."

THE HEART BULLETIN

"That light was William Harvey, 1628. This English pioneer of the scientific method – using only his eyes – observed and proved everything about circulation,"

FIGURA 3.
FIG: 4.

"except the tiny capillaries which are too small to see without a microscope, although he did predict their presence.
Your circulation, Mister Hemo, is now completely observed and proven. This chart will help explain it."

ANATOMY

CHART NO. X. VASCULAR SYSTEM

HEAD
1. ARM BONE
2. WRIST
3. SACROILLIAC
4. SHIN
5. FUNNY BONE

6. L. WRIST
7. ETC.

“Behold man, the great brain! It took him some fifty thousand years to discover me and the circulation. And it will take him another fifty thousand years to explain it with that crazy mixed up chart of some moron’s innards.

- Hey, who’s the guy full of red spaghetti?
- Must have swallowed the inside of a television set.
- You laugh, eh! I’m funny chart, hung on wall, no name, no soul, eh? Stupid people! I have name, I have soul: the great Professor Anatomy. You listen to Hemo, eh? Poet yet.
- Oh, well.
- Without my delicate machinery of circulation I built for you, you are just fertilizer.
- Oh, yes. You’re the plumber! Back on the wall, mechanic. What good is your plumbing without my richness flowing through it?
- Oh, wait a minute, wait a minute! I like Professor Anatomy. Plumbing I might understand.
- Yes, you might.
- Is beautiful, is simple. Science makes a big deal from it. Look! Two bulbs, rubber, like garage men fill battery with. I fill with red stuff, blood maybe, is not important. I glue together, side by each. Now, I take tube from right one, make big loop and stick in left bulb so. Same way, left tube into right bulb so. Everything full of liquid, understand? Now, two little musclemen. One on each bulb and we are ready to circulate. Little muscles, push!
  What’s the matter? Push!
- Something’s wrong. Nothing goes round.
- That’s right. But Professor got imagination.
- Hmm.
- Watch! Here, in the front door, I put in little reception room. One here, one here. Between reception room and main living-room, I put one-way doors: should only ‘in’ open. Where you go out from living-room, I put another one-way door: must only ‘out’ open. You come in front door, reception room, living-room and out. Can’t come in back door. Everything one way, see? Same way other living-room. Is duplex house, yes? Is genius, no?
  Now, two small musclemen to push on reception rooms and… Ready muscles?
- Roger.
- Like prizefight. One, two, push! Goes round now, no? This pump is the heart. See the little doors work? The valves of the heart. Reception rooms fill up while living-rooms pump out. Is simple, yes?
- Is simple, yes! But what about the lungs, the veins, the…
- Oh, details! You want lungs? Okay! Halt!
  Little balloon, see? Now, I put balloon inside another bulb so. Is lung. And I cut top loop and put in lung so. Now, lung is not pushing–out-machine, is sucking-in-machine. So we put two pulling musclemen on the lung, and the nose up here. Now,

muscles, pull! See? That is lung. A one-balloon lung. You got million balloons in your lungs. Little air sacks. But one air sack, billion air sacks, works all the same. Halt! Now, listen to my genius. I make this little balloon so thin gas can pass right through it."

GAS
LIQUID

"But liquid no. Ain't that something?
So now we bring the blood, pardon the expression, inside lung, make it flow around little balloon and go out. Now, slow motion, inhale. What happens? Oxygen comes in balloon, passes through my thin wall into the blood, making it bright red. The blood coming to the lungs is dark because is weak in oxygen. Instead, is full of waste gas – carbon dioxide – which passes though my thin wall into the balloon. Exhale! CO_2 goes up through and out exhaust pipe, the nose.
Now, without stopping, inhale! Exhale! Isn't that sensational? But this is just lung circulation. Down here is body circulation. So we cut and put in body. What is body? Is motor, living engine: man, woman, cat, fish, any animal is motor. What is making motor run? Air, fuel. Air is coming from lungs already. Fuel is simple: you eat. Food has carbon – fuel – like coal. But food is needing refining, digesting. So, for digesting, is stomach. For refining into high (...) and storing is liver. So now, oxygen from lungs, carbon from liver is going into motor, here. And is burnt into carbon dioxide, ashes and energy."

CO_2
ASHES
ENERGY

"Energy, body is using for working, thinking, playing Gin rummy."

TAXES
DEDUCTIBLE?
SHORT FORM?
LONG FORM?

CO_2

"Carbon dioxide, blood is taking to the lungs and out exhaust pipe, the nose. The ashes, oh! My beautiful garbage disposal: the kidney. Only five ounces this jewel but it cleans out all the ashes, garbage and trash from the blood. For this, I should two Nobel prices get. I…
Oops! Excuse it, please, Doctor.

- Get back in the chart, Professor."

ANATOMY

CHART NO. X. VASCULAR SYSTEM
HEAD
1. ARM BONE
2. WRIST
3. SACROILLIAC
4. SHIN
5. FUNNY BONE
6. L. WRIST
7. ETC.

"Y…yes, Doctor.

- Coal, motors, ash cans; he drives us crazy around here."

"So… That's science. Isn't that sensational? Let's go, fellows!

- Yeah!
- Yeah. Go! I really goofed with you guys.
- Oh, I liked the part about the funny heart bulbs.
- Mister Turtle, have you ever seen your heart?
- Me? No! Oh, I've never even seen my tail.
- Roll six.
- What are you doing, Doc? Let him go!
- It's all right! Watch.
  Mister Turtle, here is your heart.
- Well, doggone! Look at it go!
- Gosh!
- Oh!
- Look at that one!
- Yeah!
- And here is Mister Rabbit's heart.
- Oh, wow!
- How about that!
- Here is Mister Bird's heart.
- Great! Mine goes faster than the others!
- That's because you're small, Mister Bird. Small animals lose heat faster than large ones, so their blood must circulate faster to keep their bodies warm. Now, on small birds, their hearts beat about 600 times per minute. Cats: 130. Man: about 75. And a big old elephant's heart: only 25 a minute.
- Hey Doc, you got a human heart?
- Has he got a human heart? Wait till you see this.
- Roll 10.
  Physiologists have photographed, studied, analyzed... Hey, roll 10!
- There'll be a slight delay. Looks pretty good so far though."

"How about it, Jim, ready with 10 yet? Okay Doc, tell him about the human heart.

- Physiologists have photographed it, analyzed it, taken it apart, piece by piece, and it's still a mystery to us.
  Now, here's a human heart. One of Nature's masterpieces. This tireless organ the poets sing about, this seat of love and compassion weighs only about three fourths of a pound. But the work it turns out is almost incredible.
  How long would you say that it takes your heart to pump a quart of blood? Just standing around like this?
- A quart? Oh, couple of minutes, I guess.
- You're way off. Normally, the heart will pump a quart of blood in just about 10 seconds."

TEN SECONDS

"In ten minutes, it would fill the gas tank of your car."

TEN MINUTES

"And in ten hours, it would fill a gas truck."

TEN HOURS

"Just ten days, it could fill the average home swimming pool."

TEN DAYS

"And in ten years, in ten years, this living pump – only as big as your fist – would completely fill two ocean-going oil tankers."

TEN YEARS
8 MILLION GALLONS

"Holy smoke!
- I don't believe it.
- Neither do I.
- Astonishing but true. Now, watch this amazing little pump in slow motion. Your heart's the strongest and toughest muscle, about as big as your fist – or your paw – and it weighs less, but it does as much work as all the other muscles put together. And it never gets tired."

"Well, what makes it work, anyway?
- You mean the heart? What makes it beat in the first place? Well, we don't really know, do we, Doc?
- No, we don't know. We can't consciously make it stop or start. But we know something about what makes it go faster, or slower. Remember Professor Anatomy's

heart with the four rooms and the four little muscles? This muscleman that works the right auricle is the boss man. Through nerves, like telephone wires, he's connected directly to the headman in the lower brain."

THINK

"And in turn, he controls the other three muscles with telephone lines of his own. He sets the pace. That's why we call him the pacemaker.

- One, two. One, two. One, two. One, two. One, two. One, two.
- One wire, the sympathetic nerve it's called, carries the 'go faster' signal.
- Faster! Faster! Faster! Faster! Faster! Faster!
- It's been referred to as the 'whip' or the 'giddy-up' nerve.
- Faster! Faster! Faster!"

THINK

SYMPATHETIC NERVE
FASTER FASTER FASTER FASTER FASTER FASTER FASTER FASTER FASTER

"The other, the vagus nerve is the reins, or 'whoa, slow down' wire.

- Slower! Slower! Slower! Slower! Slower! Slower! Slower!"

VAGUS NERVE
SLOWER SLOWER SLOWER SLOWER SLOWER SLOWER SLOWER

"Emotional excitement, like watching a prizefight, or having an argument, or falling in love stimulates the 'giddy-up' nerve.

- Faster! Faster!
- The pacemaker speeds up the heart beat.
- Faster! Faster! Faster! Faster! Faster! Faster! Faster! Faster!"

FASTER FASTER FASTER FASTER FASTER FASTER FASTER FASTER FASTER FASTER FASTER

"On the other hand, rest or sleep brings the 'whoa, slow down' vagus nerve into action.

- Slower! Slower! Slower! Slower! Slower! Slower!"

SLOWER SLOWER SLOWER SLOWER SLOWER SLOWER

"A lie detector is based in part on changes in the heart rate due to emotional stresses under questioning.

- Hey, would you look at that!
- And another most important automatic control of the heart rate is for the protection of our brain.

- Oh, wait till you get this! This will really be news to you.
- The brain cells have priority over everything else when it comes to blood supply. If pressure in the brain is too high, it might rupture small blood vessels, damaging or killing some of the brain cells, which could result in a stroke. And if the pressure is too low, the brain isn't getting enough food and oxygen, fainting occurs.
  To maintain a constant blood pressure to the brain, there's a beautiful little device called a barostat, which controls pressure just as a thermostat controls heat. If pressure increases, it sends a message to the reflex center in the brain."

THINK

LO – OK. – HI
ZIPPY COMICS

"Pressure going up!"

THINK

"Roger. Slow down, pacemaker! You want to kill us?
- Nuts! Relax fellows, dupe. One, two. One, two. One, two.
- Pressure too low!
- Speed up! You want to starve us?
- Make up your mind! Pick it up, fellows. One, two. One, two. One, two."

"Actually, there's the… Let me show you. Come over here and lie down, will you?
- Oh, yeah.
- Er, actually, this little pressure governor in our necks, right here – one on either side –, this little pressure governor, for the discovery of which Dr. Corneille Heymans of Belgium received the Nobel Prize… This little governor keeps us from fainting when we suddenly stand up from a sitting or lying down position. As we stand up, gravity pulls the blood downward into our legs, reduces the blood pressure in the brain. But the barostat instantly increases the heart rate to help build pressure back up to normal.
- You mean just standing up on my hind legs makes my heart go faster?
- Yeah, for a few seconds it does.
- I don't believe it. Squat! Stand up!
  He's right! It does go faster.
- What did I tell you?
- Yeah, but my heart beats fast sometimes when I don't move. Like when I hide from a lion.
- Well, that's different. That's caused mainly by another kind of message to the heart. A hormone.
- A what?
- Well, a, a hormone. It's produced by the adrenal gland, a sort of chemical messenger that travels in the blood.

- Er! This may give you an idea. Er, roll 13."

LION! LION! LION! LION! LION!

"Light waves flash 'Lion!' to the deer's eyes, the eyes flash 'Lion!' electrochemically to the brain. And the brain sounds the red alert.

- Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion! Lion!"

LION! LION! LION! LION! LION! LION! LION! LION! LION! LION! LION!

LION
THINK

"General quarters, lion!"

LION

"Down the nerve goes the mobilization ordered to the adrenal gland. The adrenal gland shoots out a chemical messenger into the blood stream and he takes the message to the heart."

VITAMINS
SUGAR SUGAR

URGENT

"Get going! Lion!

- Oh, drop dead. Relax fellows, a lion. A lion! Get going! One, two. One, two. One, two. One, two."

"We've got a lot of little messengers like that running around in us, haven't we, Doc?

- Oh yes. Chemical regulators, we call them. When we experience fear, anger, worry, disease, any kind of stress.
- You left me with a lion!
- Saw you hiding, huh.
- Hmm, but I thought he'd hear my heart pounding.
- Yeah, mine too. I think I've swallowed a drum sometimes.
- So what makes that 'boom-boom' sound, Doc?
- Well, that's the heart's sounds. We call them 'lubb-dubb'.
- Jim, roll a 'lubb-dubb' reel, will you?"

LUBB LUBB LUBB LUBB LUBB LUBB LUBB LUBB

“The ‘lubb’ is a vibration caused by the contracting ventricles and the slamming of the front doors, these valves, here. The second sound, the ‘dubb’ is the sound made by the closing of these two valves, the slamming shut of the two back doors, as Professor Anatomy might say.”

LUBB DUBB, LUBB DUBB, LUBB DUBB, LUBB DUBB, LUBB DUBB, LUBB DUBB, LUBB DUBB, LUBB DUBB

“Here’s how these valves work in a real heart. As photographed by Doctor Karl Klassen of Ohio State University. *Lubb, dubb. Lubb, dubb. The beat of life. The oldest rhythm. It beats in babes before they’re born. It beats in eggs, before they’re hatched, in creatures huge or microscopic. Nature beats creation’s rhythm.”*

NORMAL
EPINEPHRINE

“Mystery and the wonder of life. It beats in hearts completely removed from the body. It even beats in pieces of this ‘never-say-die’ muscle, such as the courage and integrity of your heart.

- Gee! Hearts has got guts, ain’t they?
- Hmm.
- Sure have. I got two of them.
- Two hearts?
- I can feel another one right here in my foot.
- No, no, that’s your pulse, ninny.
- My what?
- Your pulse! The, you know, the thing they take when you’re… well… You tell them, Doc!
- What you feel is your blood spurting through you artery.
- Oh, oh, more plumbing. Let’s go!
- Oh no, Hemo. This is fun.
- I’m learning something.
- Hey poet, you’re losing your fans.
- What’s an artery, Doc?
- You see, from the heart, the blood is pumped to every inch of the body through strong elastic tubes we call ‘arteries’, sending traveling waves of surging blood through them, which we feel as pulse. Now, here’s the main artery. The aorta, it’s called. A big one-inch freeway through which all the blood leaves the left side of the heart under high pressure.”

AORTA

“As almost everybody knows, the aorta branches out into smaller freeways: first, to the heart itself, and the brain, arms, stomach, down to the legs and so forth. And these freeways branch out into hundreds of miles of smaller one-way streets and alleys, until they get so tiny you can’t see them with a naked eye.

The blood starts fast at the heart and slows way down at the end of the microscopic arteries. Beyond this dividing line, the tiny arteries become tiny veins which are much thinner and less muscular because of much lower pressures: almost a mirror image of the arterial flow away from the heart.
Now, the important news about veins is the one-way valves inside them, which allow blood to flow toward the heart but snap shut and stop any flow away from the heart. Now, when we lie down, there's enough pressure left at the end of the arteries to push the blood back to the heart through the veins. But when we stand upright, the veins in the lower part of the body need outside help to push the blood uphill. Since the veins are very thin, every time we move a muscle, the contraction squeezes the veins near that muscle. And since the blood can only go one way because of the valves, the muscles squeezes it on up toward the heart.

- Isn't that something?
  Every time you move an arm or a leg, or even make a face, you're squeezing veins and helping to get blood back to the heart. Isn't that it, Doc?
- That's right."

STATE

"That's, that's why you stretch after sleeping, to squeeze veins and get the circulation into high gear for daytime activities. That's why soldiers who stand at rigid attention for a long time often faint, keel over. Lack of muscle movement causes blood to, to collect in their legs, cutting down the necessary supply to their brains. That's why it's less tiring to walk than it is to stand still."

FIT?
CHEW

"That's why your feet swell when you sit motionless for hours in a plane. Th..., that's also why people who spend a great deal of time on their feet, sometimes have trouble with their leg veins. The constant weight of blood distends the leg veins so much the check valves pull apart and let the blood leak back down.
Ever since I learned this, I make a point of sitting down, putting my feet up every chance I get. Hey Doc, not to change the subject, but where does this magnificent Hemo do most of his work? In the veins or in the arteries?

- He does no work at all in the veins or the arteries.
- Well, where does he do it?
- Oh, that's a good question. But before I can go into that, I'll have to tell you something about blood itself.
- Just a moment, Brother Scientist. So far, your chatter on plumbing has been, er, elementary, but harmless. But now that you've come to me, I refuse to listen further unless you first describe me in just two words.
- I can!
- Never mind! Professor? Mention the two key words and I'll know you understand the poetry, the mystery and the true meaning of blood. Otherwise, back to your plumbing.

- Hey Doc, he's trapping us. Do you know what the two words are? Oh, you do?
- The two words that best describe you and connect you with the mystical origins and traditions of life are: 'sea water'.
- Sea water?
- What a square!
- Quiet! Brother Research, my apologies.
- You mean he's right?
- Listen to this learned man and you'll hear a real tale.
- Sea water.
- Doctor, please, tell them who I am.
- Well, thank you, it's only a theory, of course.
- This I got to see.
- But if you squeezed the human body as you would a sponge, you'd squeeze out some 30% of the body weight as about 6 gallons of free water, which we shall call 'body fluid'. This squeezed out body fluid has a salt content of 1%. Tropical sea animals might exist in this aquarium of body liquid."

BODY FLUID
SALTS 1%

"Now, the salts in sea water are like the salts in body fluid, as you can see, although sea water today is two or three times saltier than body fluid."

SEA WATER		BODY FLUID
80%	SODIUM	80%
4%	CALCIUM	4%
4%	POTASSIUM	4%
2%	MAGNESIUM	10%
10%	OTHER SALTS	2%

"Some biologists account for this difference by saying that body fluids today represent the less salty composition of sea water, as it was nearly 400 million years ago, when life emerged from the sea and began to crawl on land. At any rate, a billion and a half or two billion years ago, life is presumed to have originated in the warmth of tropical waters, as a minute single-celled aquatic organism. Something akin to the tiny living single cell we know today as the amoeba. This shapeless jellylike primeval cell absorbed its food and oxygen directly from the sea and passed out its carbon dioxide and other wastes to the warm ocean. In the beginning, Hemo was the sea!

- Please, please!
- Time crawled in those days. There's been life on this planet for at least a billion and a half years, yet for hundreds of millions of those years, life is supposed to have existed as separate one-cell microscopic water animals. Then, something wonderful happened, obeying a great plan not given to us to know. Groups of these cells came together to live as colonies and new animals were born.

But just as the early American colonials gathered in colonies behind stockades, yet each fed and clothed himself independently, so did the early colonial cells exist independently. They hadn't learned to specialize yet and each cell in these primitive organisms had to have individual contact with its great provider, the sea. Consequently, no little sea animal could be more than two cells thick in any of its parts. That stymied their growth for a long time. The hydra, one of those early cell groupings, was Y-shaped, two cells-thick, and had an opening or primitive mouth through which the sea water could flow in and out to bathe and feed the inner cells."

MOUTH

"That was the crude beginning of internal circulation. Just as the early colonials specialized for the good of the community, some becoming carpenters, blacksmiths, weavers, while others raised the food, so did the cells in primitive sea animals begin to specialize: some in telling others what to do became the brain, others in building and became bones. Those interested in feeding became stomachs, while still others organized themselves into a pump and a closed circulating system to bring the precious fluid to the cells that were too deeply embedded in the body to have direct contact with the sea. New organisms could now be more than two cells thick. And they grew fast. About 400 million years ago, the first fish took form: thousands of cells thick with a simple circulation system which is still in fish today.

- Come here, come here! Look!
- A low-pressure, two-chambered heart with one ventricle, one auricle and one slow circulation which pumps blood – a specialized form of sea water – up to the gills for oxygen and directly to the body cells."

VENTRICLE
AURICLE
GILLS
BODY

"Because their blood is cooled by outside water surrounding the gills, fish are cold-blooded, that is their bodies have the same temperature as the water they swim in."

60°
ALSO 60°

"When, for some reason known only to God, water animals first crawled out on land, they had to learn to breathe in air as well as in water. So, some of the internal cells organized themselves into a lung through which blood could extract oxygen from air. The lungfish is an early example.

- Yeah, but what about frogs?
- Amphibious animals like frogs, also cold-blooded…
- Come here! Come here! Three chambers.
- … have a three-chambered heart and two circulations.

- Lungs.
- One to the lungs.
- Body.
- The other to the body."

LUNGS
BODY

"But the two circulations are both pumped from one ventricle at medium speed and pressure since the blood doesn't have to regulate their temperature."

VENTRICLE

"But as soon as the heart became a four-chambered pump…

- Look ! Power !
- …two separate high-speed, high-pressure circulating systems became possible.
- Lungs. Body."

LUNGS
BODY

"And land animals could live entirely out of water, at a constant warm temperature, regardless of their surroundings. But these land animals, whether they looked like birds or bears, or baboon, are still composed of billions of cells that have to be bathed, fed, serviced, or as the great French physiologist Claude Bernard put it: 'kept in a constant internal environment in the same way their ancient predecessor, the tiny one-celled amoeba was bathed in sea water.' Only now, land animals have to manufacture their own kind of sea water in the form of blood and other body fluids.

- Now, wait a minute Doc, wait a minute! Are you trying to say that I'm descended from some kind of sea gnat?
- You have a human spirit that separates you entirely from the animal world.
  But there's great mystery and great wonder in the fact that our body – this temple of the spirit – is built of billions of highly specialized individual cells, like minute tropical sea animals that could only live in – well, say – Tahiti. Externally, your address may be in Ethiopia, Tibet, or Kansas City, but internally, we're all basking in the warm waters of the South Sea isles.
  Thank to Hemo the Magnificent, whom the poet Goethe described as that 'entirely wonderful sap!'
- Please.
- Tahiti? Right inside me? Oh, girls, ukuleles. But you know I could sell tickets."

"So, you see, Mister Hemo, bit by bit we've come to know that your job is to play sea water to our body cells.

- Er, excuse me.

- Oh, what's the matter, turtle boy?
- Hemo's big job, he don't do it in the veins and he don't do it in the arteries. So where does he do it? Out in the field?
- Brother Turtle, you're pretty sharp. Now, I can see how you beat Mister Rabbit in that famous footrace.
- Oh, I just…
- All right, but you pay close attention. Believe it or not, Mister Hemo does all his great work in this thin line that separates the arteries from the veins, in the capillaries, tiny little blood tubes, too small to see with a naked eye. You remember, the little primitive sea animals were only two cells thick because each cell had to have contact with sea water? Well, our bodies, they're so crisscrossed with billions of capillaries, that – except in our bones and eyeballs – not one of our cells is more than two cells away from the nearest capillary. In just the tip of your little finger, you have thousands of capillaries. This illustration might help.

  Now, here's the end of one of the billions of tiny arteries, branching off into several capillaries which are surrounded by customers, the muscle cells."

ARTERY

MUSCLE CELLS
CAPILLARY
CAPILLARY
CAPILLARY
CAPILLARY
MUSCLE CELLS

"Passing slowly through, the blood services the customers, then collects in a tiny vein and hurries on back for a new load of food and oxygen."

VEIN

VEIN

MUSCLE CELLS
CAPILLARY
CAPILLARY
CAPILLARY
CAPILLARY
MUSCLE CELLS

ARTERY

“These capillaries are only about one fiftieth of an inch long. And so fine that red cells – only one three thousandth of an inch – have to squeeze through in single file. A bundle of fifty capillaries is still finer than a human hair.”

RED CELL
RED CELL

“The walls of the capillaries are only one cell thick. And it’s through the chinks in this thin wall that Hemo serves his customers with food and oxygen, like a grocery man, and takes out the waste products like a garbage man.”

FOOD
OXYGEN

CO_2
GARBAGE

“Now, a very important key figure in this whole goings on is this little gatekeeper muscle here, in the tiny artery that feeds each of the billions of capillaries. Most of the time, he opens and closes according to the local needs of his alley of customers.”

SERVICE SERVICE

“If they need service, he opens up, lets Hemo come in to do his grocery man, garbage man act.

- Service!
- Service. Service.
- Service! …”

ENOUGH
EEEEENUFF
ENOUGH! ENOUGH! ENOUGH! ENOUGH!

ENOUGH
EEEEENUFF
ENOUGH! ENOUGH! ENOUGH! ENOUGH!

ENOUGH
EEEEENUFF
ENOUGH! ENOUGH! ENOUGH! ENOUGH!

ENOUGH

EEEEENUFF
ENOUGH! ENOUGH! ENOUGH! ENOUGH!

“Service over, he closes down again.

- Enough!
- Enough. Enough.
- Enough!
- Enough! …
- In a muscle at rest, only about one percent of the capillaries are opened up at any one time.
- Service!
- Service! …
- But in a very active muscle, they all open up.
- Service!
- Service. Service.
- Service! …”

SERVICE! SERVICE!

SERVICE! SERVICE!

SERVICE! SERVICE!

SERVICE! SERVICE!

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SERVICE! SERVICE!
SERVICE! SERVICE!

“But Doc, doesn’t Mister Gatekeeper muscle also take orders from the central government? From Mister Big, up here in the brain?

- Yes, sir, through nerves, telephone lines.”

THINK

“In case of an emergency or, if blood is urgently needed elsewhere…

- Will call!
- The brain orders Mister Gatekeeper to stay closed.
- Dispatcher, close down sphincter X315J1O.
- Oh, goody, boss. X315J1O, close your little capillary, or else!
- And Mister Gatekeeper stays closed…
- Service!
- Service. Service.
- Service!…
- Shut up, boss says no!”

SERVICE SERVICE SERVICE SERVICE SERVICE SERVICE SERVICE SERVICE SERVICE SERVICE SERVICE SERVICE SERVICE SERVICE SERVICE

“No matter how loud his local customers yell for service.

- Yeah but if you can’t see the cap, er, capireally, er, how you, er, how you gonna know all this guff?
- Ah, more magic. Roll 16.

  Now, Mister Turtle, these are microscopic scenes of the actual blood flow in live bats, frogs, and hamsters, as taken by Doctors George P. Fulton and Brenton R. Lutz of Boston University and by Doctors Paul A. Nicoll and Richard L. Webb of Indiana University.

  To the sharpest naked eye, all this would be invisible. This is a minute highly magnified artery branching into smaller arteries. The blood still travels pretty fast here and in a moment, you’ll see it slow way down in the capillaries.

  Notice the pulsing flow as the heart pumps Mister Hemo into billions of these ever-branching, ever-smaller microscopic arteries.

  Now, we’re down to the finest of arteries, where you can see the individual red cells, little flat concave disks.

  And branching off, is the tiniest of all blood vessels, the capillary – so thin the blood cells have to go through in single file. Surrounding the capillary are the customers, the, the muscles cells which Hemo services.

  After traveling through the capillary – now, remember, it’s only about a fiftieth of an inch long – Hemo collects in tiny veins, which join up in the larger veins, which flow into still larger veins, as Hemo races back to the heart and lungs for a new load of food and oxygen.

Now, let's get back to the capillaries where the main show takes place. Here's where the magnificent Hemo does his stuff.

Everything else in the circulation system, heart, arteries, veins, are all designed for just one purpose: to take Mister Hemo to and from his work in the capillaries. And here's the key actor in the show: the donut-shaped sphincter muscle. The gatekeeper that opens or closes the capillary on orders from his muscle customers or from the headman in the brain. Here's another gatekeeper. There are billions like him, probably the most important muscle in your body. Yet, you can't see him without a high-powered microscope. Now, watch this when closed down. Huh, service is over. This very choosy gatekeeper is letting the red cells in one at a time. Remember these red cells are so tiny a row of three thousand of them laid flat wise would measure just one inch. Now, watch how beautifully this character controls the number of red cells going into his capillary.

Now, over on the other end of the capillaries in the tiny veins, there's another gatekeeper valve that, well, it's still a big mystery to us.

In dozens of research centers all over the world, scientists are burning the midnight oil, trying to find out why, when and what makes this strange little muscle open and close.

Now, Mister Turtle, what do you think of that?

- Gee, I wish I was a scientist.
- Yeah, Hemo. Why don't you ever show us magic things like that?
- Hemo can't, he's a poet.
- Friends, you might as well know it. The magic of knowledge and reasoning is only for humans.
- Mister Hemo, we only wish it were magic. Nobody's born with knowledge. Has to be acquired with hard work added to and passed on. Every doctor, every scientist, every nurse, student, technician that ever lived has enriched the future by adding his or her two-cent worth to the common fund of human knowledge.

  Few of these people may win prizes but the rest are rewarded with the greatest of all awards: personal satisfaction with their creative work.
- Are you saying science is an art?
- Sure it's an art! Thoreau once defined art as 'that which improves the quality of the day'. Well, what's improved our daily lives more than science, huh?
- What do you do around here?
- Er, me? Well, I, I try to make things easier, I guess.
- If you made things easier for me, you'd live longer.
- He's right.

  Roll 21. Let me show you how right he is.

  We have three main body activities: thinking, eating and moving, represented by the brain, stomach and muscles. Each has its separate blood supply. Now, if all three functions were going full blast at the same time, all the capillaries in the body would be open. To fill them we'd need ten times as much blood, and a heart ten times as big to pump it around. But this would be a big waste, because we don't think, eat and run at the same time.

- Television writers do.
- Yes, but normal people have a wonderful mechanism that cuts down blood flow to parts of the body that are not going full blast, diverts it to the organs and muscles that are working.
  Now, as we've seen, at the end of each of the microscopic arteries, just ahead of the capillaries, there's a small muscle, that acts as gatekeeper or flow-controller."

OPEN
OPEN
OPEN

"Each has his own private nerve line to the brain."

MUSCLES
STOMACH
BRAIN

"Upon orders from the dispatcher in the brain, each of the billions of tiny gatekeepers, here represented by one only, will open or close his own particular valve."

OPEN
CLOSE
OPEN
CLOSE
OPEN

"Now for the open position, which is normal, the gatekeeper muscle just relaxes."

CLOSE

"And when signaled to close down his capillary, the gatekeeper has to apply constant pressure or the valve will spring open.
Now, first, the brain. Whether we're thinking hard, or just day-dreaming, the brain valves are always open."

BORROWED
LOANED
2ND TRUST
DEED
INVOICE
PAST DUE
$1.000.00
NET GAIN
EARN!

INCOME TAX
DEDUCTIBLE
APRIL 15: $998.00
DEPRECIATION
20.000.00
NET GAIN
2ND MORTGAGE

OPEN

“No matter what the rest of the body is doing, these non-replaceable, non-reparable VIP governing cells must be constantly supplied with a rich flow of Hemo, or goodbye body!

- Hmm.
- But if we’re digesting a big meal, the digestive valves open wide, and the muscle valves are ordered to close.”

CLOSED
OPEN

OPEN
OPEN

CLOSED

“Conversely, if we run, exercise, work hard, the muscle valves open and the digestive system is mostly closed.”

OPEN

OPEN
CLOSED

“What about eat-and-run guys, like me? What happens to us?

- Well, several things that are all bad: the brain has top priority but muscles have priority over digestion because muscles mean survival. You fight, you run with them.”

MENU
SOUP
SALAD
SEAFOOD COCKTAIL
FILET MIGNON
NEW POTATOES
ASPARAGUS

BAKED ALASKA

“Suppose you’ve just finished a seven-course dinner, the works. Your abdominal valves are wide open, and about a quarter of your blood is racing through the digestive capillaries, while the muscle gatekeepers get that red ‘Stay closed!’ light.”

OPEN

CLOSED

“Yeah, but Doc, suppose I get up from a big meal and, er, I run or I go swimming or, or suppose my girl insists on doing a fast polka, what then?

- Well, you’ll have a good time, because the brain dispatcher will do his duty, even though he knows you’re off your trolley.”

STOMACH
BRAIN

MENU
SOUP
SALAD
SEAFOOD COCKTAIL
FILET MIGNON
NEW POTATOES
ASPARAGUS
BAKED ALASKA

OPEN
CLOSED

CLOSED
OPEN

“He orders the digestive gatekeepers to close down and the muscle gatekeepers to open up, since they now have priority, leaving the stomach holding the bag with a big meal it can’t digest.”

MENU
SOUP
SALAD
SEAFOOD COCKTAIL
FILET MIGNON
NEW POTATOES
ASPARAGUS

BAKED ALASKA

“For which, it complains bitterly by giving you indigestion.”

PAIN
HEARTBURN
UGH
GAS
ULCERS

“But if the girl’s pretty, it’s worth it.

- You mean they don’t sleep after eating?
- What’s indigestion?
- It means you’re civilized.”

“Doc, since we’re all human, doesn’t our brain dispatcher ever make mistakes in sending messages to the capillaries?

- Oh yes, just as a quarterback occasionally balls up signals. Do you watch boxing matches?
- Er, oh prizefights, sure! Boxing matches.
- The next time you see a knockout, remember that it’s balled-up signals that are doing the knocking out.
- You’re kidding!
- No! A boxer’s blood is mostly flowing through his active muscles.”

OPEN

CLOSED

“Practically no blood in his stomach and intestines. A hard blow to the chin smashes the jaw bone back against the brain dispatch center...”

MUSCLES
STOMACH
BRAIN

“Hey!

- … blitzing communication to the capillaries.
- But what the…
- Things happen fast. The ‘close signal’ to stomach gatekeepers goes dead. They relax.”

CLOSE
OPEN

“Unattended valves spring to normal open position and bingo, about a third of his blood just pours into millions of empty abdominal capillaries. The blood pressure takes such a sudden nosedive that the VIP brain cells pass out from lack of blood.”

BLOOD PRESSURE

THINK

“The fighter loses consciousness, he drops like a log and the referee starts counting.

- One.
- And the crowd goes mad.
- Two. Three.
- If the brain dispatcher gets his wrecked communications straightened out before the count of ten,…
- Four.”

STOMACH

“What a mess! Close down! Close down!

- Five…
- …he frantically signals the abdominal gatekeepers to ‘Close down!’, ‘Close down!’
- Six.”

CLOSE

OPEN
CLOSED

CLOSED
OPEN

“And the blood is quickly diverted back to the brain and muscles.

- Seven. Eight.
- Blood pressure goes up again.”

BLOOD PRESSURE

“Brain cells come to.

- Nine.”

THINK

MUSCLES
STOMACH
BRAIN

“Who hit me?

- Nine and a half…
- And the fighter staggers to his wobbling feet and goes at it again.
- So that’s what happens when the guy I bet on gets flattened. I always thought it was the same as shock.
- No, it isn’t shock, this is knockout. Shock’s different and… Shock, Mister Hemo is one of the many things we still don’t know about you. Some experts think that in shock, our regulating mechanism breaks down under too heavy a stress. Everybody knows that too big a load will make a mule lie down, or a car clunk out, or a fuse blow. Anyway, shock usually occurs when our body is subjected to a sudden and extremely heavy stress, say from a serious injury, or a severe burn, or even during a major operation. We’re pretty sure that in some way, somewhere in the circulating system, a goodly portion of our gallon and a half of Hemo gets trapped and stops circulating. You might say the result’s the same as if one suddenly lost half of his blood. There’s a decrease in blood flow back to the heart, the heart shrinks and the blood pressure goes way down. And the critical brain supply gets so low the brain cells begin to starve, and shortly to die. Millions of people used to die from shock. Today, we save most of them. We may not know the exact cause but we know a good treatment: a quick transfusion with emphasis on the *quick*. A few minutes can mean life or death to the brain cells. That’s why helicopters fly the wounded. That’s why traffic stops for ambulances. That’s why, during an operation on a patient whose blood pressure drops too low, he’s given a transfusion, adding outside blood to raise the pressure up to where the brain cells can remain alive, giving time for the trapped blood to become untrapped, put back into the normal circulation again. These are just a few of the highlights in what little we know of the story of blood and circulation, Mister Hemo. But the unsolved mysteries are legion. A few examples: what is health? How does the body protect itself as a whole? We don’t know. What causes hardening of the arteries, or high blood pressure, or anemia? We just don’t know. Is each person’s blood slightly different from all others? Might be. What is a fever? We don’t know that. And this one’s got us all scratching. An automobile changes chemical energy into mechanical movement by burning fuel and oxygen in its cylinders. Well, a muscle does this too, but how? In living cylinders? And get this for ignorance: how long is life? How long might a person live if his body cells were untouched by disease? A hundred years, two hundred?
- Hmm, they’re all riddles that challenge the spirit of man. And there’re hundreds of others, but the men of science will solve them, Brother Hemo. Some day!
- Sure you will. What better way to love thy neighbor than to heal him? I’ve got my little set job and my little animal friends have theirs. But we’re limited. Man’s not limited. You’re Creation’s favorite, you can imagine, reason, dream, create. You know right from wrong. To use these divine gifts is your job. And all Nature’s waiting to see

how you handle it. You're right, Brother Writer. Research into Nature's mysteries could well become the most rewarding and far-reaching of all the arts. One of your greatest physicists, Max Planck, said that over the temple of science should be written the words 'Ye must have faith.'"

YE MUST HAVE FAITH

"Your great Apostle, Paul, wrote to his new church in Thessalonica: 'Prove all things, hold fast that which is good.'"

PROVE ALL THINGS
HOLD FAST THAT WHICH IS GOOD

"A scientists says: 'Have faith!', a saint says: 'Prove all things!', together, they spell 'Hope'."

HOPE

"Dream big! Take a lesson from your heart!"

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