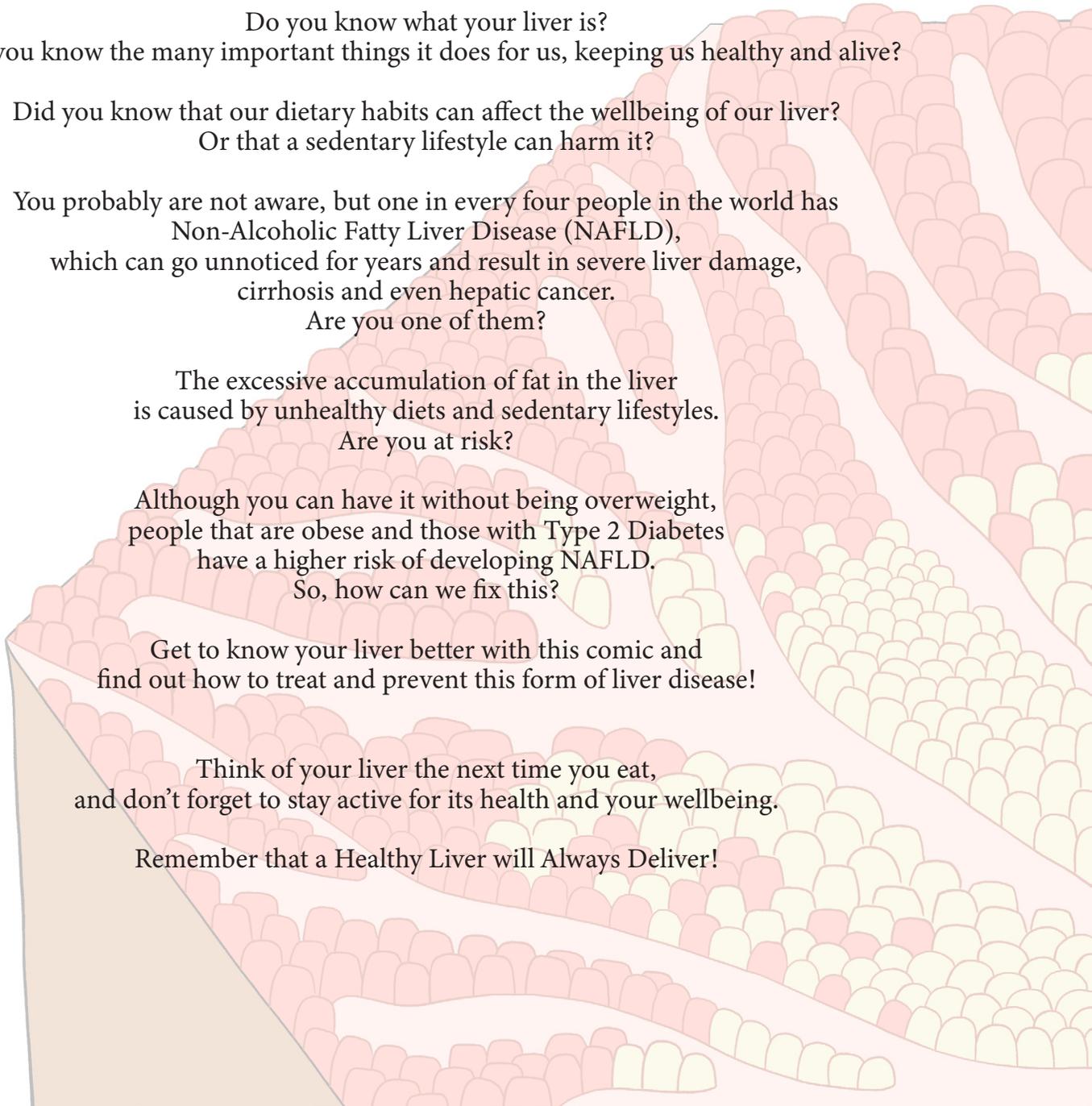


A Healthy Liver Will Always Deliver!

Concept & story: **Mireia Alemany i Pagès** · Script: **João Ramalho-Santos**

Illustration: **Rui Tavares** · A participatory approach with editorial support by **Anabela Marisa Azul**





Do you know what your liver is?
Do you know the many important things it does for us, keeping us healthy and alive?

Did you know that our dietary habits can affect the wellbeing of our liver?
Or that a sedentary lifestyle can harm it?

You probably are not aware, but one in every four people in the world has
Non-Alcoholic Fatty Liver Disease (NAFLD),
which can go unnoticed for years and result in severe liver damage,
cirrhosis and even hepatic cancer.
Are you one of them?

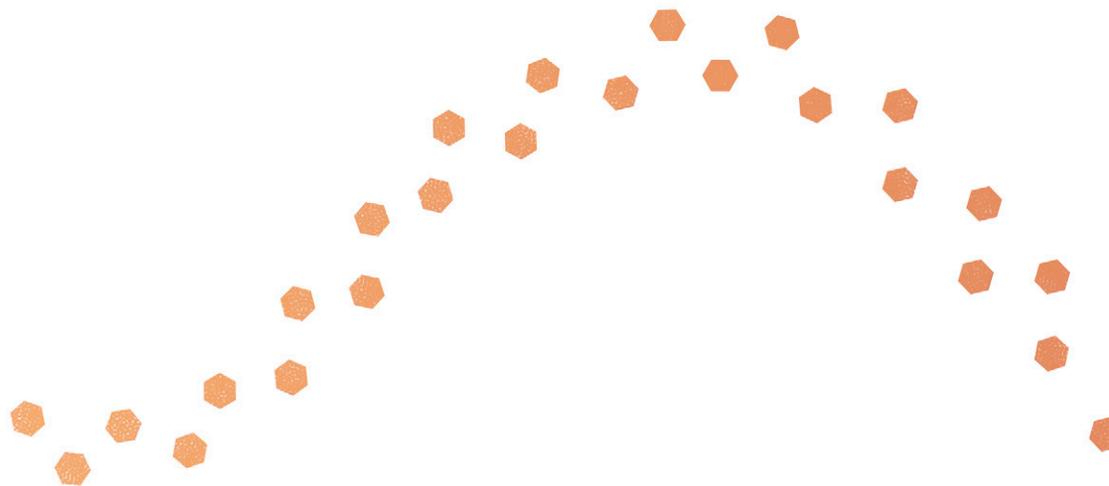
The excessive accumulation of fat in the liver
is caused by unhealthy diets and sedentary lifestyles.
Are you at risk?

Although you can have it without being overweight,
people that are obese and those with Type 2 Diabetes
have a higher risk of developing NAFLD.
So, how can we fix this?

Get to know your liver better with this comic and
find out how to treat and prevent this form of liver disease!

Think of your liver the next time you eat,
and don't forget to stay active for its health and your wellbeing.

Remember that a Healthy Liver will Always Deliver!



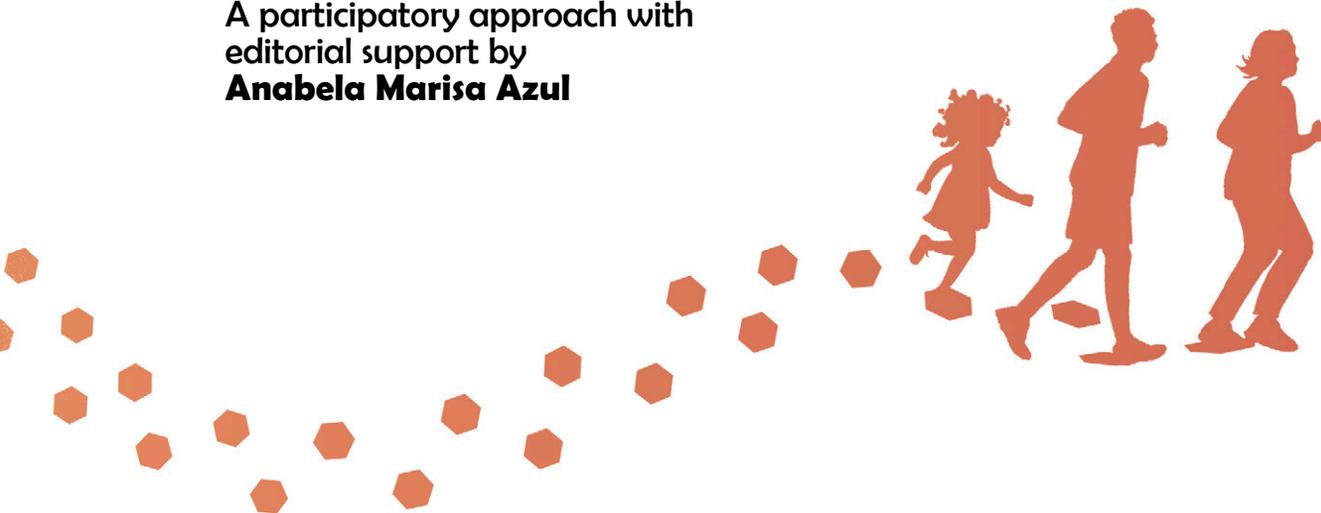
A Healthy Liver Will Always Deliver!

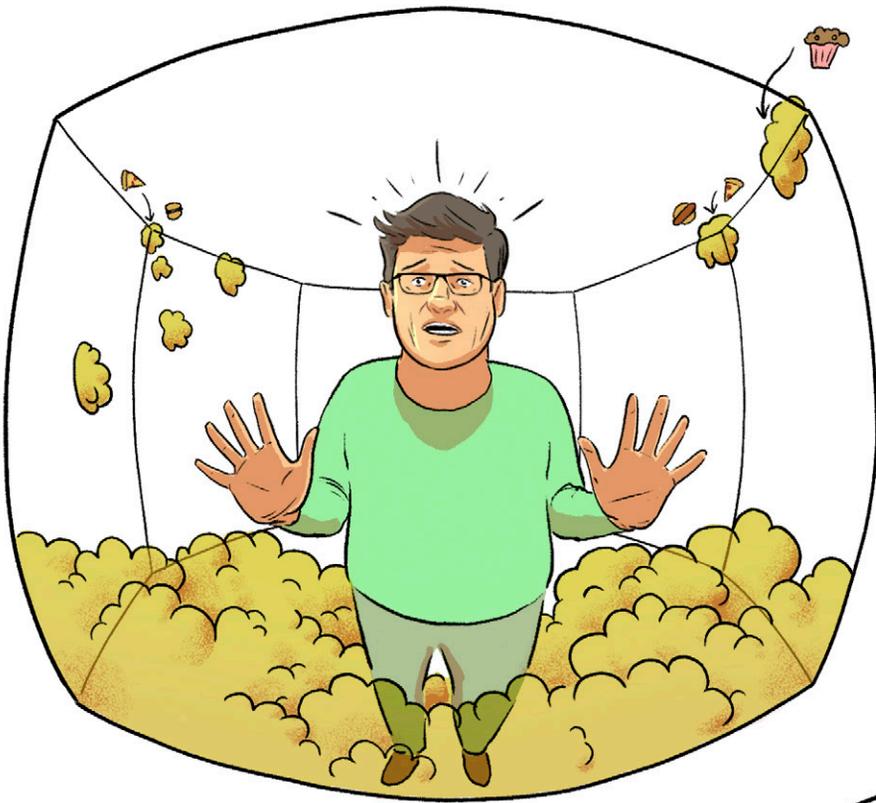
Concept & story
Mireia Alemany i Pagès

Script
João Ramalho-Santos

Illustration
Rui Tavares

A participatory approach with
editorial support by
Anabela Marisa Azul





WHEN WE ARE TOLD WE ARE ILL, WE
LEARN MANY NEW THINGS...THAT AT TIMES,
EVEN SHOW UP IN OUR DREAMS

SO MUCH
BAD BEHAVIOR
IS GETTING YOUR
LIVER FATTY...

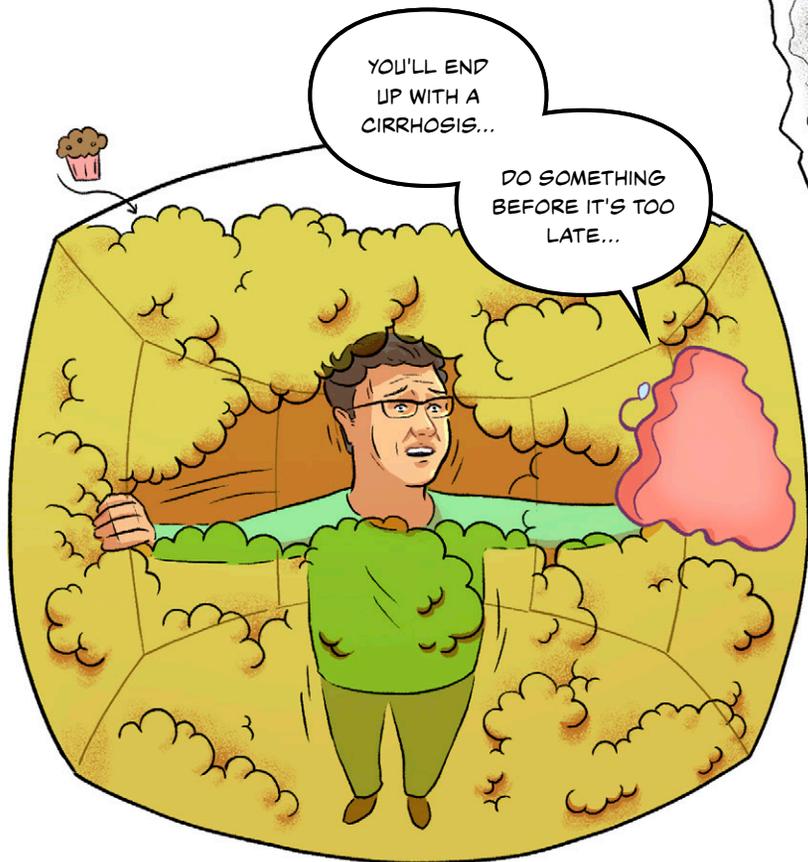


GIVING OUT
ADVICE, WARNING OR
FRIGHTENING US...



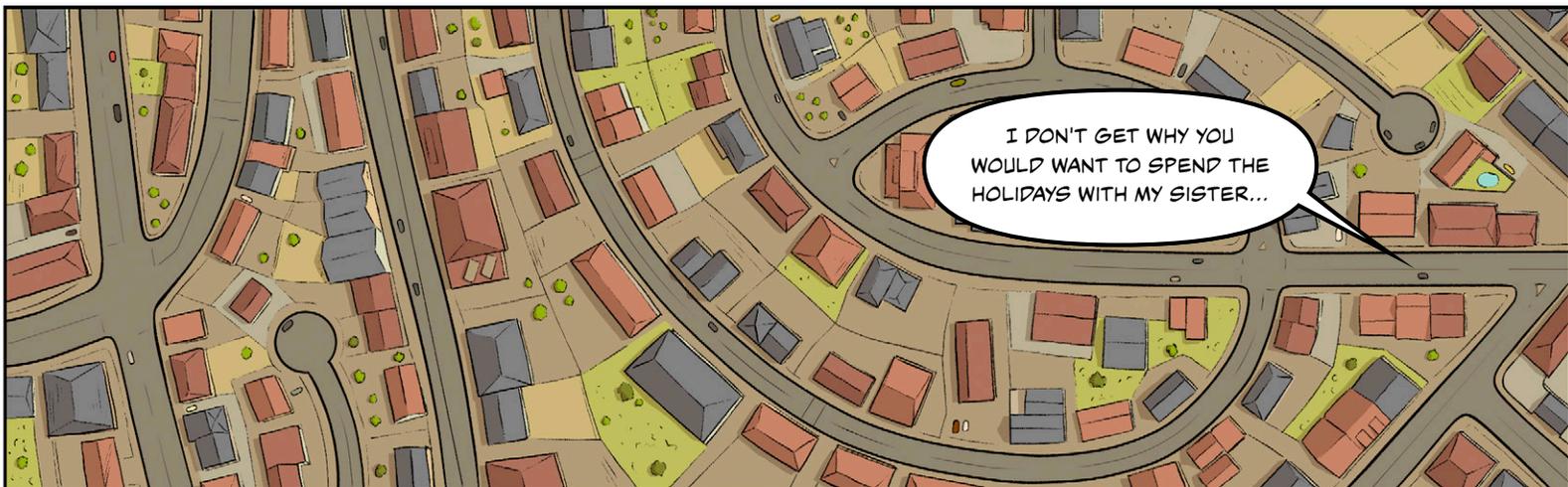
YOU'LL END
UP WITH A
CIRRHOISIS...

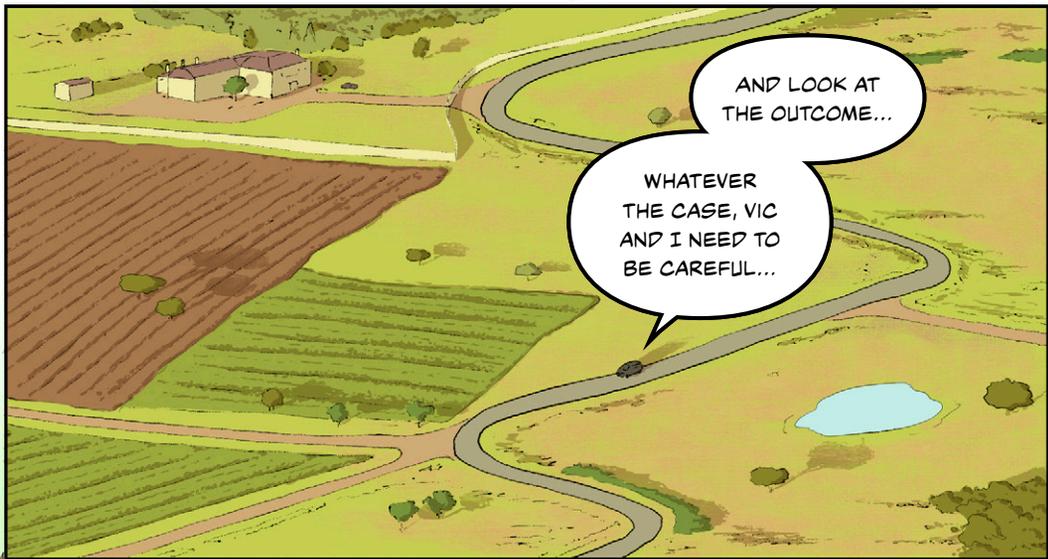
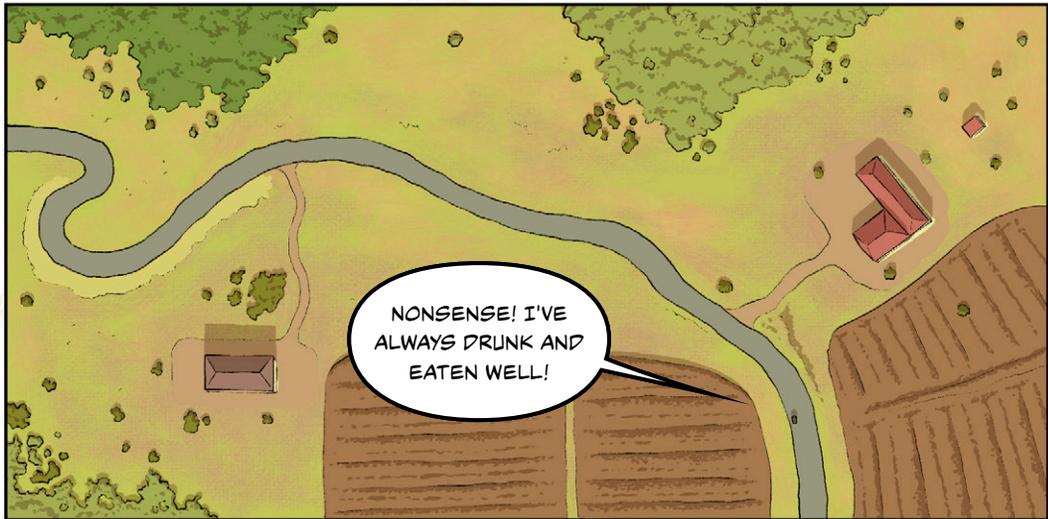
DO SOMETHING
BEFORE IT'S TOO
LATE...



AND
WE MUST
WAKE UP.









HERE
WE ARE!



Dear family,
I went shopping.
Brother: use your key
and get yourselves in...
See you soon!
Alice



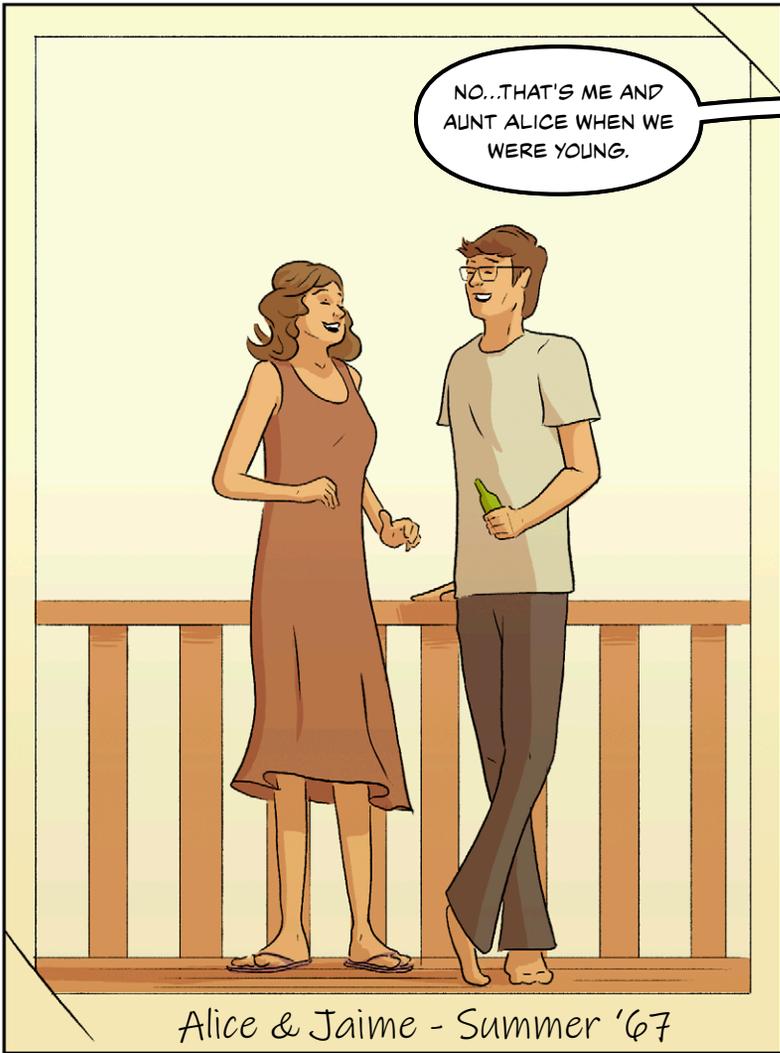
VICTORIA, COME,
DO YOU WANT TO SEE
SOMETHING?

YES,
GRANDPA!



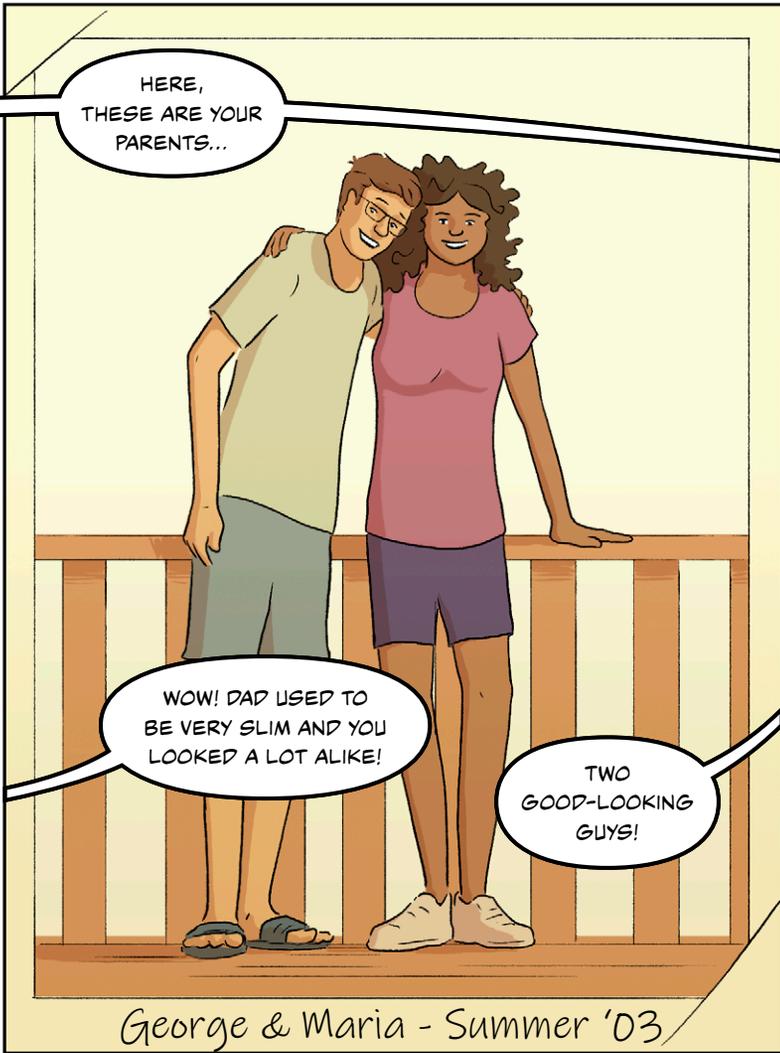
LOOK,
IT'S DAD!

BUT THAT'S
NOT MOM!



NO...THAT'S ME AND
AUNT ALICE WHEN WE
WERE YOUNG.

Alice & Jaime - Summer '67



HERE,
THESE ARE YOUR
PARENTS...

WOW! DAD USED TO
BE VERY SLIM AND YOU
LOOKED A LOT ALIKE!

TWO
GOOD-LOOKING
GUYS!

George & Maria - Summer '03

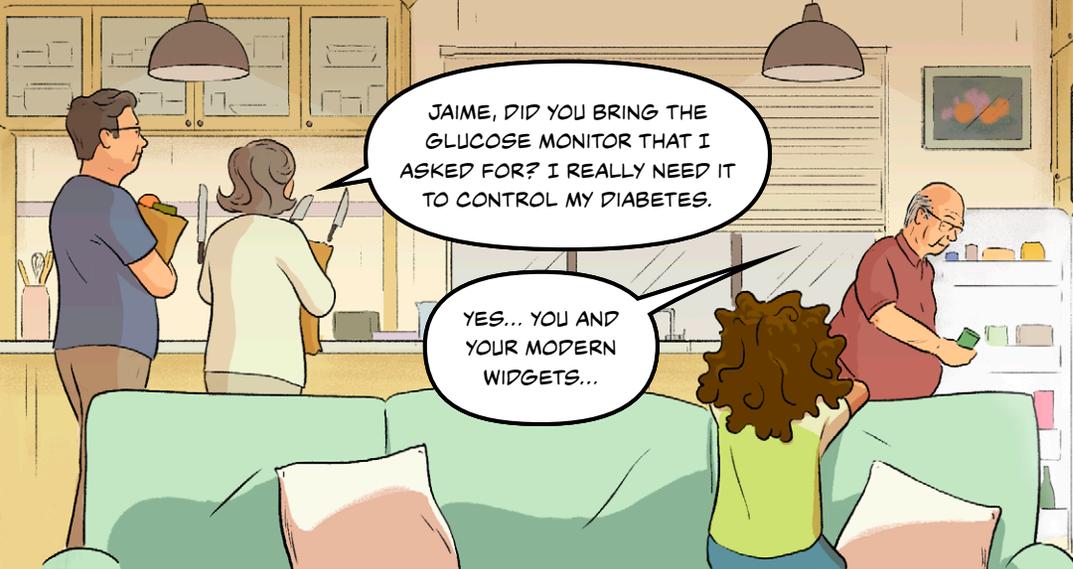


HELLO,
HELLO! HOW
WAS YOUR
TRIP?



IT WAS
FINE, SIS.

THANK YOU FOR
HAVING US AUNT
ALICE.

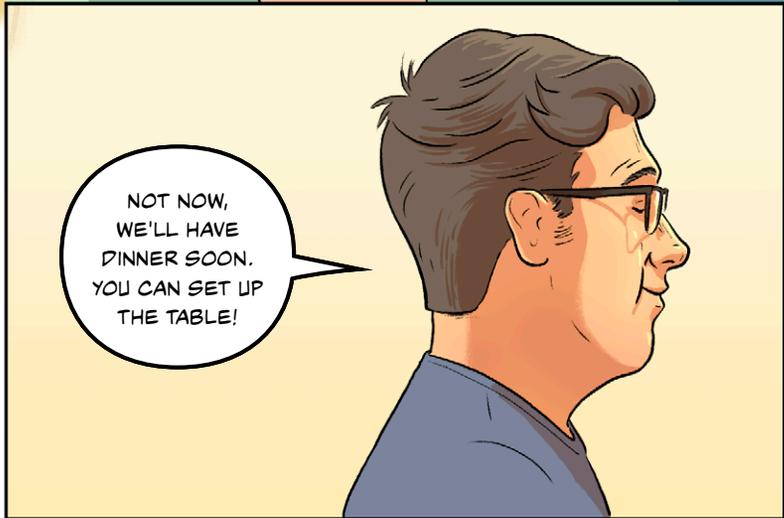


JAIME, DID YOU BRING THE GLUCOSE MONITOR THAT I ASKED FOR? I REALLY NEED IT TO CONTROL MY DIABETES.

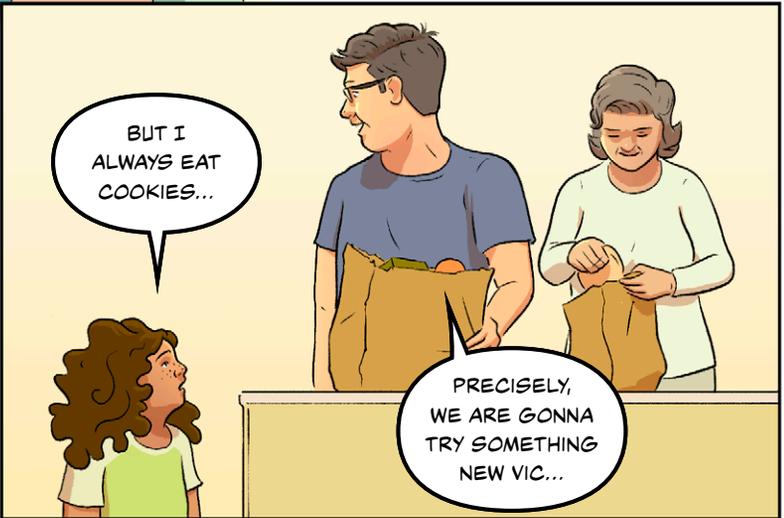
YES... YOU AND YOUR MODERN WIDGETS...



I'M HUNGRY! CAN I HAVE SOME COOKIES?



NOT NOW, WE'LL HAVE DINNER SOON. YOU CAN SET UP THE TABLE!



BUT I ALWAYS EAT COOKIES...

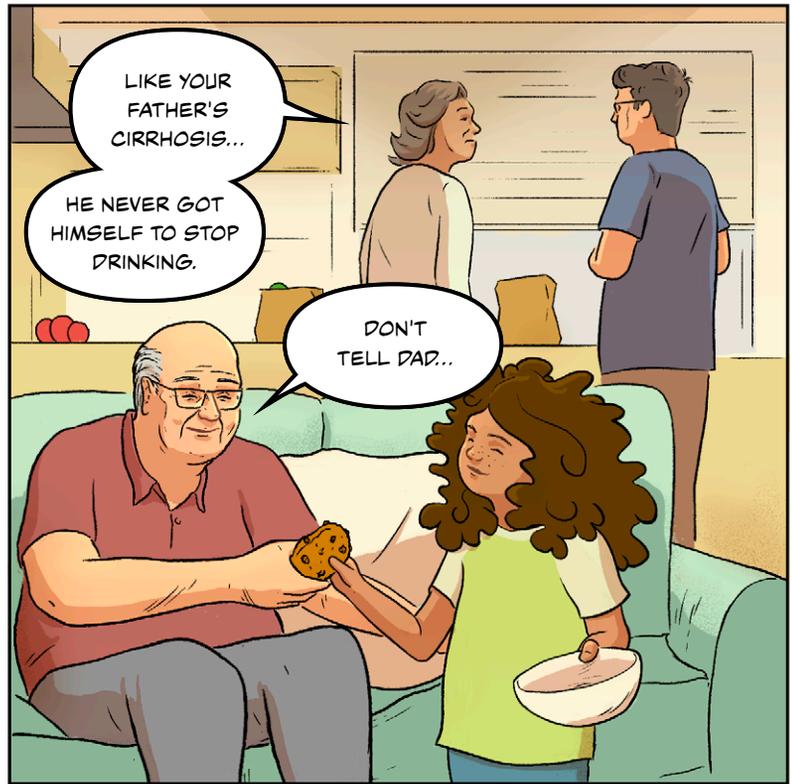
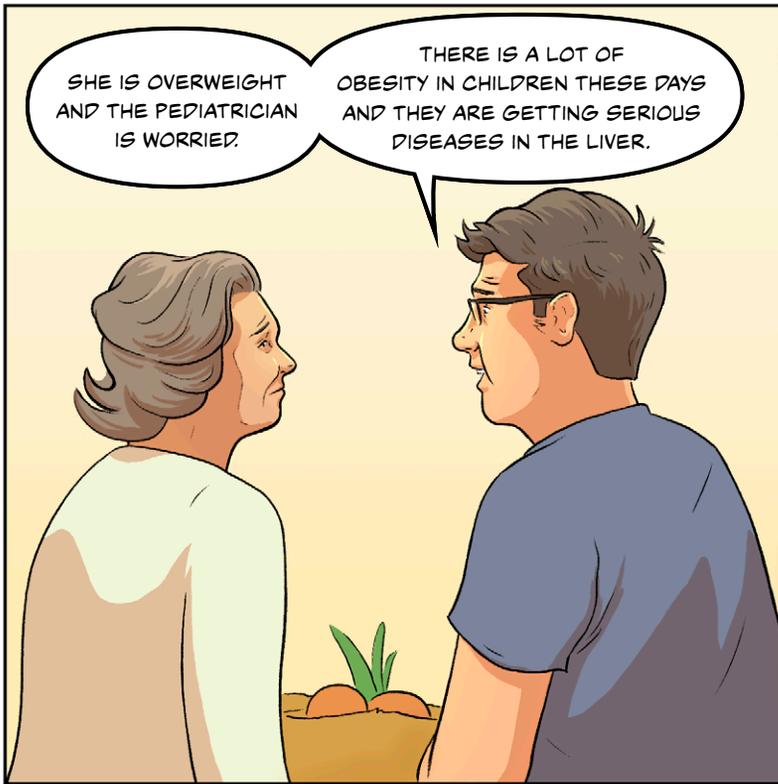
PRECISELY, WE ARE GONNA TRY SOMETHING NEW VIC...



DOCTOR'S ORDERS.



IS VIC SICK?



YEAH, THE DOCTOR SAID THAT PEOPLE THAT DON'T DRINK CAN HAVE CIRRHOSIS, EVEN KIDS...





THAT'S WHY SHE DIDN'T COME WITH US, I AM TRYING TO SEE IF I MAKE SOME CHANGES IN MY LIFE...

BUT VIC HAS CIRRHOSIS?!



WHAT DO I HAVE, DAD? WHAT IS A MITOSIS?



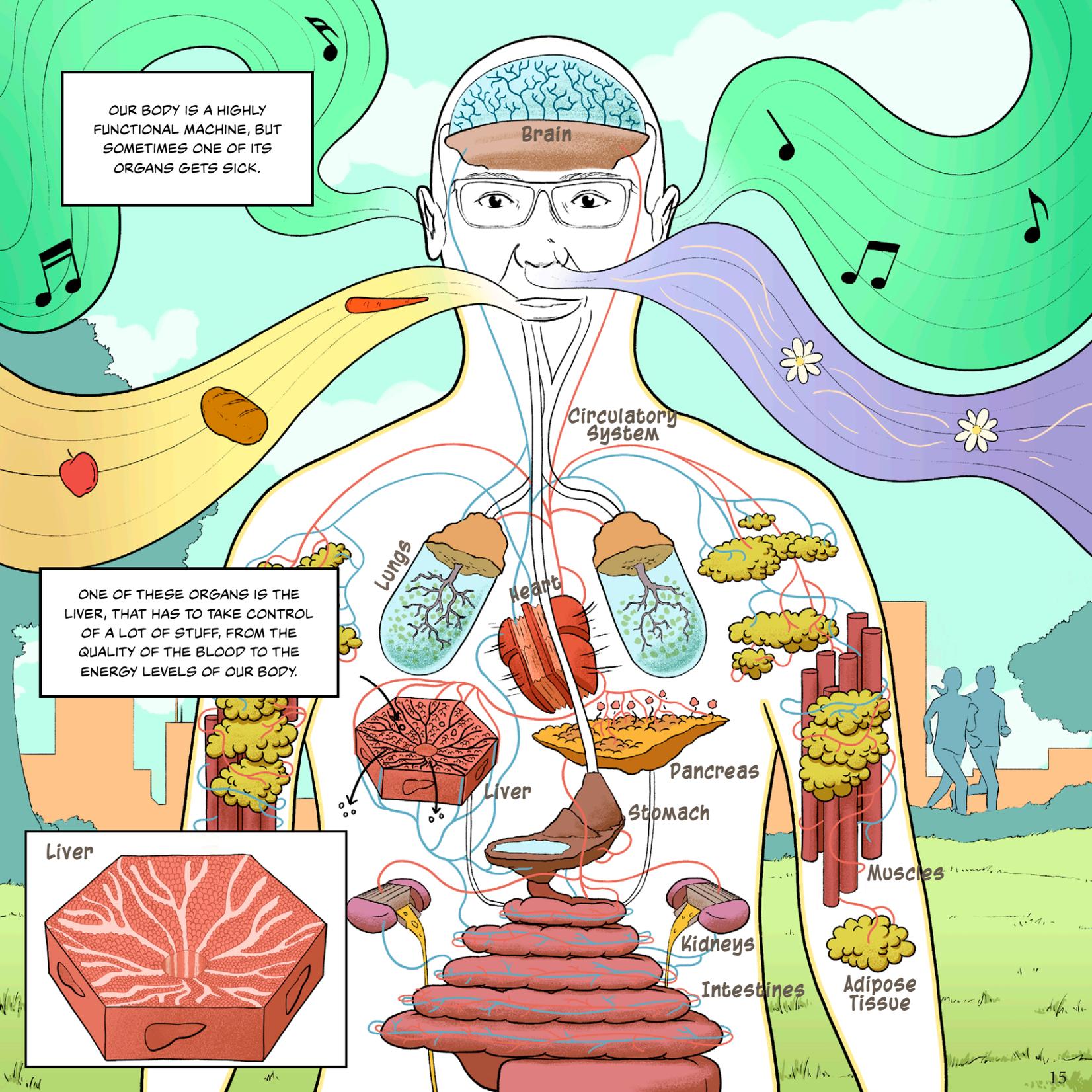
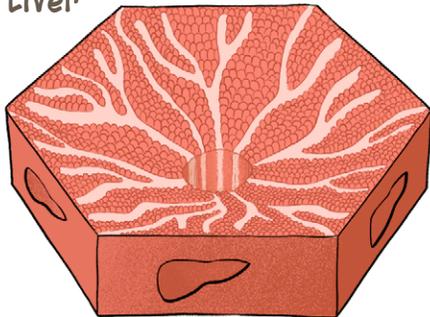
CIRRHOSIS, LOVE... AND YOU HAVE NOTHING OF THE SORT. IT'S GRANDPA WHO HAS IT.

BAH!

OUR BODY IS A HIGHLY FUNCTIONAL MACHINE, BUT SOMETIMES ONE OF ITS ORGANS GETS SICK.

ONE OF THESE ORGANS IS THE LIVER, THAT HAS TO TAKE CONTROL OF A LOT OF STUFF, FROM THE QUALITY OF THE BLOOD TO THE ENERGY LEVELS OF OUR BODY.

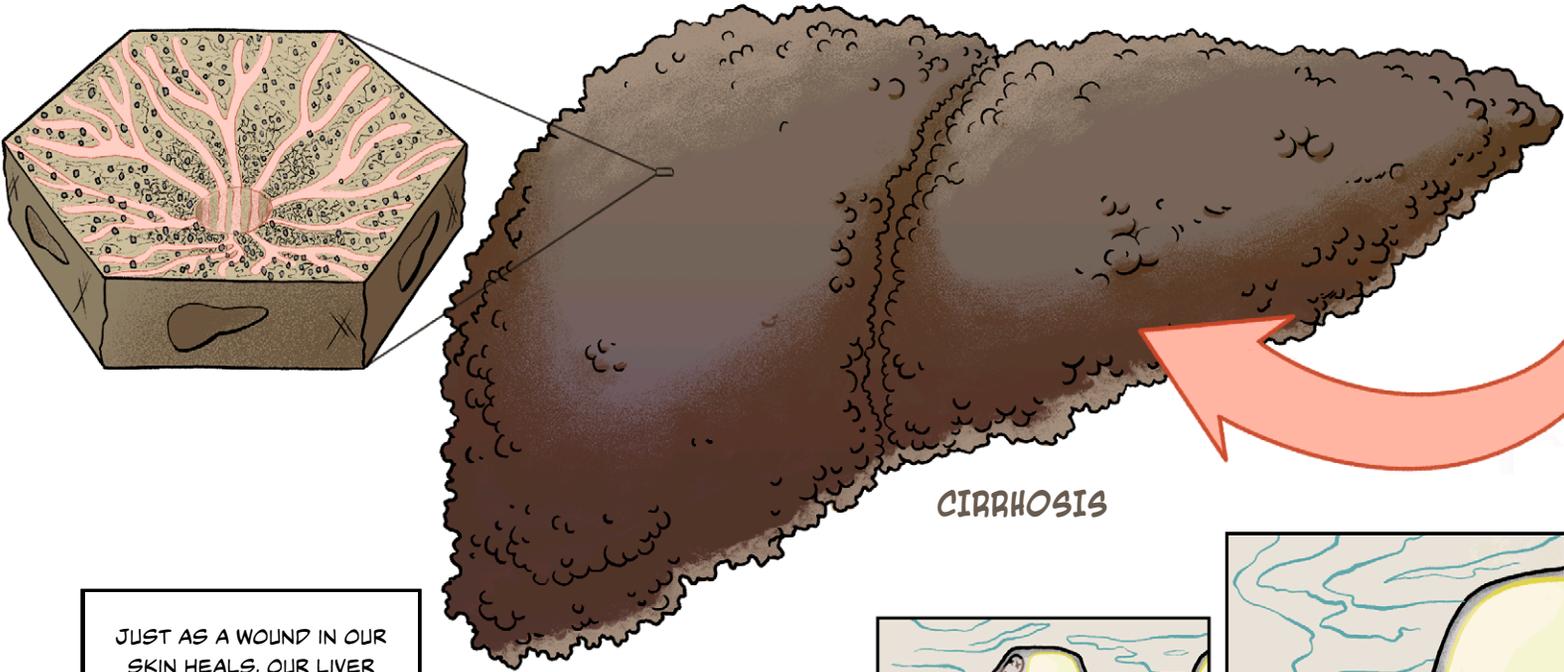
Liver





WHEN THE LIVER HAS BEEN SUFFERING FOR A VERY LONG TIME IT CAN STOP WORKING AND DEVELOPS A DISEASE CALLED CIRRHOSIS.

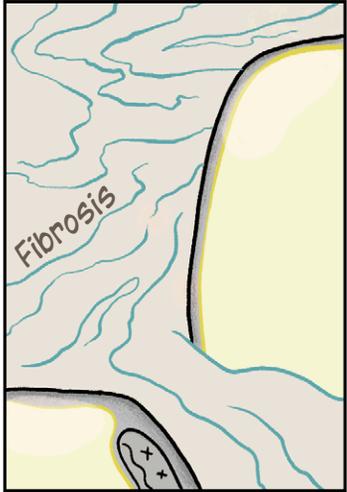
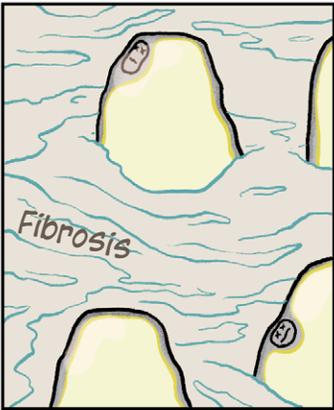
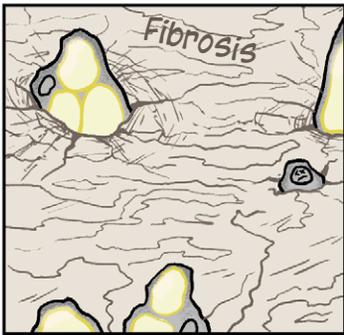
THERE ARE PEOPLE THAT EVEN NEED A NEW LIVER...



CIRRHOSIS

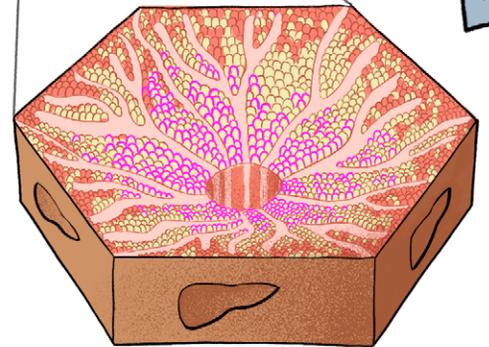
JUST AS A WOUND IN OUR SKIN HEALS, OUR LIVER TOO MENDS ITS INJURIES WITH A SCAR.

THE SCARS OF THE LIVER ARE CALLED FIBROSIS.

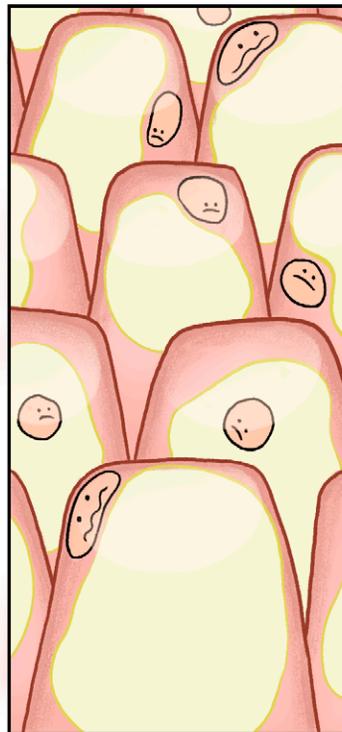
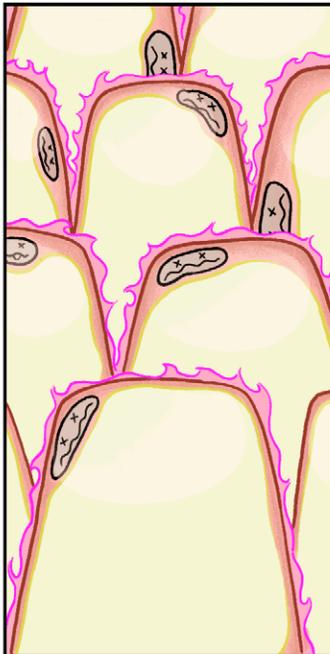
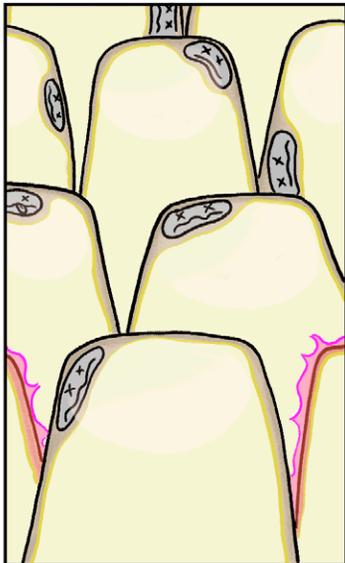


INJURING THE LIVER OVER AND OVER AGAIN CAUSES INFLAMMATION. THAT IS CALLED HEPATITIS AND FORCES SCARRING ON THE LIVER.

STEATOHEPATITIS



CIRRHOSIS DEVELOPS OVER A LONG TIME, AS FIBROSIS ACCUMULATES.



WHAT AN EXAGGERATION!
YOU ALL WANT TO DIE
FULL OF HEALTH...



IT IS A VERY LONG PROCESS. WE DON'T EVEN NOTICE...

HOW WAS THE GYM?



2005

DO YOU WANT SOME SALMON WITH VEGGIES?



I'LL DEFROST SOMETHING LATER, GO AHEAD.

2015

2018

Non-Alcoholic Fatty Liver (NAFL)

Non-Alcoholic Steatohepatitis (NASH)

BUT OVER TIME, SOME OF OUR BEHAVIORS FORCE OUR LIVER TO ACCUMULATE A LOT OF FAT...

IT'S NOT THE LIVER'S FAULT, BUT GETTING FATTY CAN CAUSE INFLAMMATION.

DO YOU DRINK?

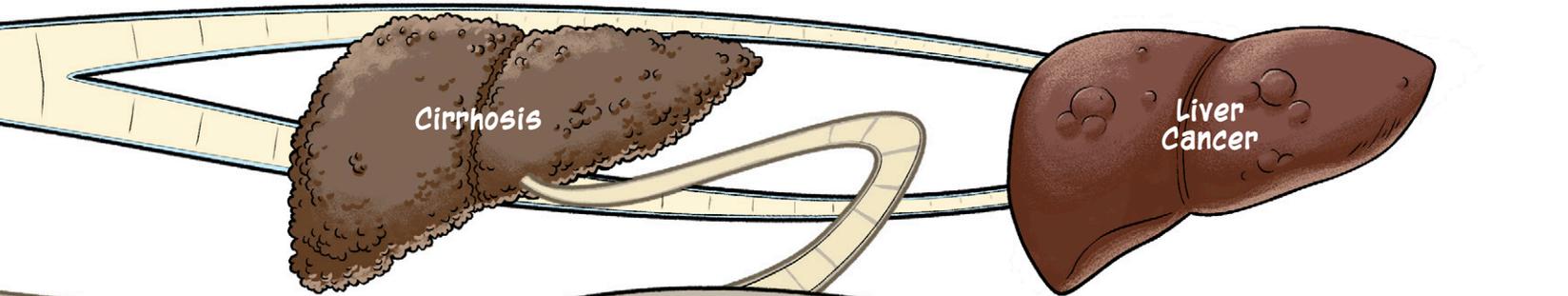
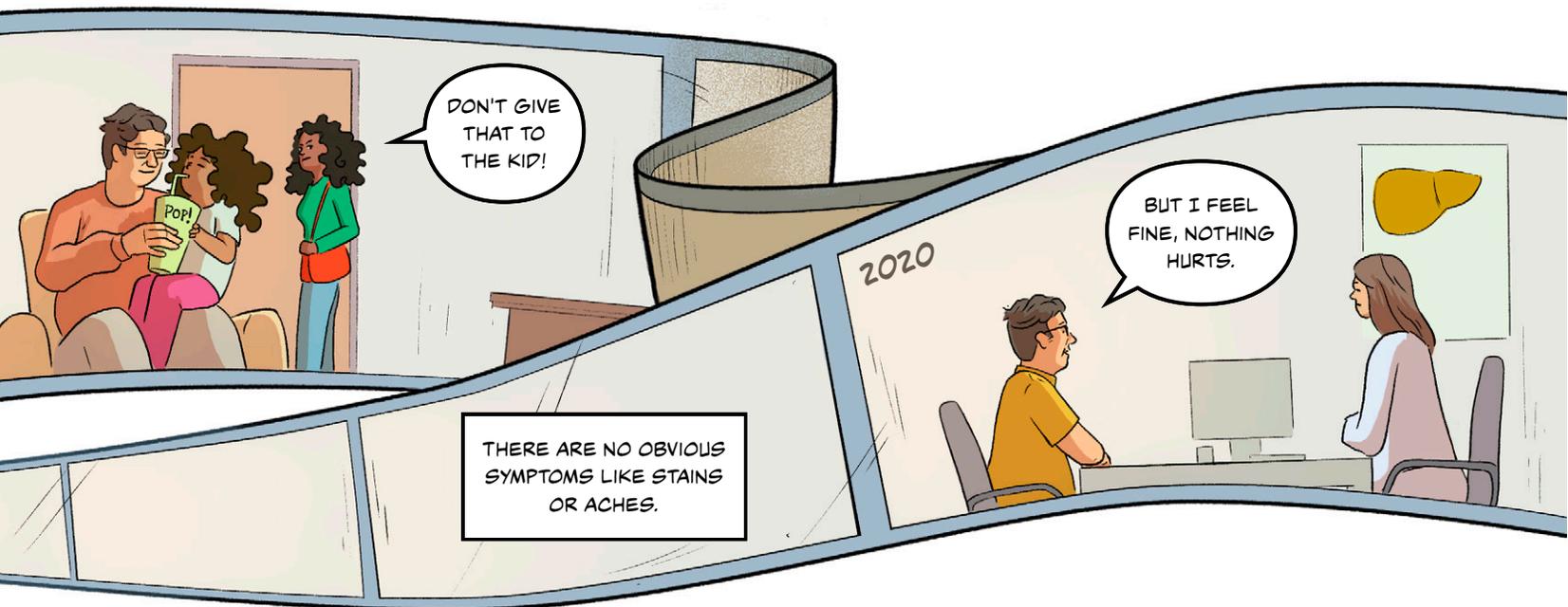
NOT MUCH...

2005



ANOTHER GLASS?





UNHEALTHY DIETS, THE LACK OF PHYSICAL ACTIVITY, THE EXCESS OF ALCOHOL...

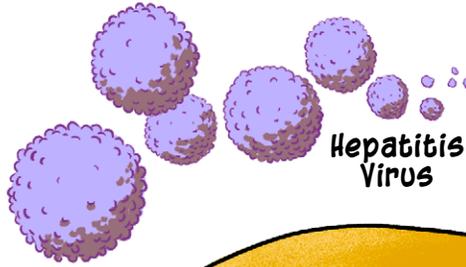


Non-Alcoholic Fatty Liver

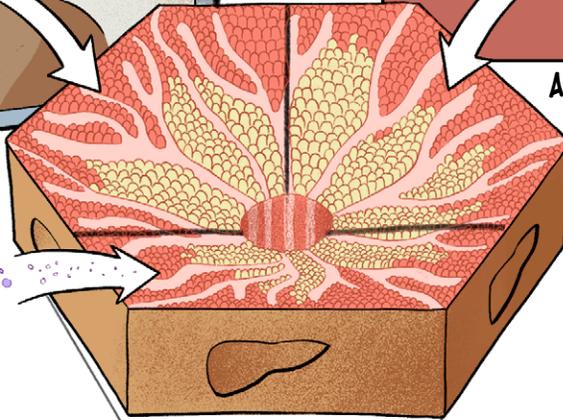


Alcoholic Fatty Liver

SO, IT'S NOT A DISEASE THAT YOU CAN CATCH, LIKE THE FLU?

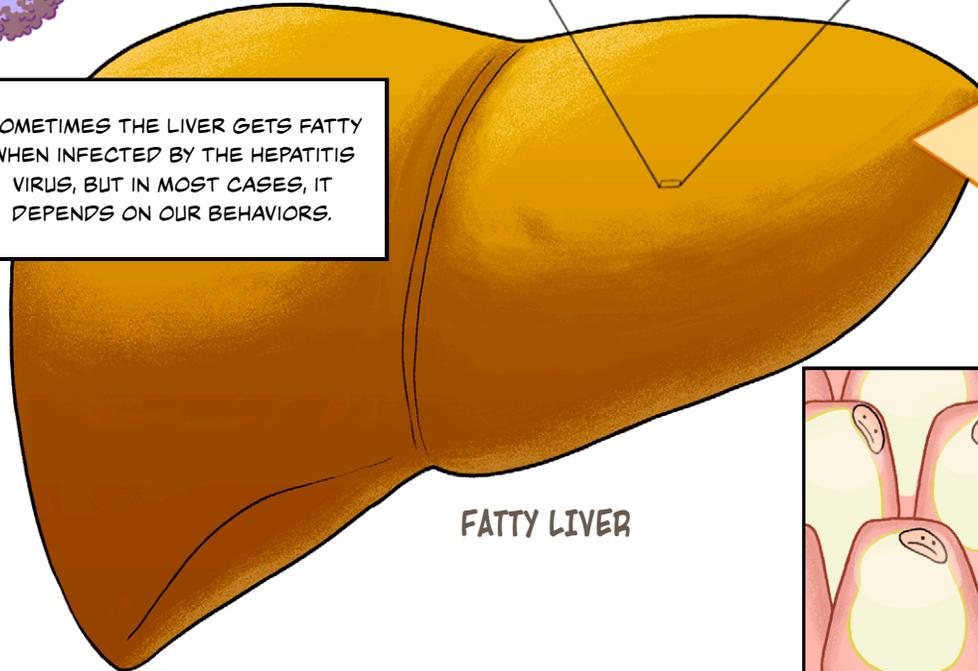


Hepatitis Virus

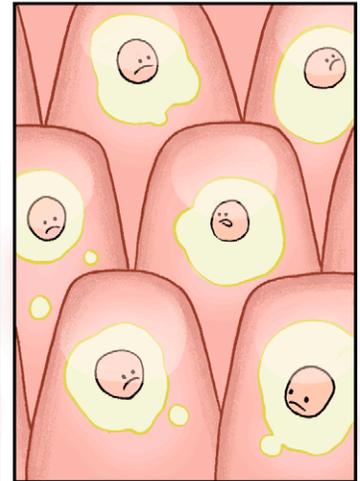
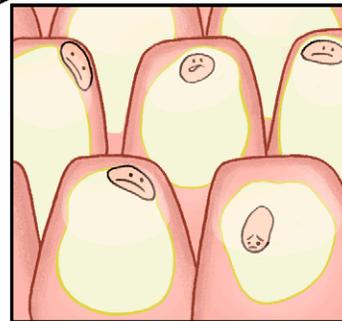


SOMETIMES THE LIVER GETS FATTY WHEN INFECTED BY THE HEPATITIS VIRUS, BUT IN MOST CASES, IT DEPENDS ON OUR BEHAVIORS.

1 in every 4 people



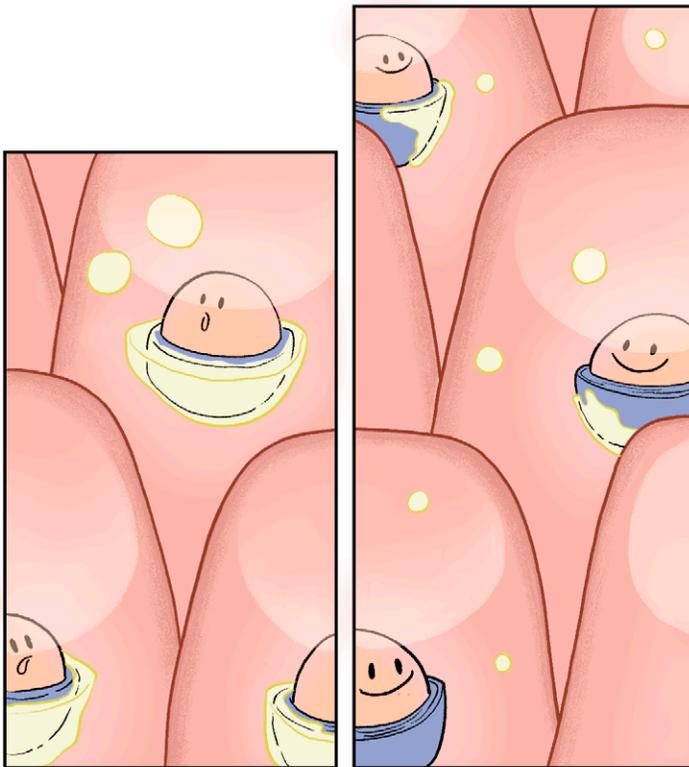
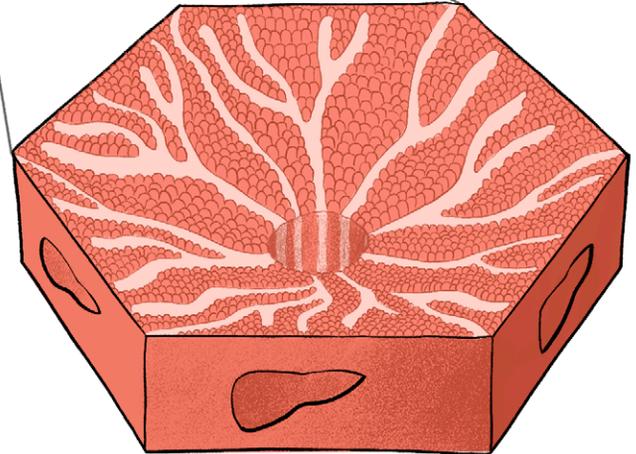
FATTY LIVER

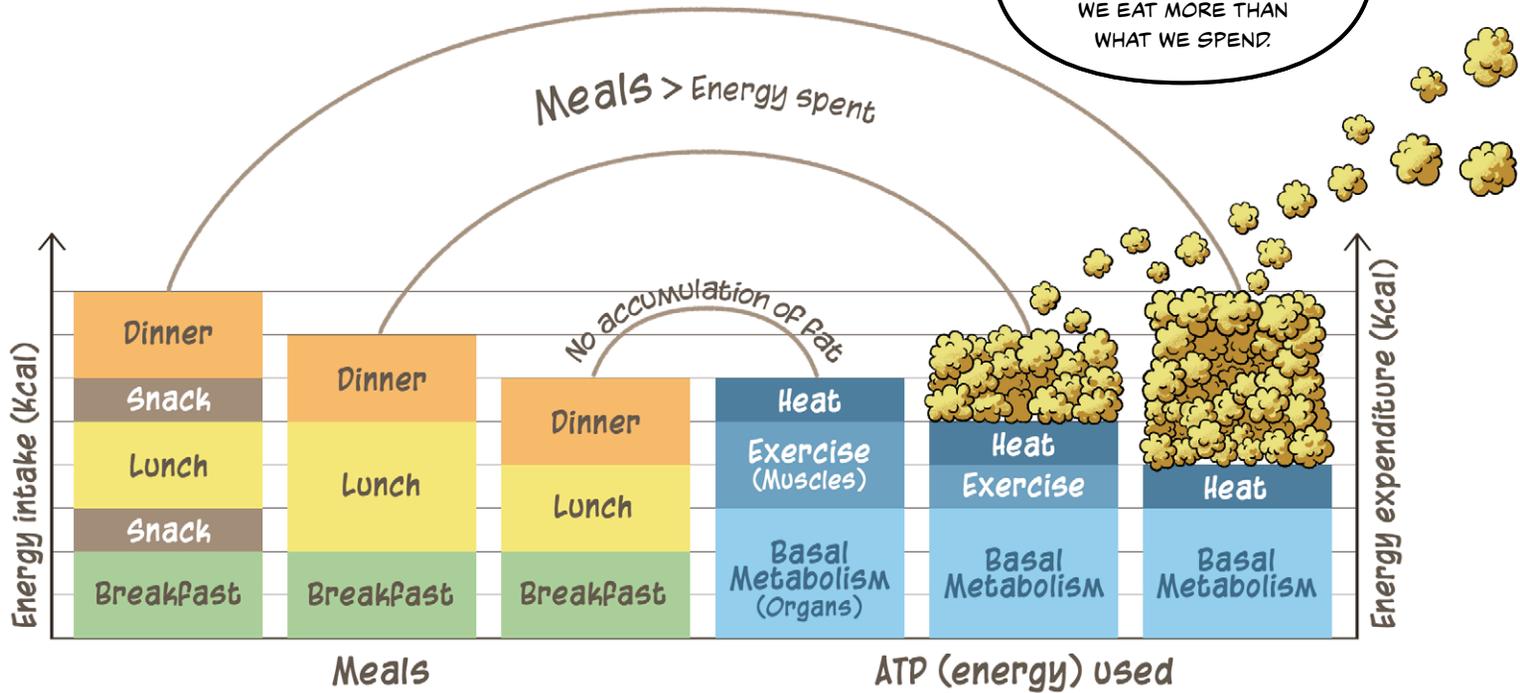
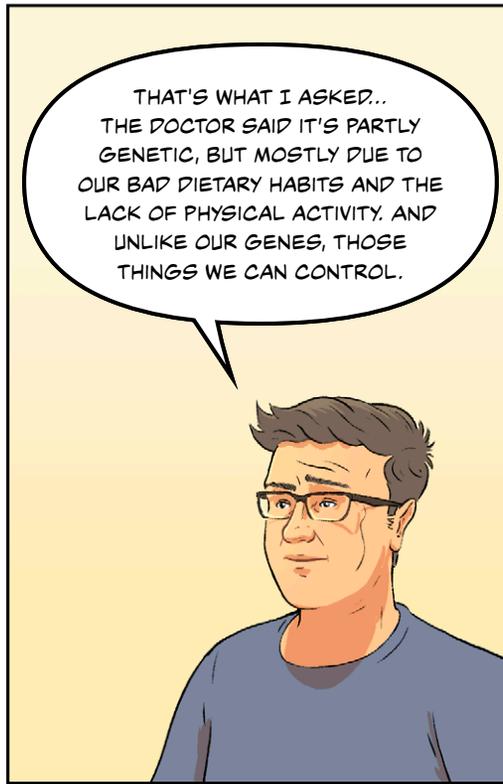
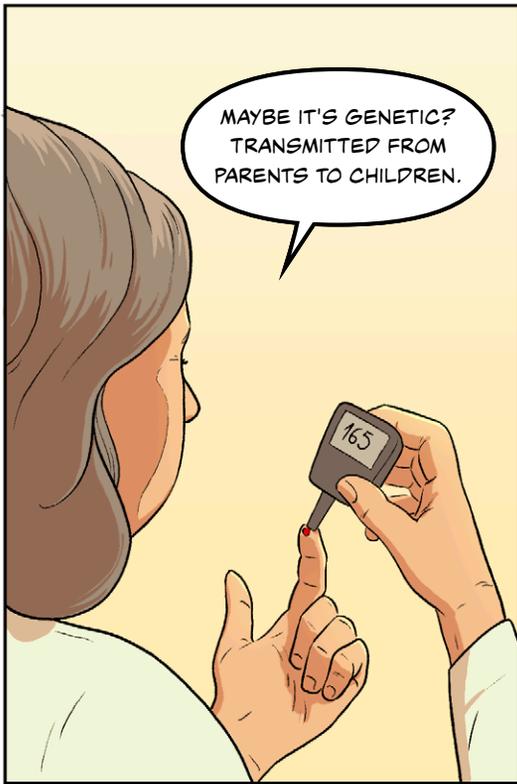


IF WE EAT BADLY, DRINK TOO MUCH AND DON'T EXERCISE, THE LIVER HAS TO WORK OVERTIME, AND EVENTUALLY IT GETS TIRED.. IT DETERIORATES AND BECOMES FATTY.

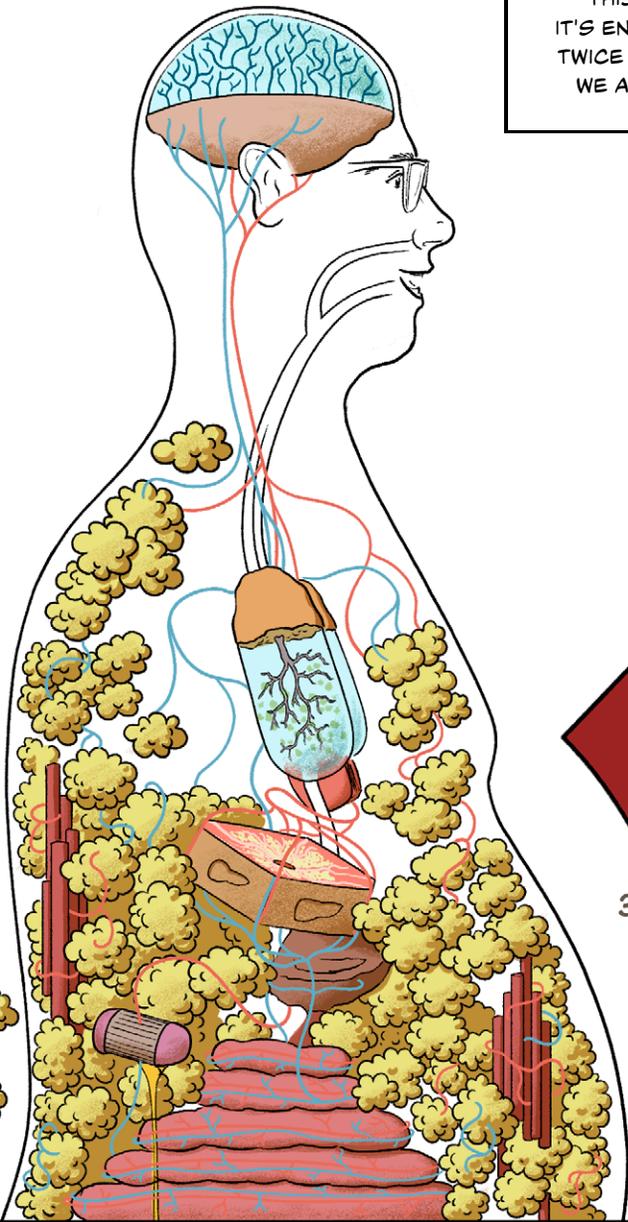
IT DOESN'T STOP WORKING ALL OF A SUDDEN, BUT IF WE DON'T DO ANYTHING ABOUT IT, IT KEEPS ON GETTING WORSE...

HEALTHY LIVER

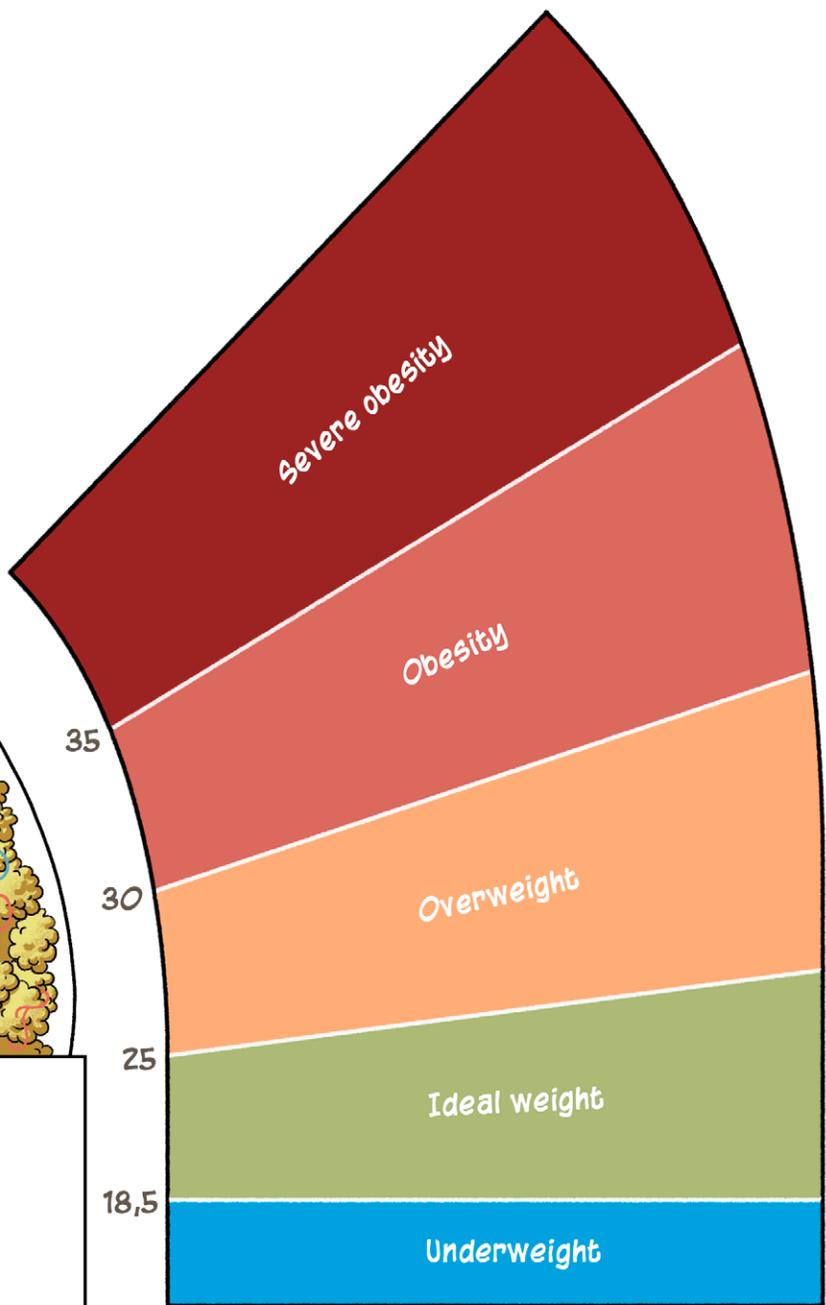




THIS CAN MAKE US GAIN WEIGHT.
IT'S ENOUGH TO DIVIDE OUR WEIGHT BY
TWICE OUR HEIGHT TO KNOW WHETHER
WE ARE IN RANGE OR OVERWEIGHT.



$$\text{BMI} = \frac{\text{Weight}}{\text{Height}^2}$$



WHEN WE BECOME OVERWEIGHT, OUR FAT RESERVOIRS FILL UP..

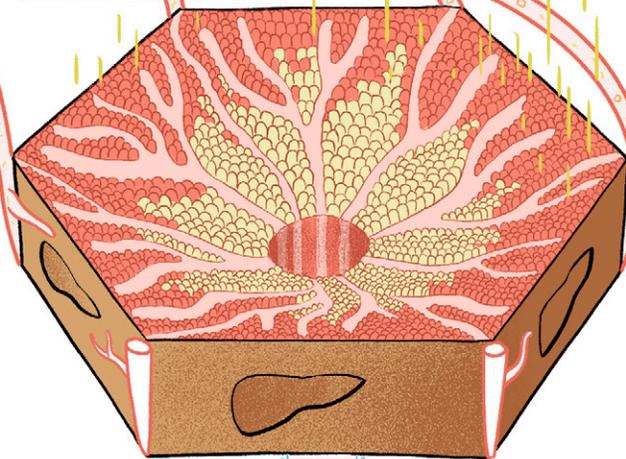
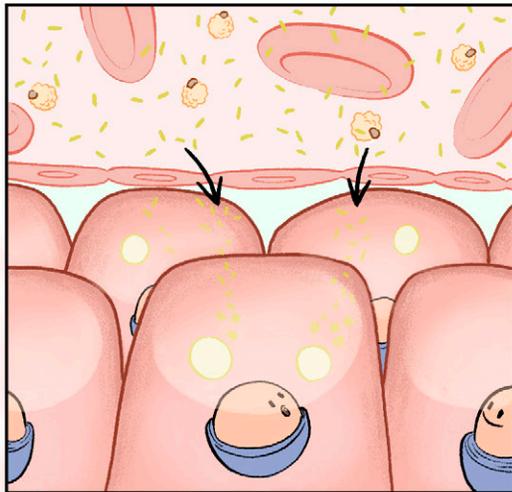


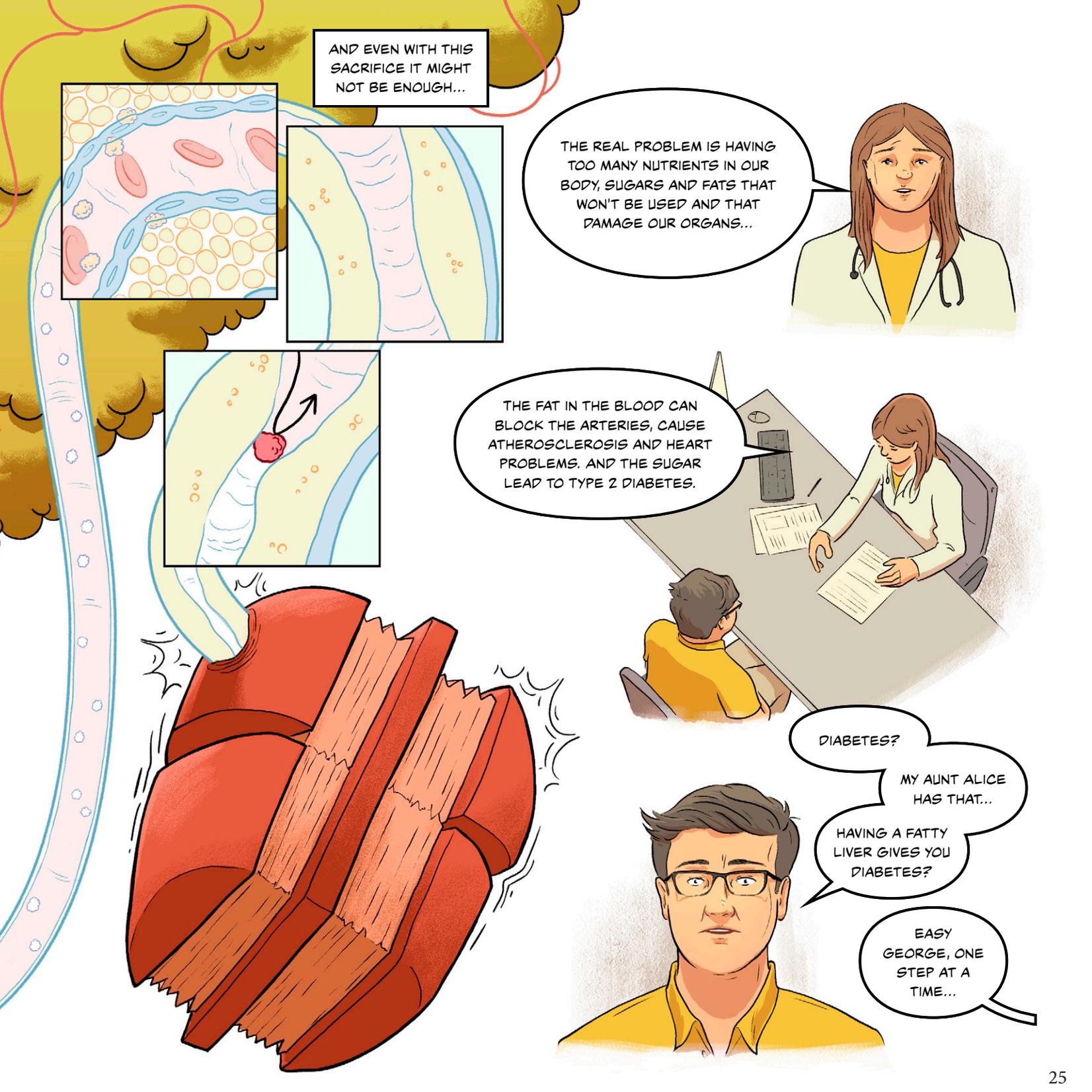
THEY DON'T MANAGE TO STORE IT ALL CORRECTLY AND THE FAT SPILLS INTO THE BLOOD..

AND IT HAS TO BE THE POOR LIVER THE ONE THAT DEALS WITH IT.

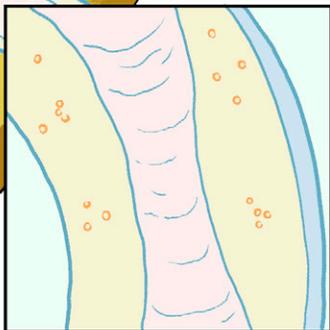
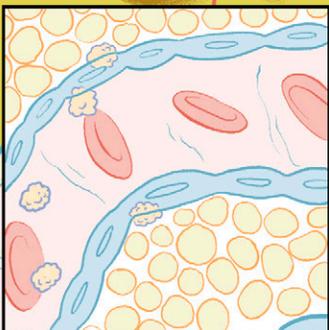
THE LIVER WORKS AS A FILTER THAT CATCHES THE FAT FROM THE BLOOD AND RETAINS IT. THAT'S HOW IT BECOMES FATTY.

ITS INTENTION IS TO HELP, BUT IN DOING SO, HE SUFFERS...





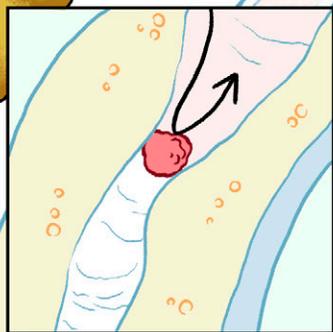
AND EVEN WITH THIS SACRIFICE IT MIGHT NOT BE ENOUGH...



THE REAL PROBLEM IS HAVING TOO MANY NUTRIENTS IN OUR BODY, SUGARS AND FATS THAT WON'T BE USED AND THAT DAMAGE OUR ORGANS...



THE FAT IN THE BLOOD CAN BLOCK THE ARTERIES, CAUSE ATHEROSCLEROSIS AND HEART PROBLEMS. AND THE SUGAR LEAD TO TYPE 2 DIABETES.

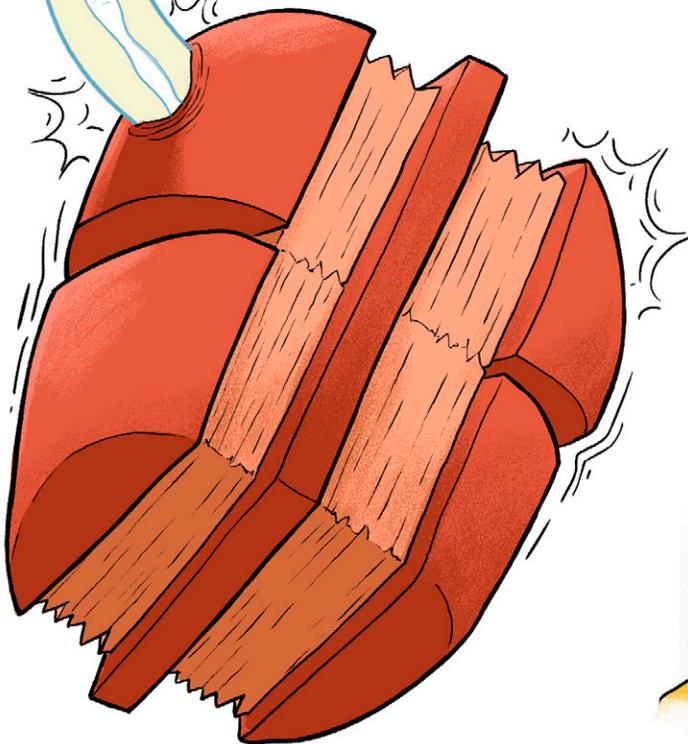


DIABETES?

MY AUNT ALICE HAS THAT...

HAVING A FATTY LIVER GIVES YOU DIABETES?

EASY GEORGE, ONE STEP AT A TIME...





IF ONE THING LEADS TO THE OTHER, YOU BETTER SHAPE UP! I CAN ASSURE YOU THAT HAVING DIABETES IS NOT FUN...



YEAH... YOU KNOW, I'VE KNOWN ABOUT THIS FATTY LIVER THING FOR A WHILE NOW...

BUT KNOWING THAT VIC COULD HAVE THE SAME THING SCARED THE HELL OUT OF ME!



I CAN ALSO GET THAT THING YOU HAVE DAD?

NO!



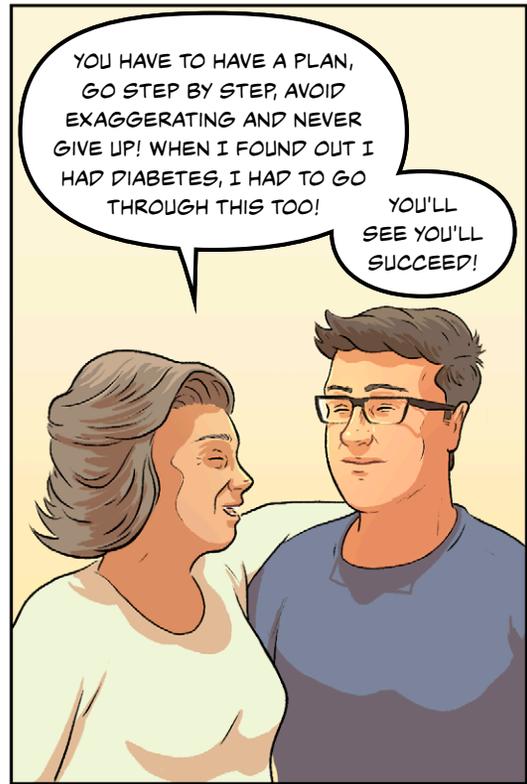
SO, WHAT DO YOU THINK WE SHOULD DO?

EAT LESS?
GO RUNNING?



EXACTLY!
START EATING BETTER AND EXERCISING MORE. BUT WE HAVE TO BE PERSISTENT...

I'VE TRIED TO LOSE WEIGHT SO MANY TIMES ALREADY...



YOU HAVE TO HAVE A PLAN, GO STEP BY STEP, AVOID EXAGGERATING AND NEVER GIVE UP! WHEN I FOUND OUT I HAD DIABETES, I HAD TO GO THROUGH THIS TOO!

YOU'LL SEE YOU'LL SUCCEED!



ONE WEEK LATER

A GOOD WALK
IS EASY AND CHEAP. FIVE
KILOMETERS A DAY WOULD
DO THE WORLD OF GOOD
TO YOU!

AH, LUCKILY
YOU'VE KEPT
THE BIKE!

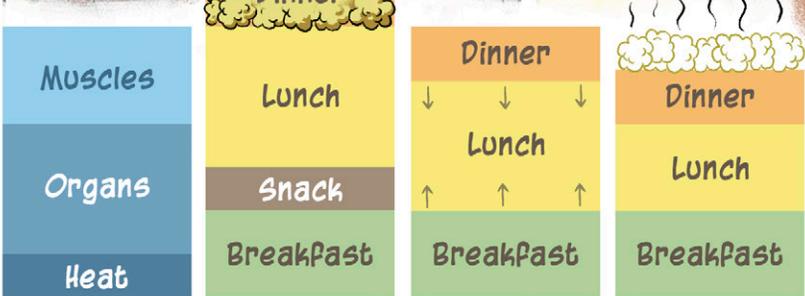
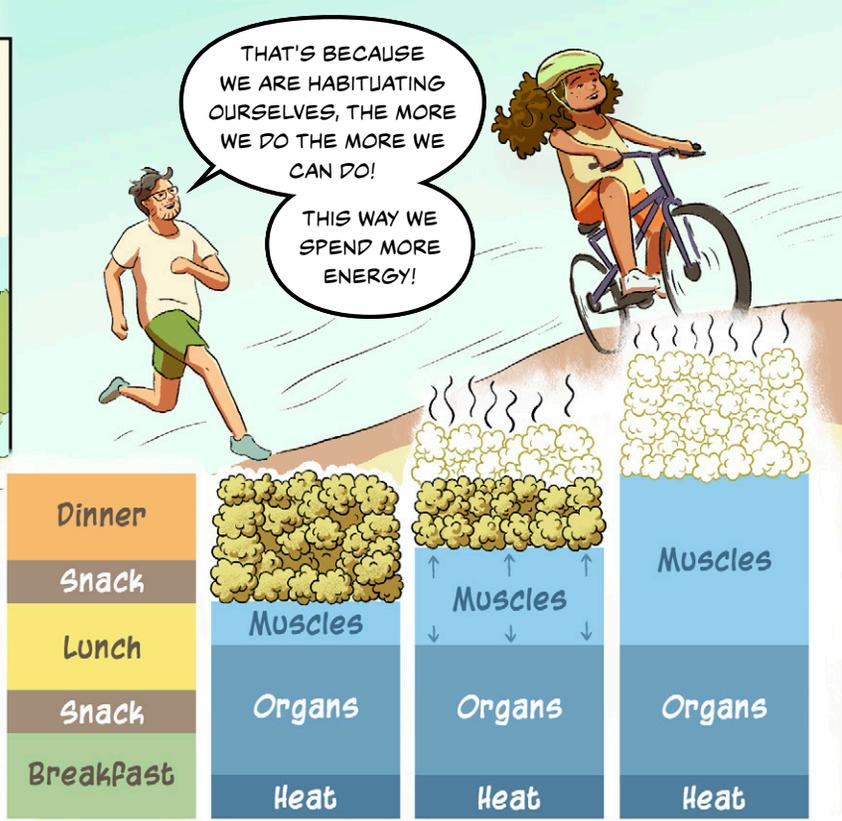


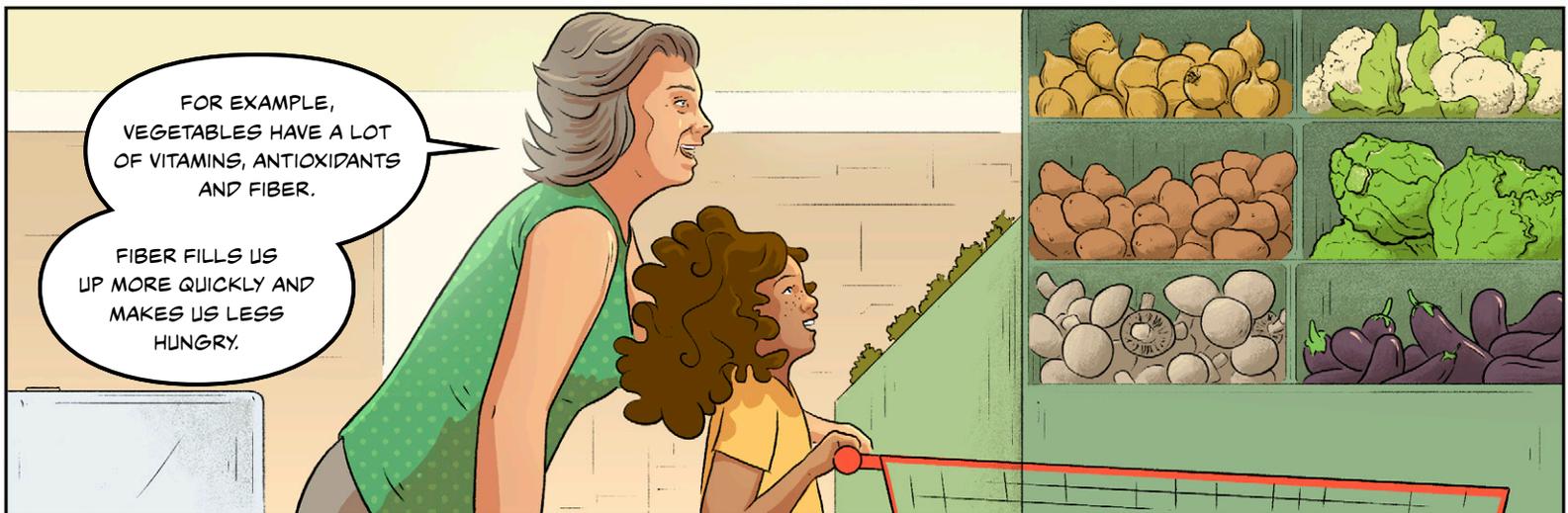
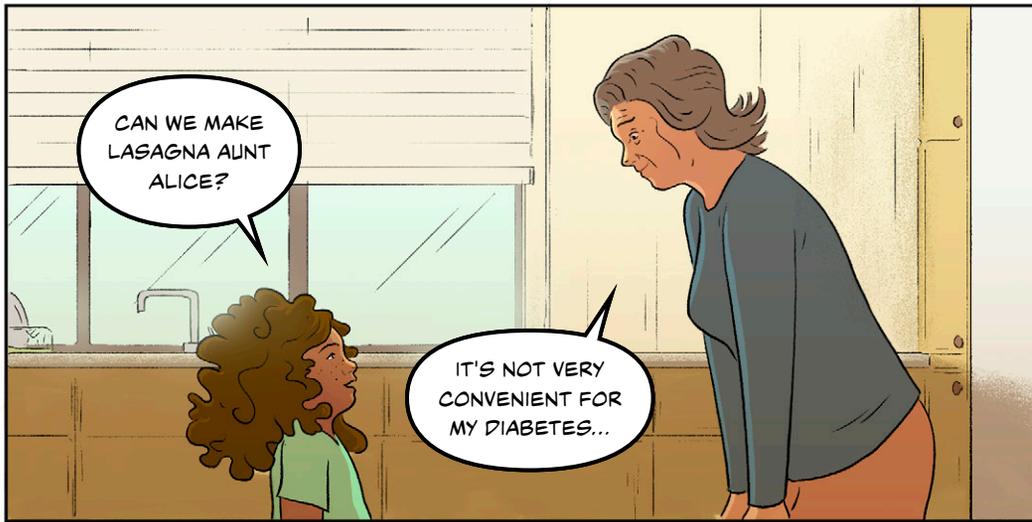
GOOD
EFFORT. WELL
DONE!

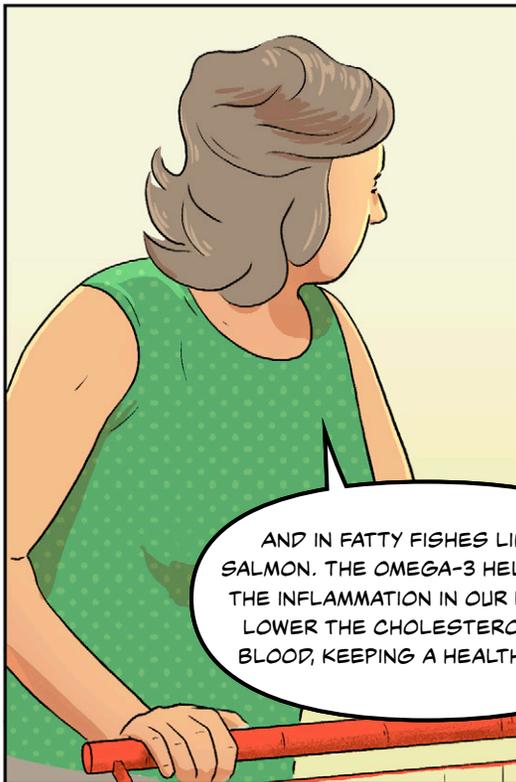
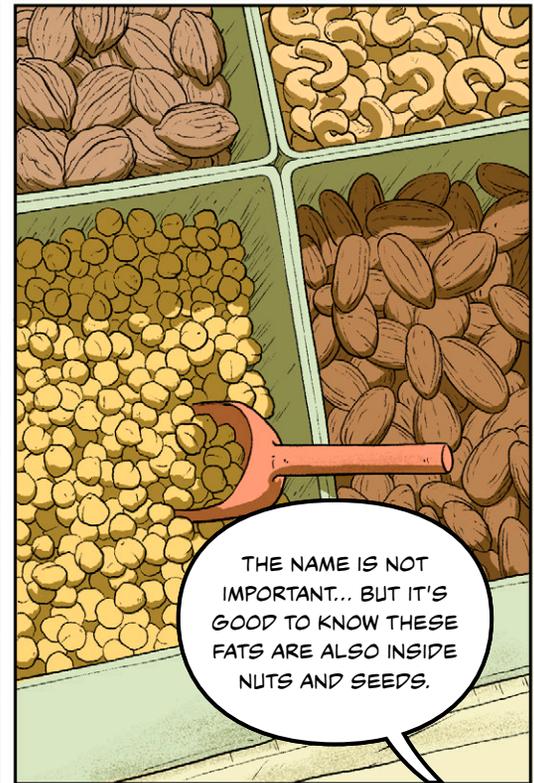


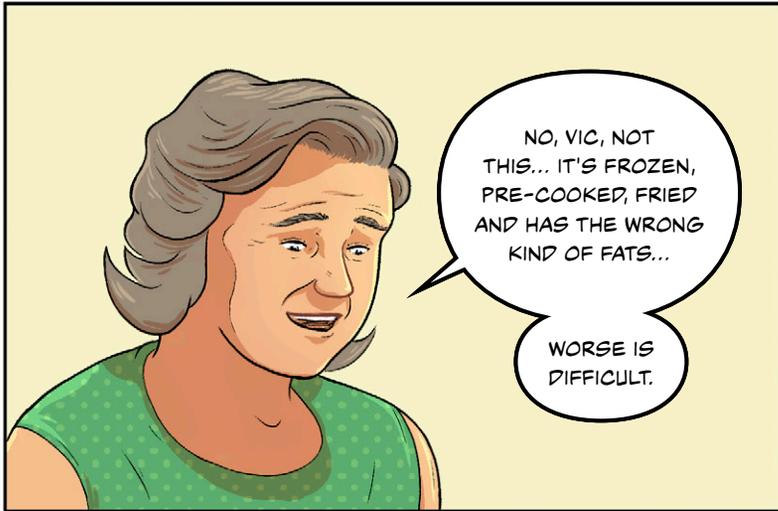
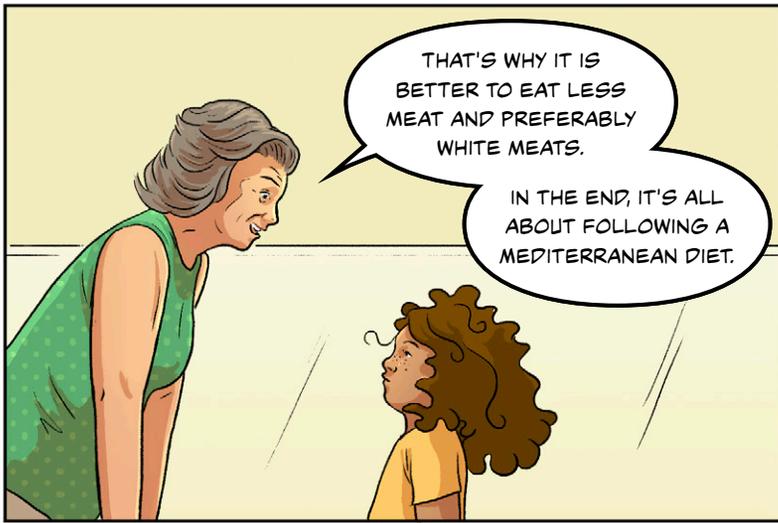
LET'S SEE HOW
LONG IT TAKES US
TODAY VIC.











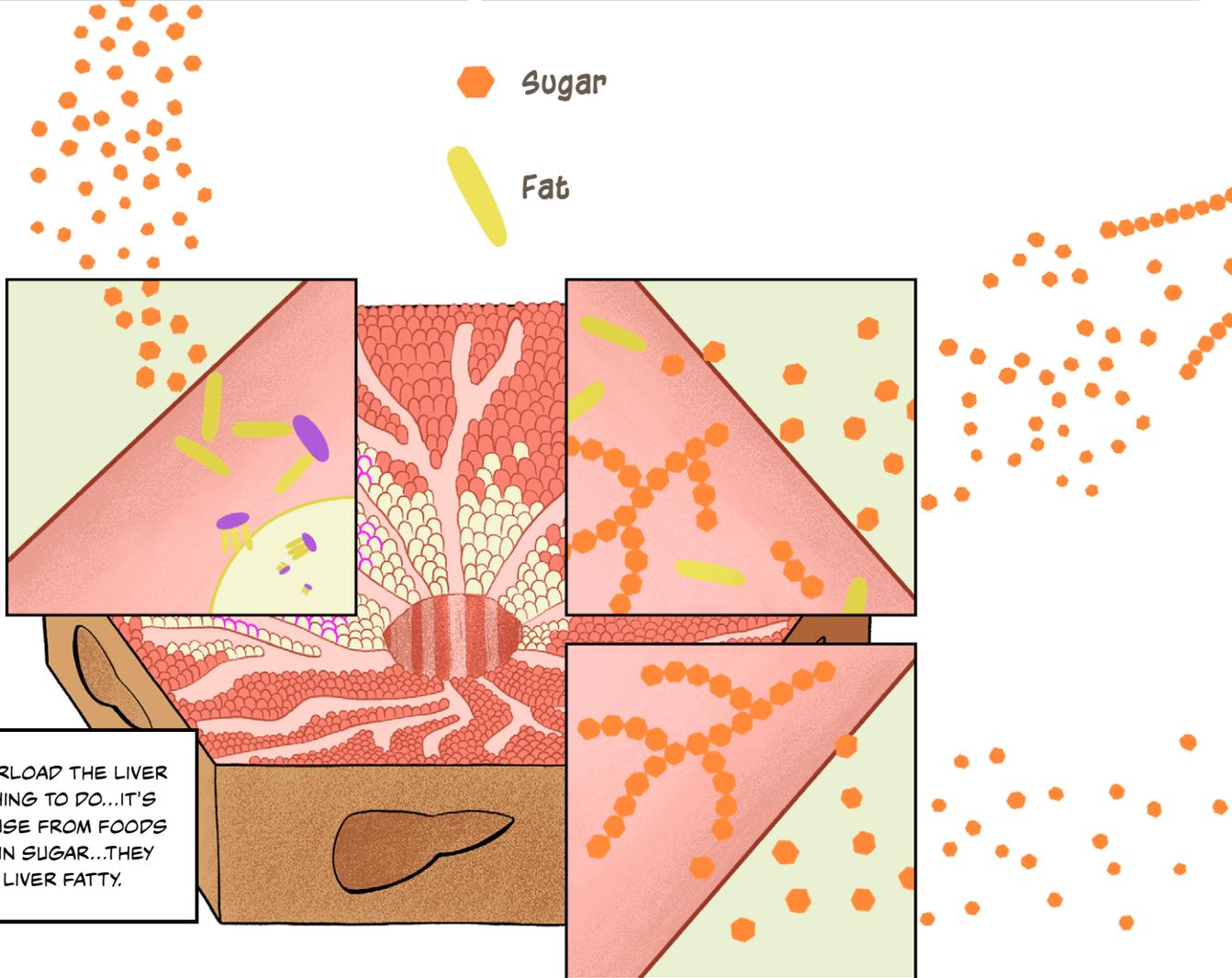
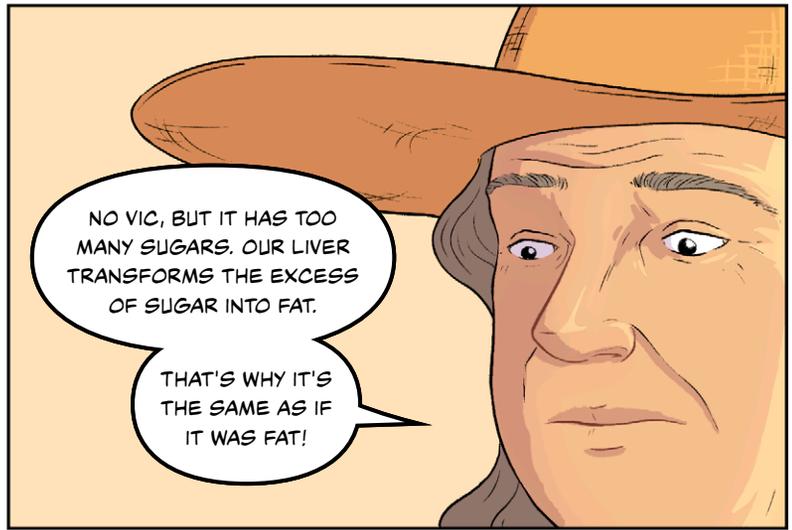
ONE WEEK LATER

SO, HOW WAS THE RIDE TODAY?

AWESOME!
WE'D NEVER GONE FARTHER NOR FASTER!

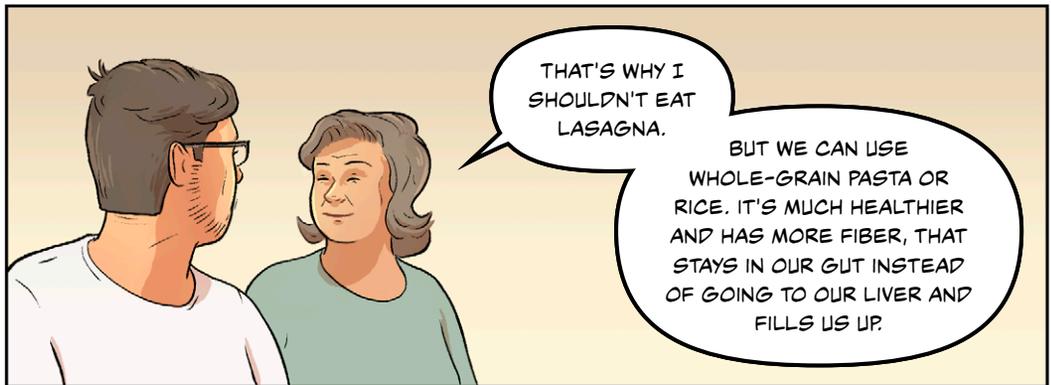
I'M HUNGRY!







AND NOT ALL THE THINGS HIGH IN SUGAR ARE SWEET. STARCHES LIKE PASTA, RICE OR POTATOES ALSO HAVE A LOT OF SUGAR.



THAT'S WHY I SHOULD'N'T EAT LASAGNA.

BUT WE CAN USE WHOLE-GRAIN PASTA OR RICE. IT'S MUCH HEALTHIER AND HAS MORE FIBER, THAT STAYS IN OUR GUT INSTEAD OF GOING TO OUR LIVER AND FILLS US UP.



ONE WEEK LATER

MOM!

DARLING!
HOW ARE
YOU?

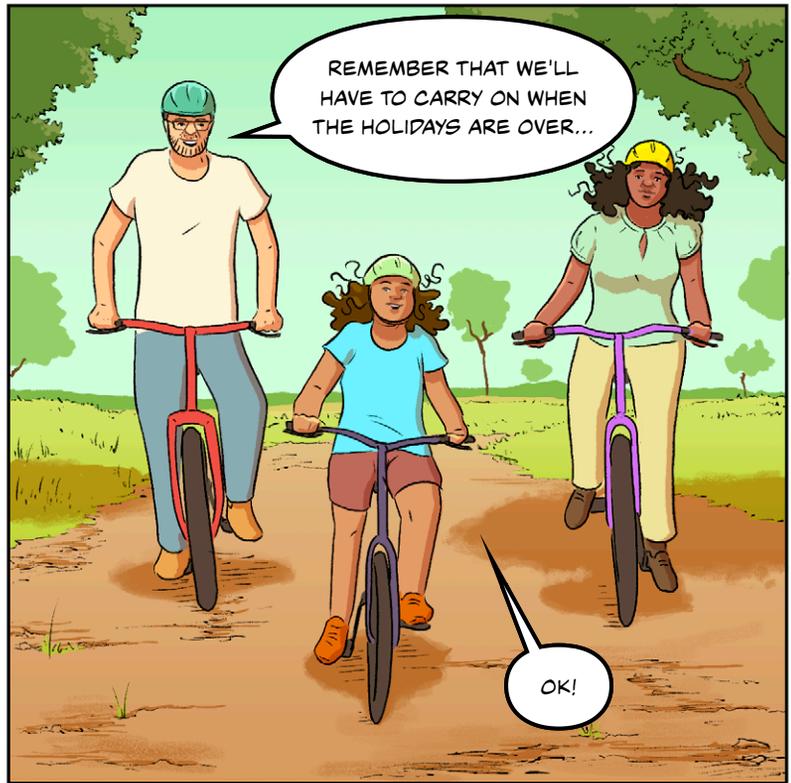
SUPER. I'VE LEARNED
SO MANY THINGS WITH
AUNT ALICE AND DAD!

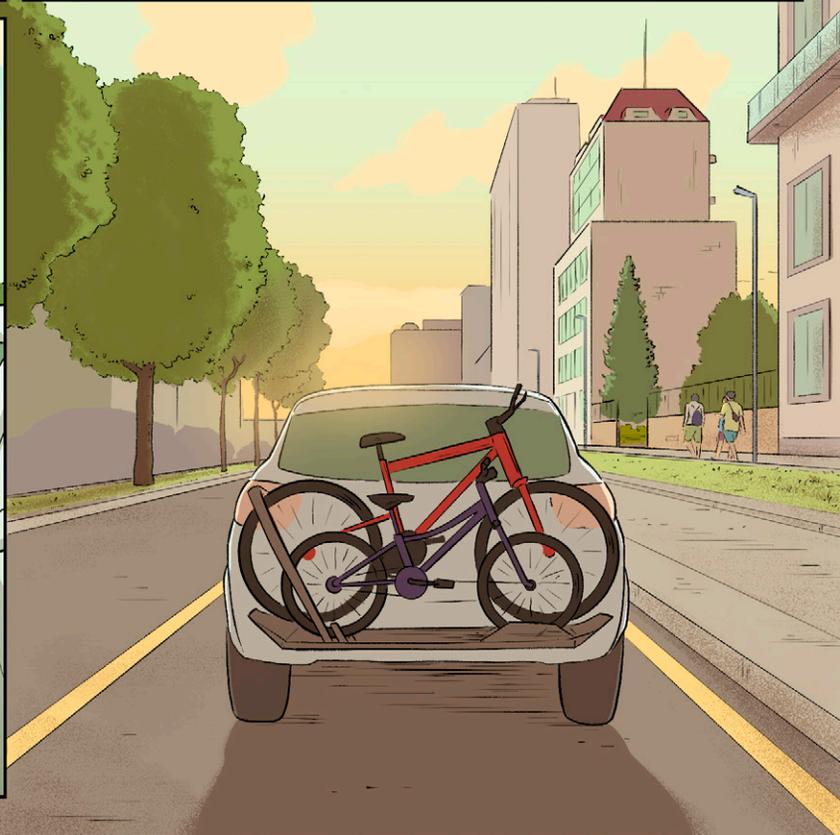
REALLY?

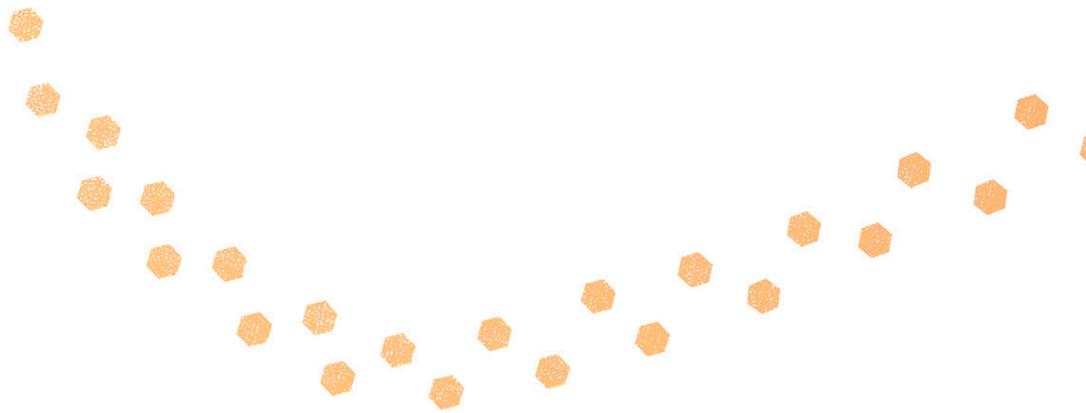
WHAT A NICE MEAL!
VERY DIFFERENT FROM
WHAT WE EAT AT HOME.

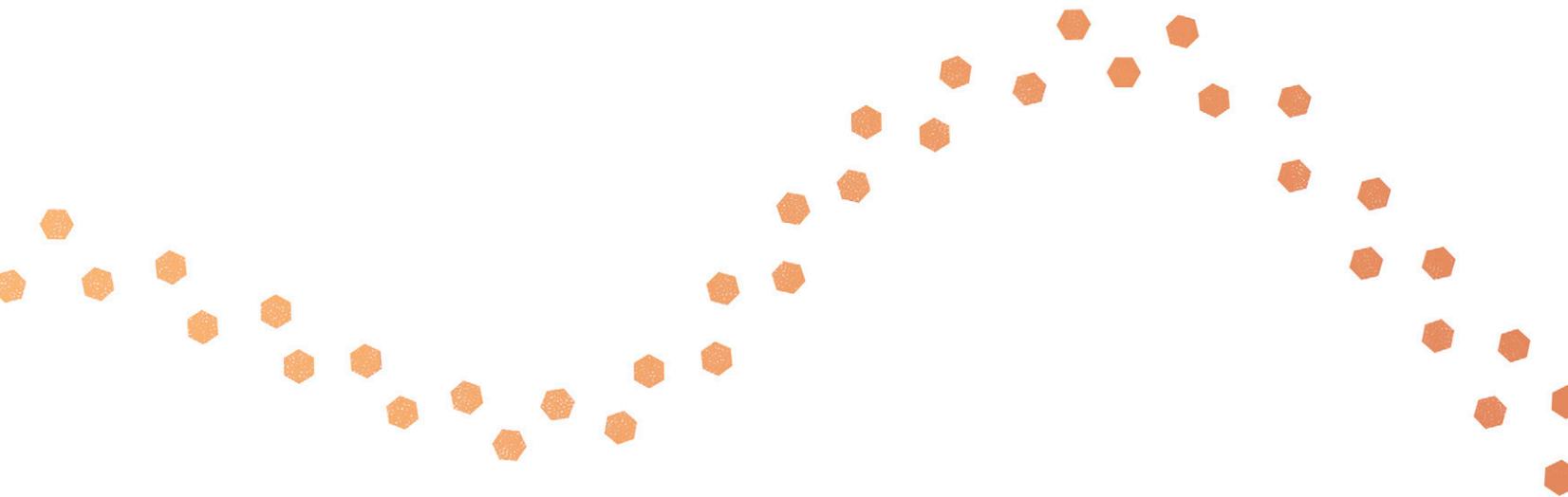
BAH...

IT'S ALL
PART OF THE
PLAN!

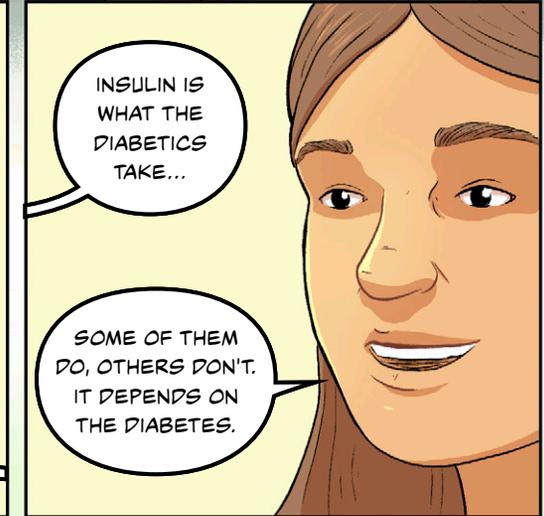
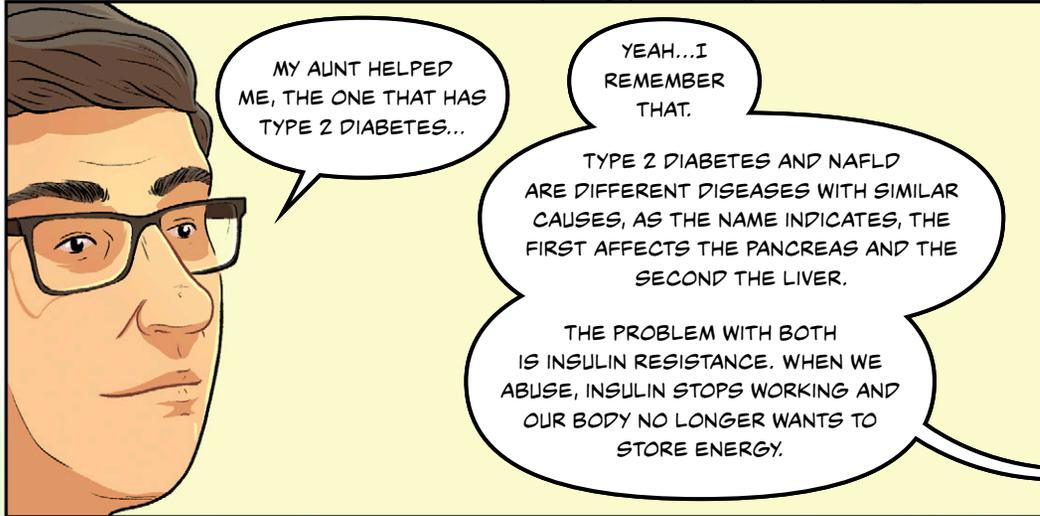
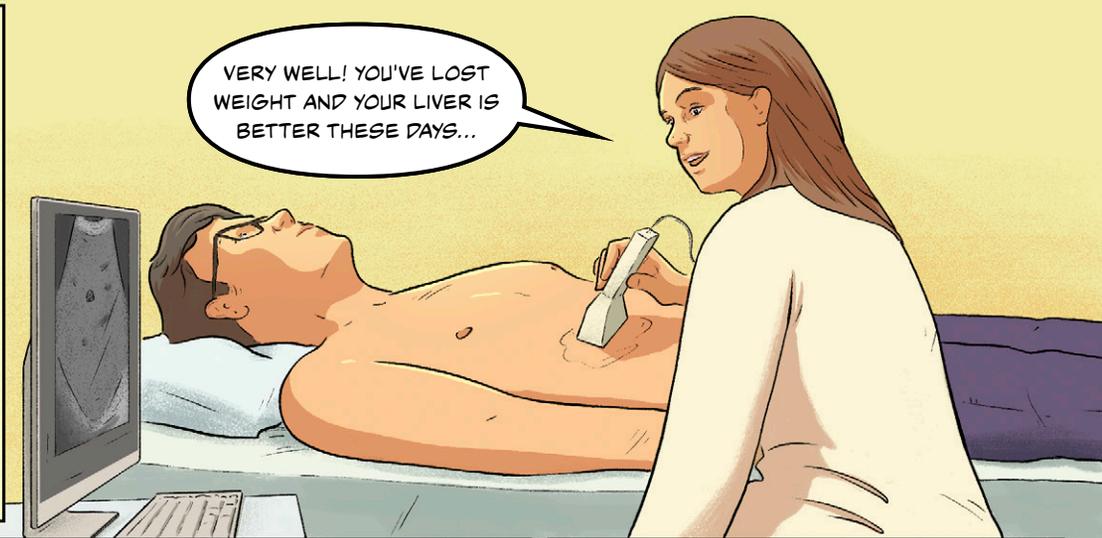










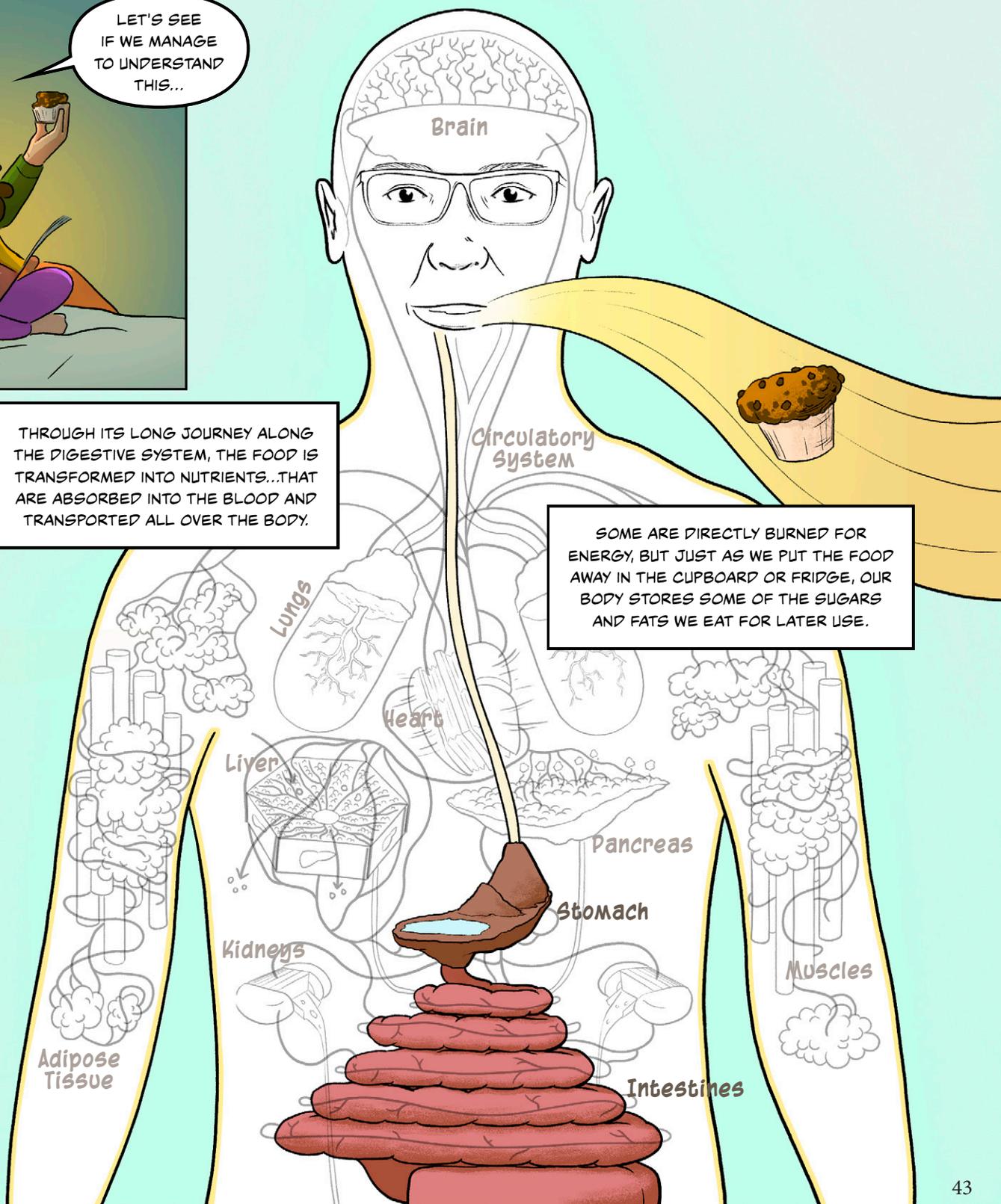




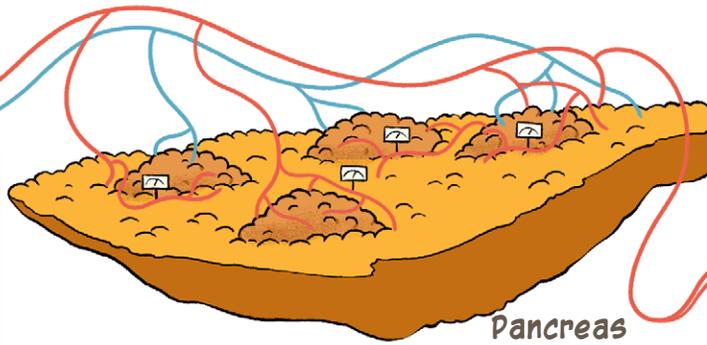
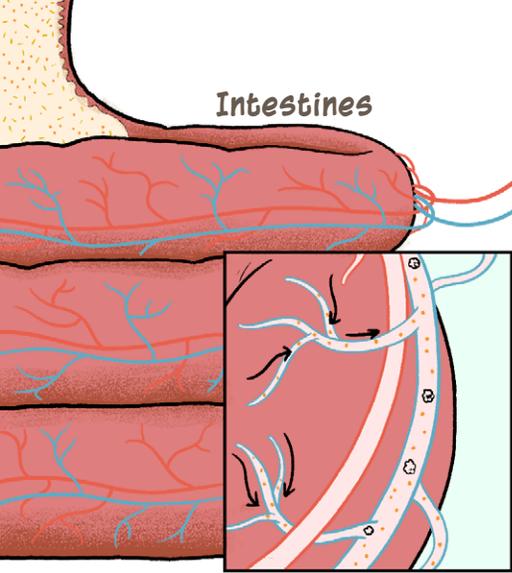
LET'S SEE
IF WE MANAGE
TO UNDERSTAND
THIS...

THROUGH ITS LONG JOURNEY ALONG
THE DIGESTIVE SYSTEM, THE FOOD IS
TRANSFORMED INTO NUTRIENTS...THAT
ARE ABSORBED INTO THE BLOOD AND
TRANSPORTED ALL OVER THE BODY.

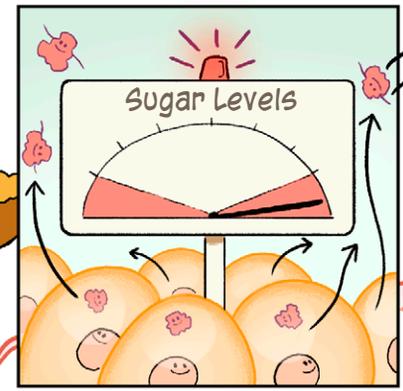
SOME ARE DIRECTLY BURNED FOR
ENERGY, BUT JUST AS WE PUT THE FOOD
AWAY IN THE CUPBOARD OR FRIDGE, OUR
BODY STORES SOME OF THE SUGARS
AND FATS WE EAT FOR LATER USE.



Intestines

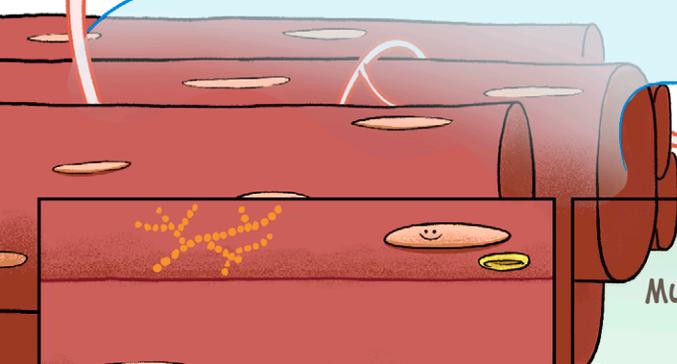


Pancreas



EQUIPPED WITH SUGAR DETECTORS, THE PANCREAS IS THE FIRST TO NOTICE THE HUGE AMOUNT OF NUTRIENTS CIRCULATING AND SENDS INSULIN TO WORK ITS CHARM.

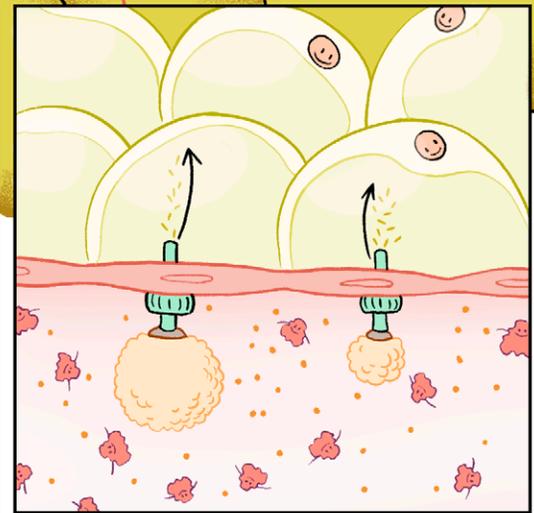
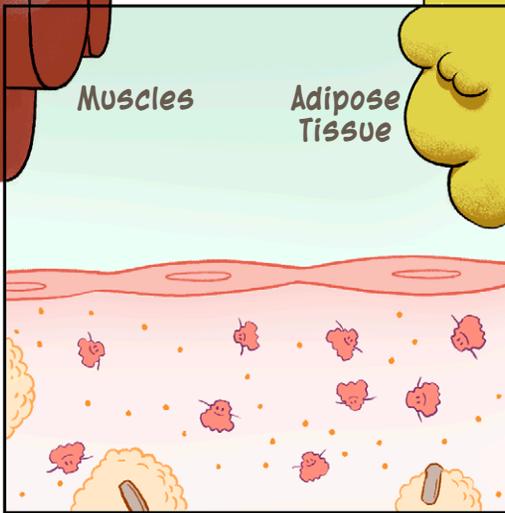
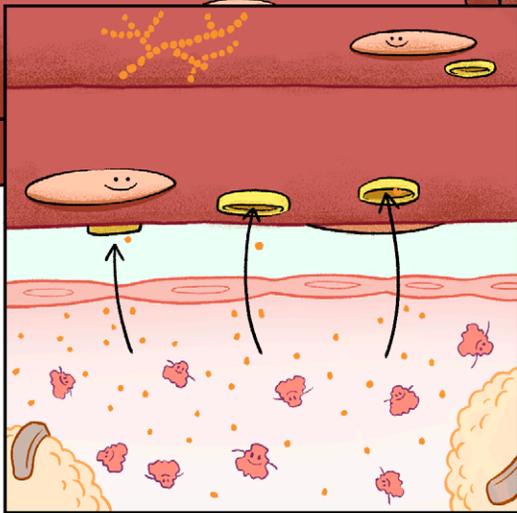
UNDER INSULIN'S ORDERS, THE NUTRIENTS ARE STORED AWAY, EACH ON ITS RIGHTFUL CABINET. SUGARS IN THE MUSCLE,



Muscles

Adipose Tissue

FATS IN THE ADIPOSE TISSUE,

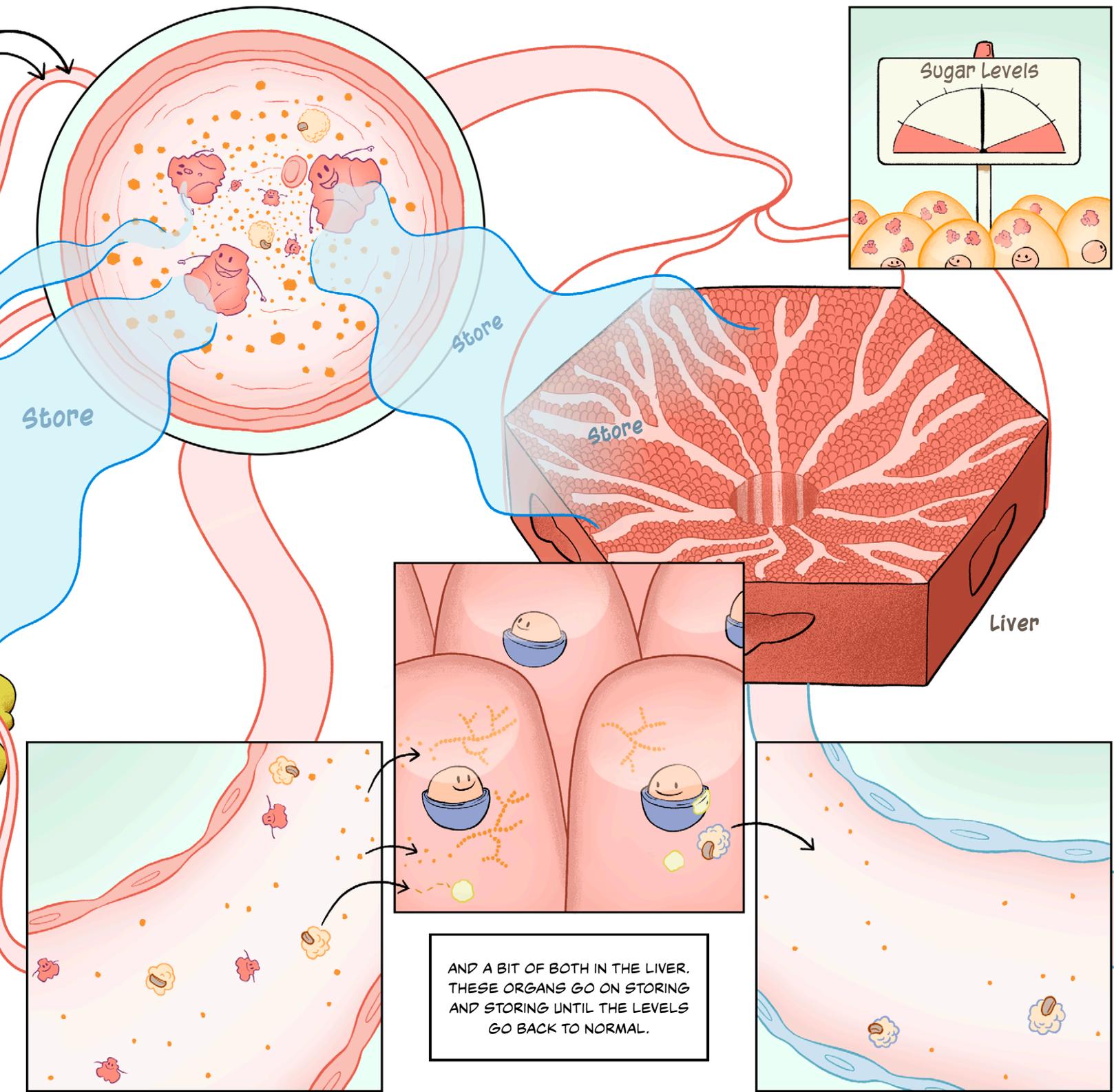


Store

Store

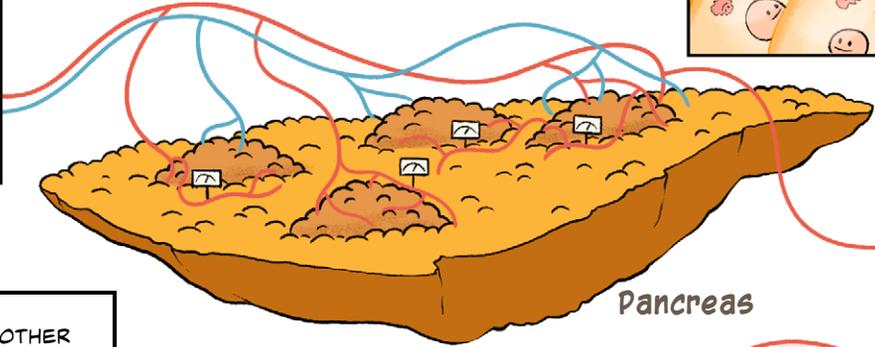
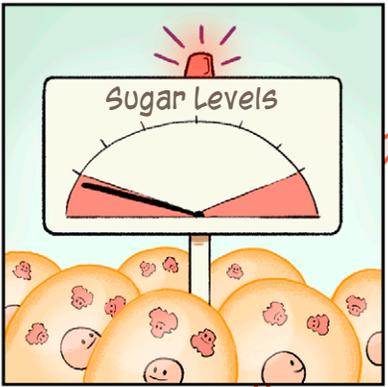
Store

Store

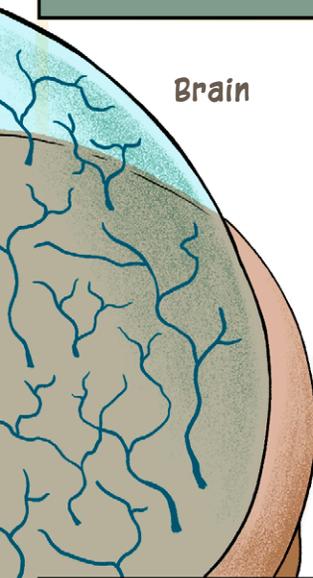




THANKS TO INSULIN WE DON'T NEED TO EAT ALL THE TIME AND WE CAN SLEEP, RESTING AT EASE.

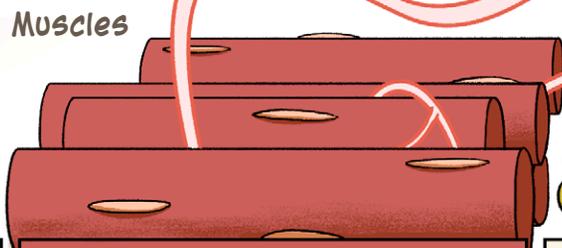


Pancreas

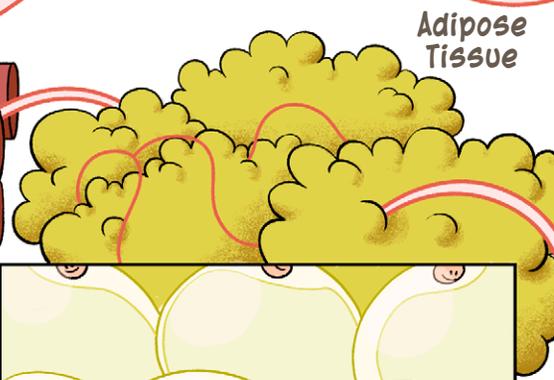


Brain

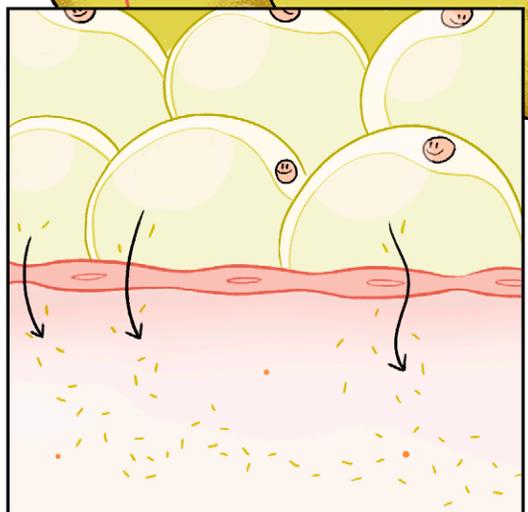
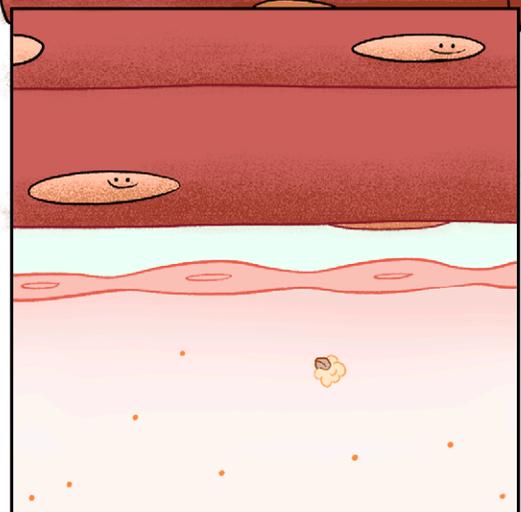
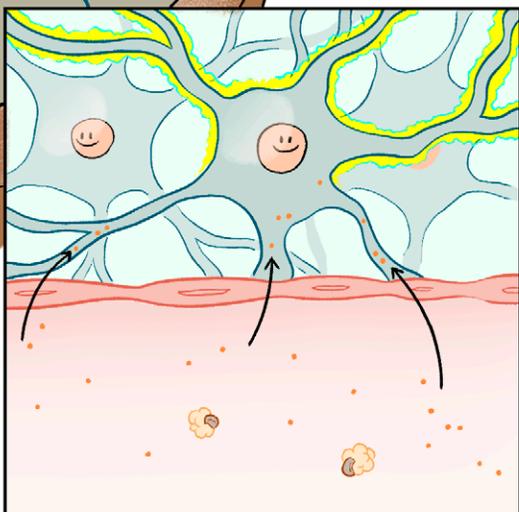
THE BRAIN AND OTHER TISSUES CONSTANTLY NEED NUTRIENTS FROM THE BLOOD TO WORK.

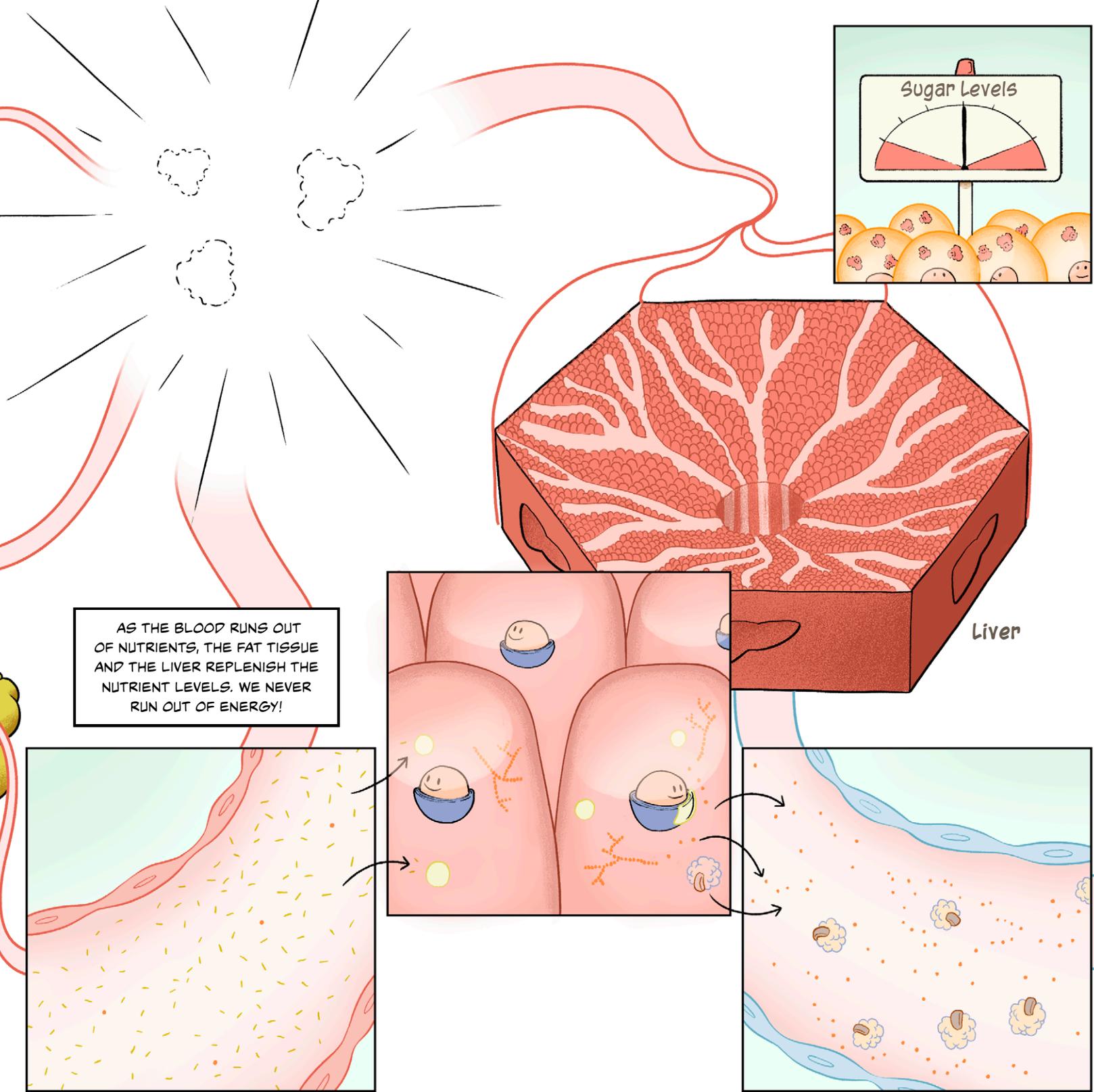


Muscles



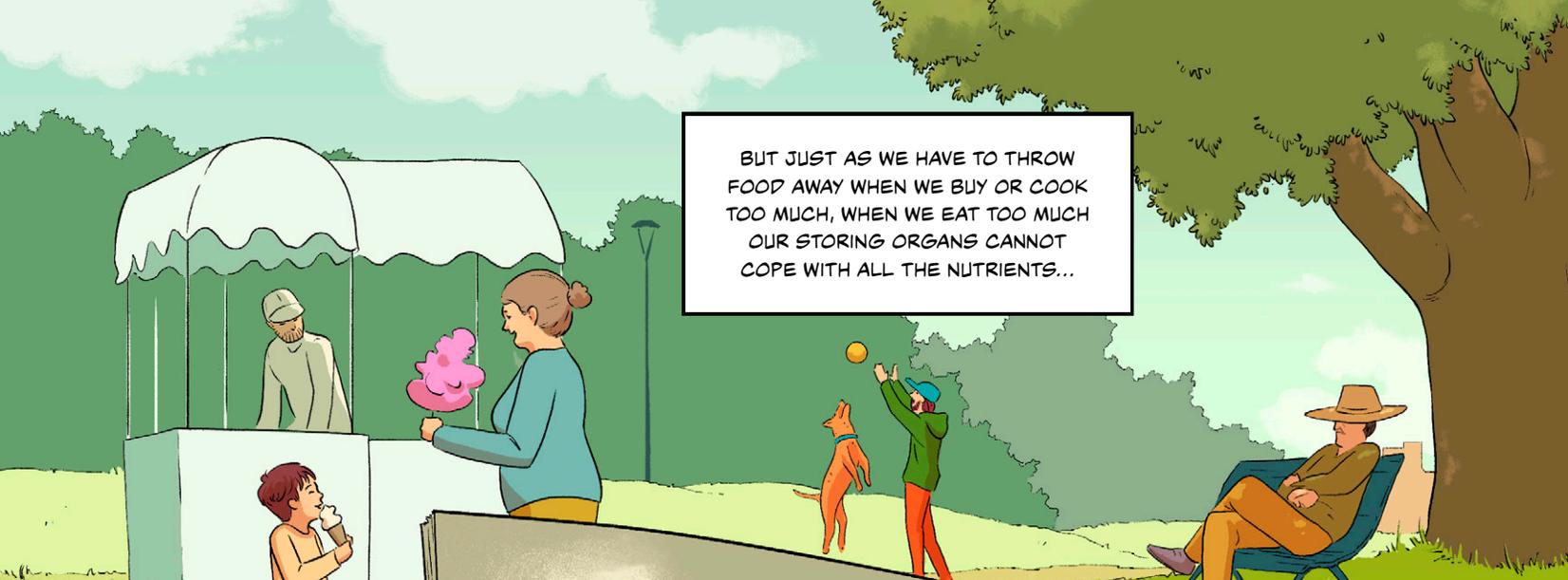
Adipose Tissue



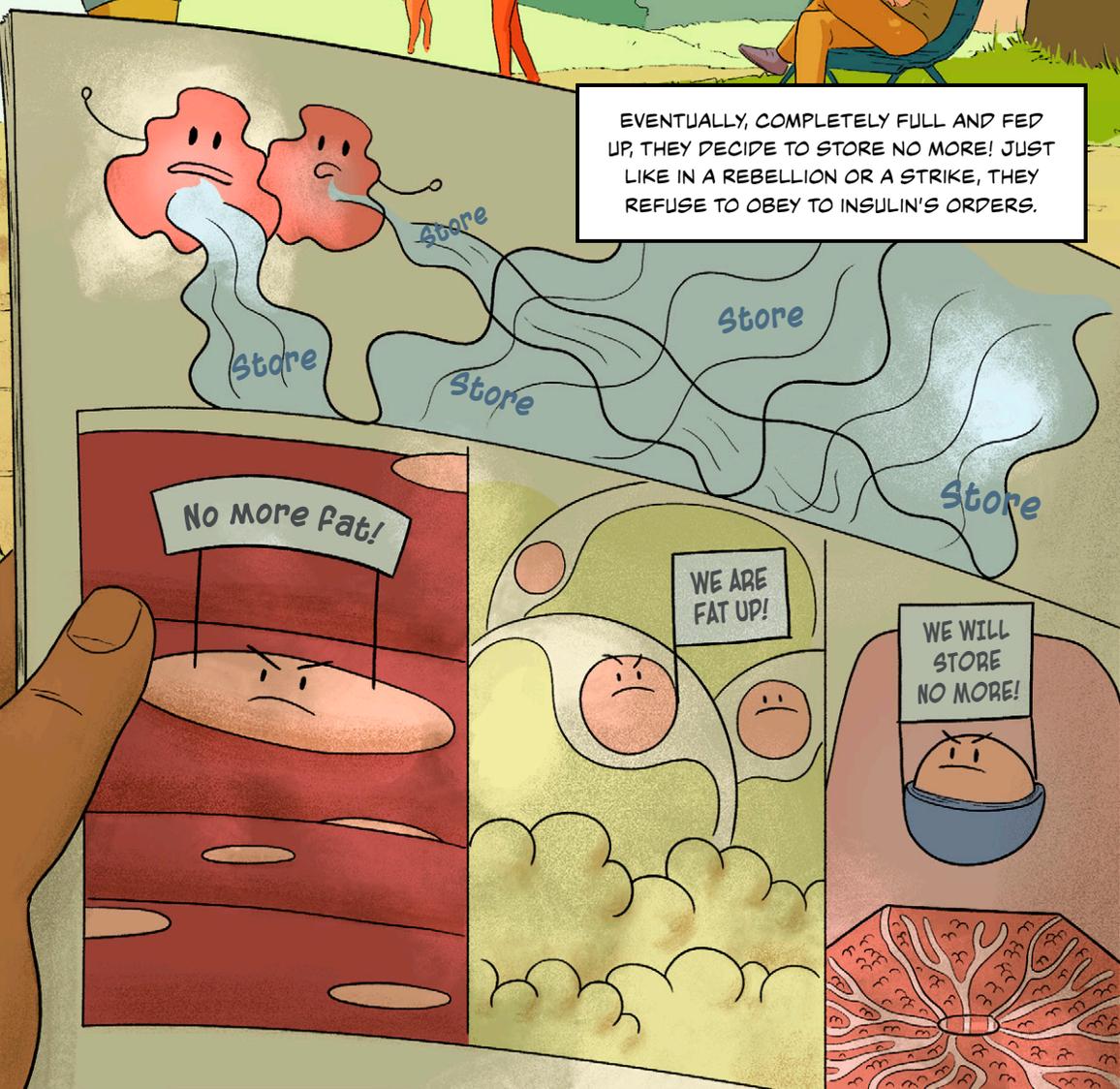


AS THE BLOOD RUNS OUT OF NUTRIENTS, THE FAT TISSUE AND THE LIVER REPLENISH THE NUTRIENT LEVELS. WE NEVER RUN OUT OF ENERGY!

Liver



BUT JUST AS WE HAVE TO THROW
FOOD AWAY WHEN WE BUY OR COOK
TOO MUCH, WHEN WE EAT TOO MUCH
OUR STORING ORGANS CANNOT
COPE WITH ALL THE NUTRIENTS...

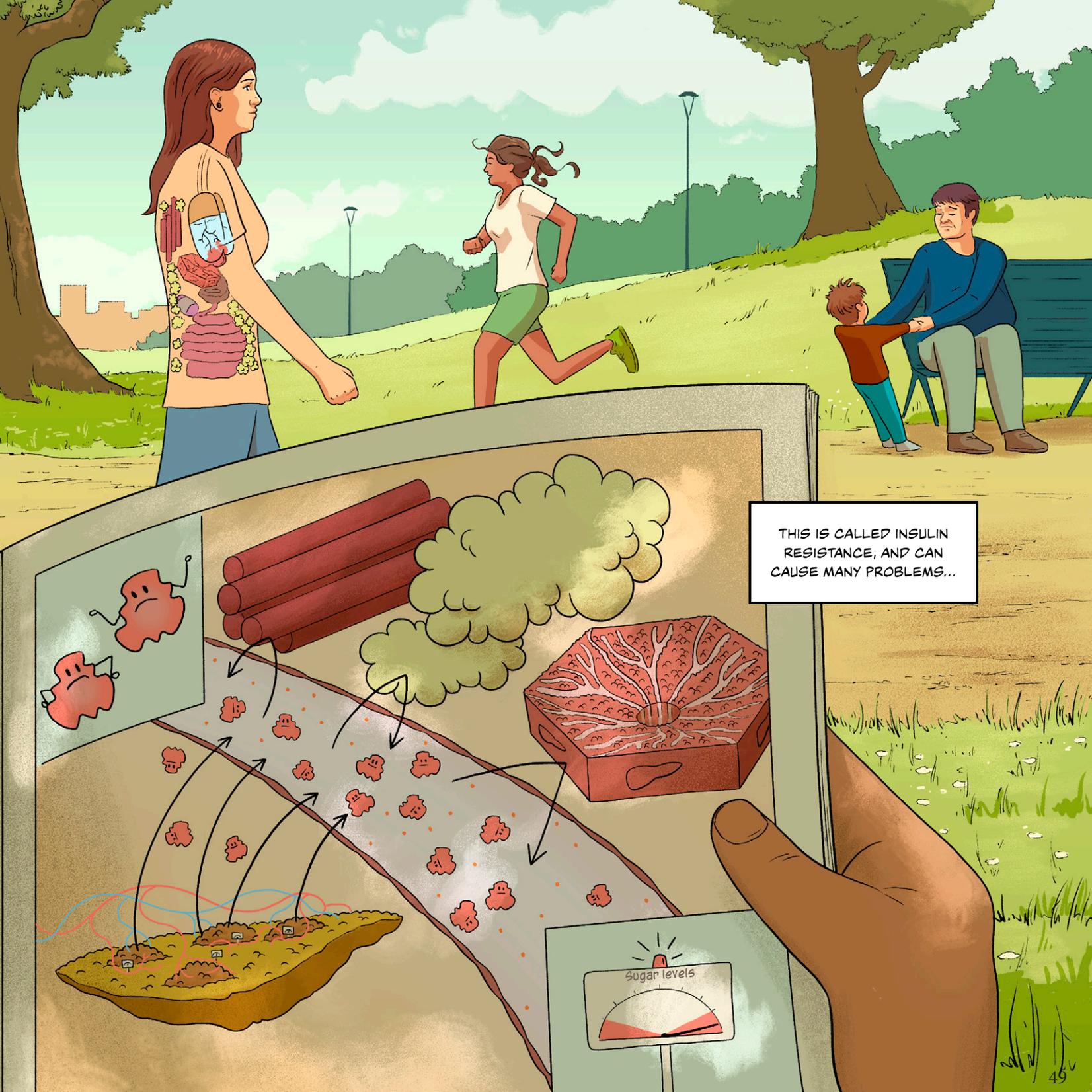


EVENTUALLY, COMPLETELY FULL AND FED
UP, THEY DECIDE TO STORE NO MORE! JUST
LIKE IN A REBELLION OR A STRIKE,
THEY REFUSE TO OBEY TO INSULIN'S
ORDERS.

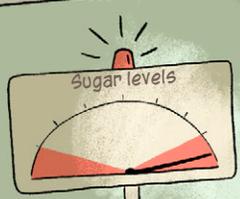
No more Fat!

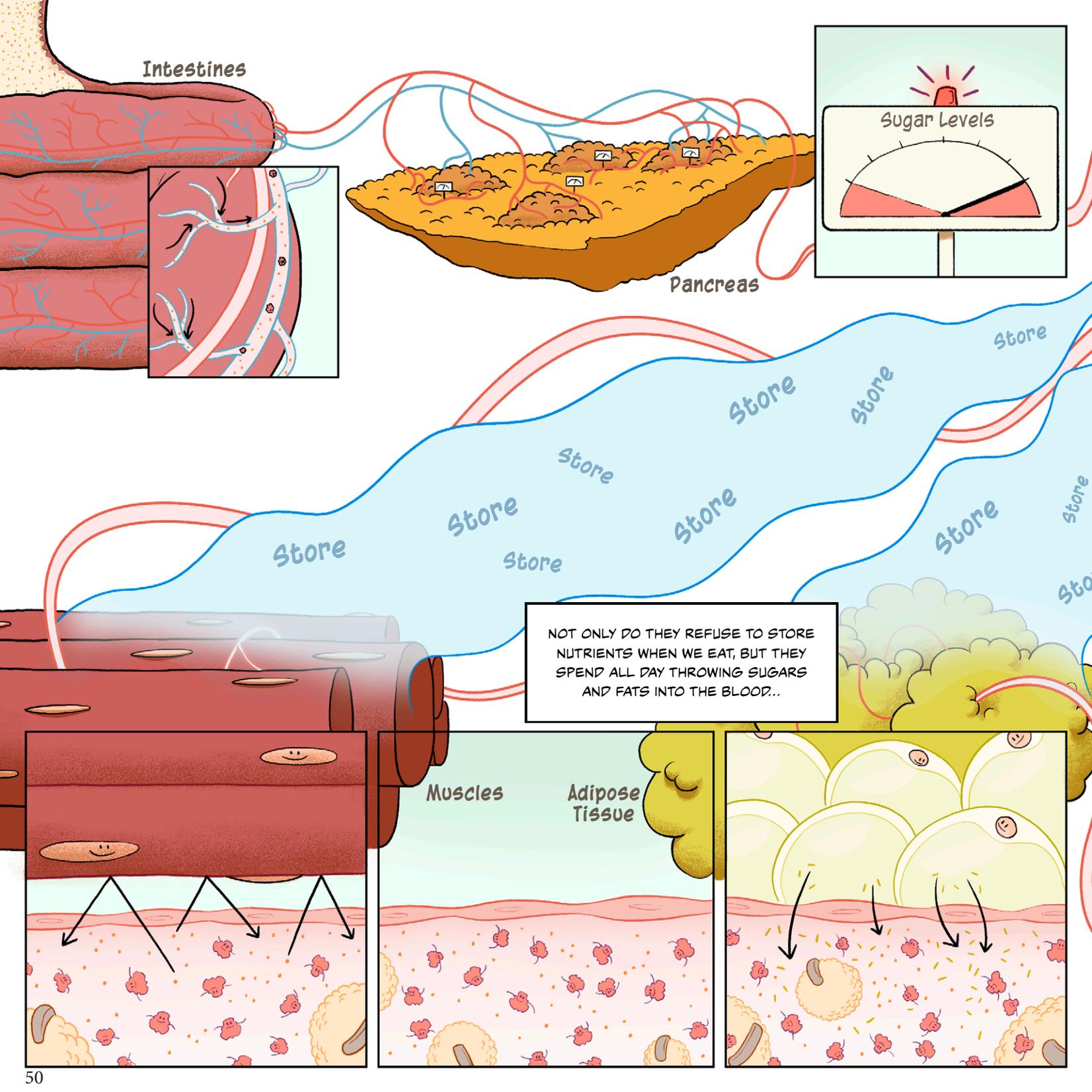
WE ARE
FAT UP!

WE WILL
STORE
NO MORE!



THIS IS CALLED INSULIN RESISTANCE, AND CAN CAUSE MANY PROBLEMS...





Intestines

Pancreas

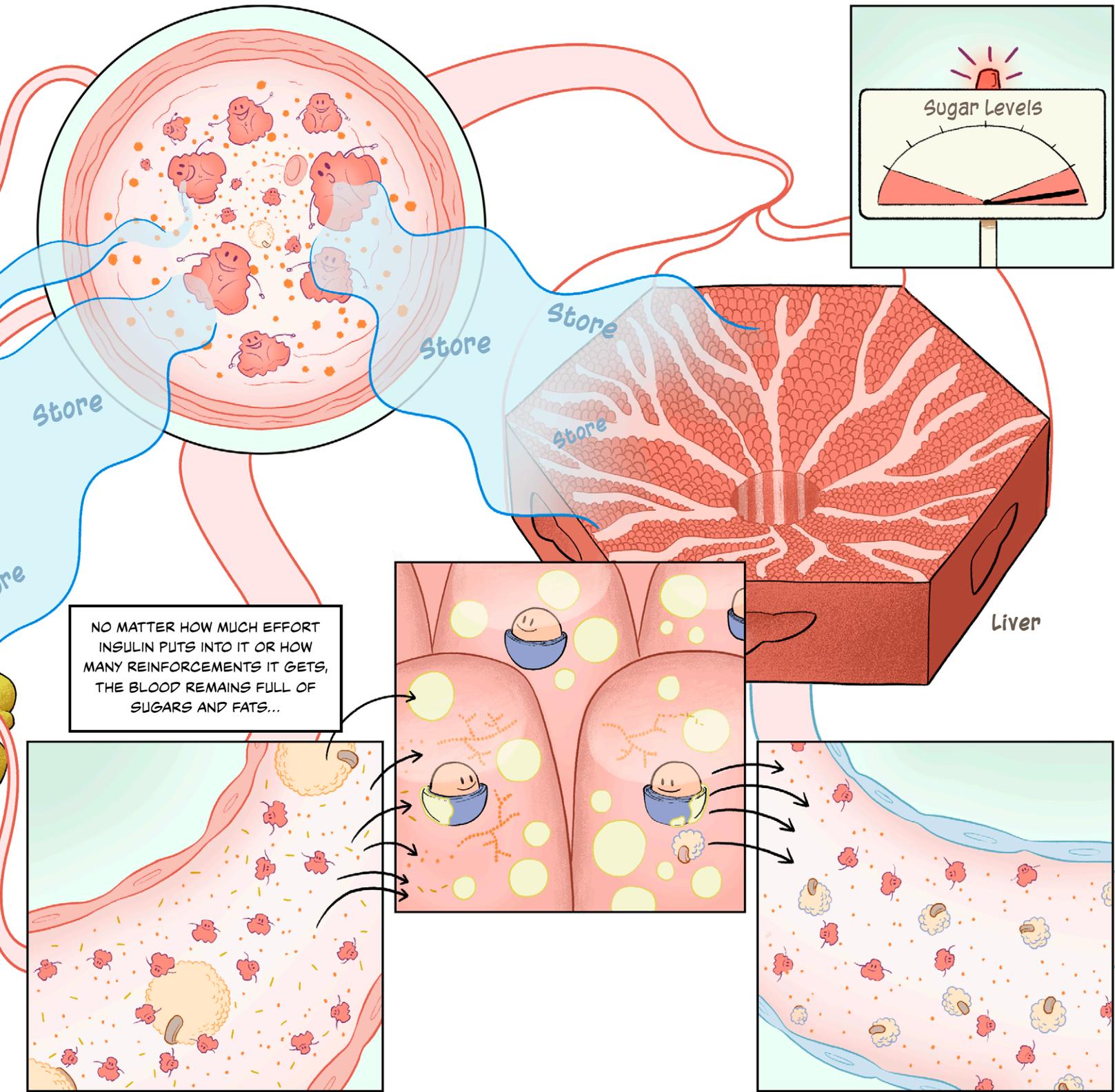
Sugar Levels

Store

NOT ONLY DO THEY REFUSE TO STORE NUTRIENTS WHEN WE EAT, BUT THEY SPEND ALL DAY THROWING SUGARS AND FATS INTO THE BLOOD...

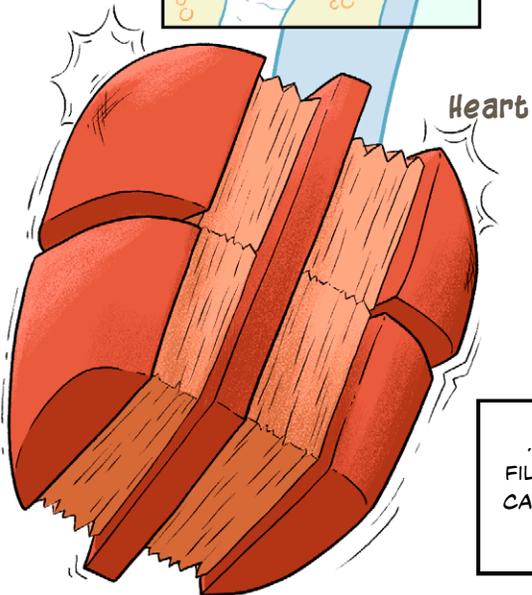
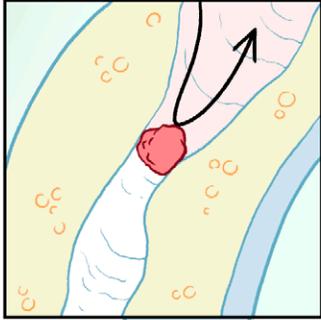
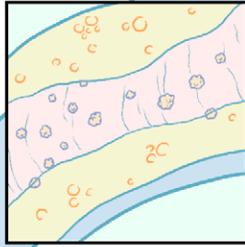
Muscles

Adipose Tissue

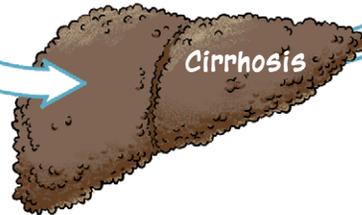
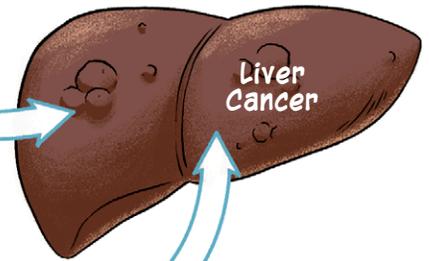
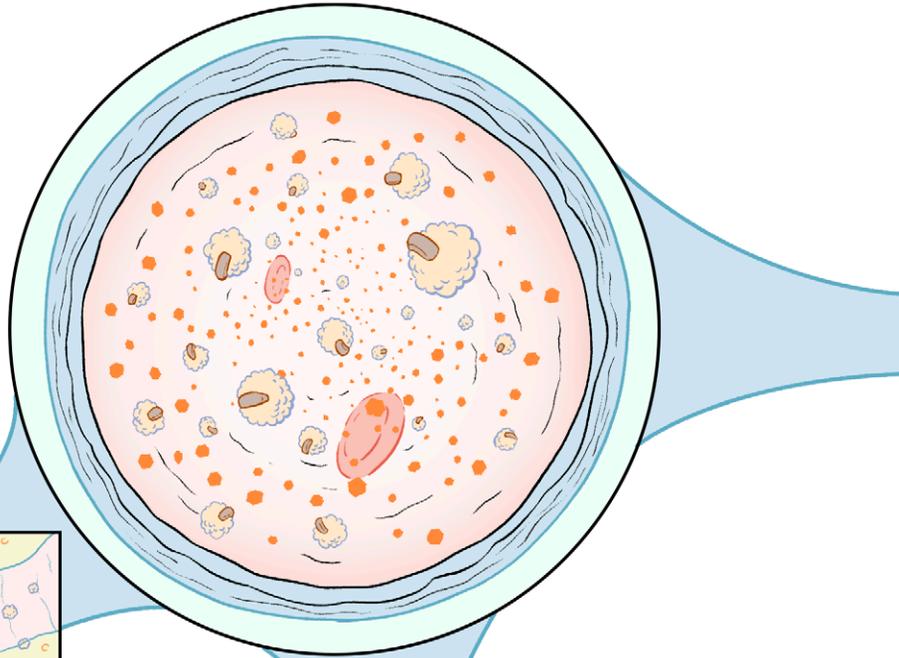




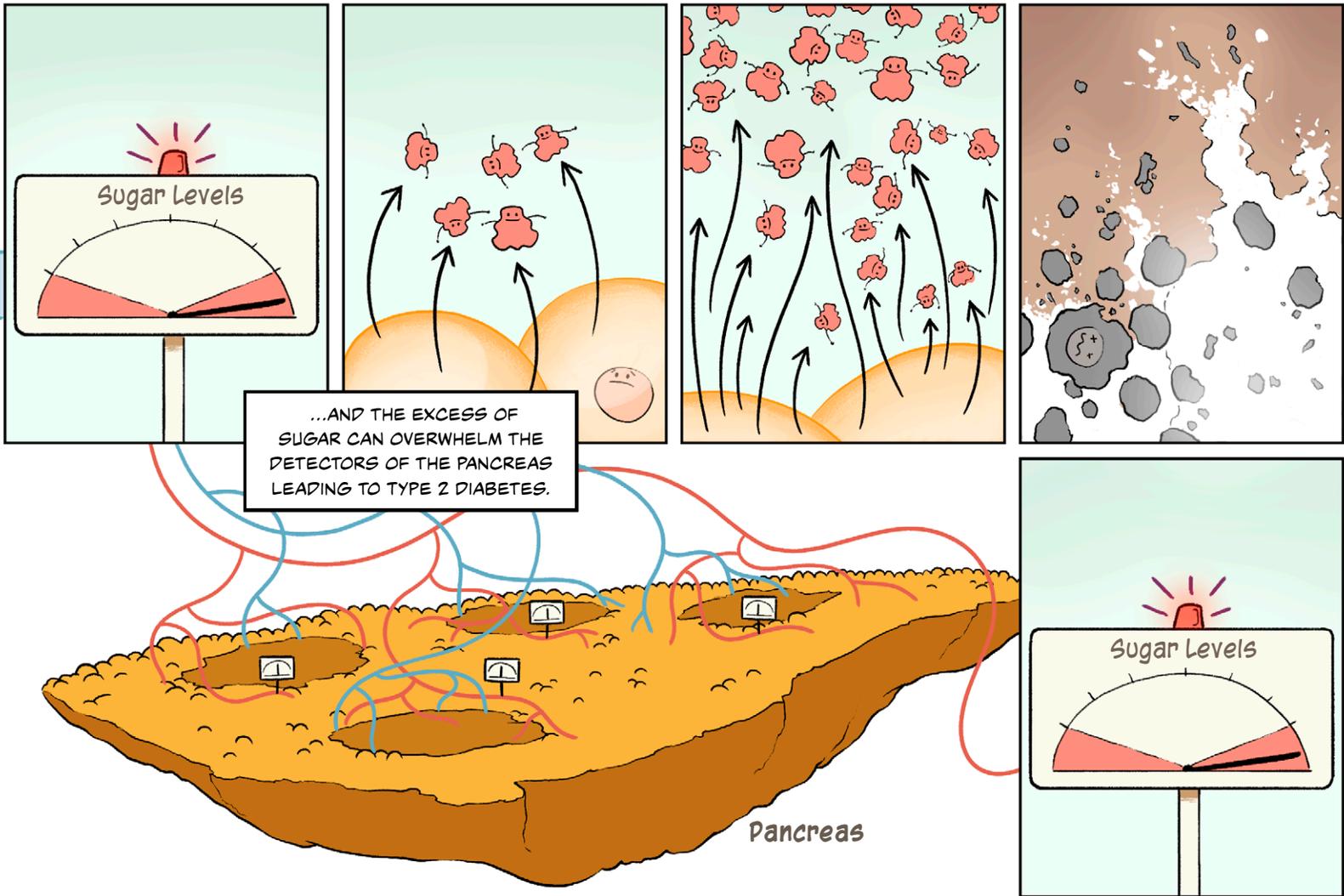
THE EXCESS OF FATS IN THE BLOOD CAN FORM ATHEROSCLEROSIS, NARROWING THE SPACE FOR BLOOD TO FLOW AND INCREASING THE RISK FOR HEART ATTACKS...



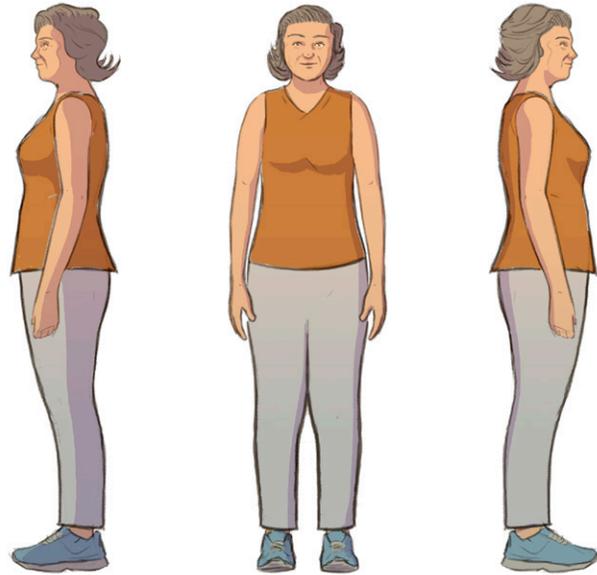
Heart



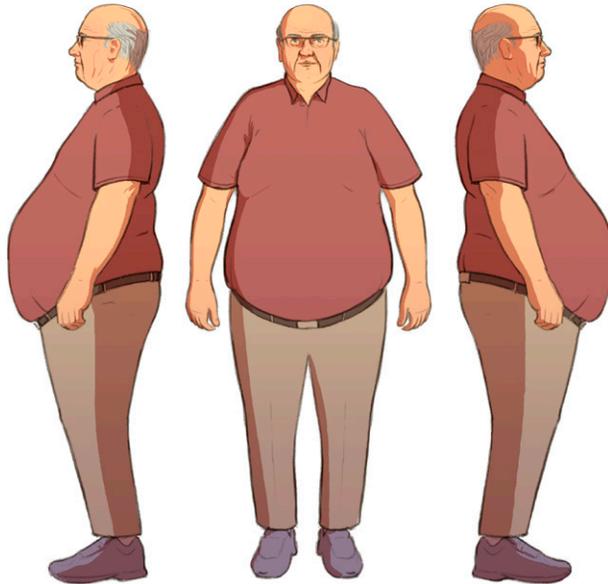
...THE LIVER IN TRYING TO FILTER THE EXCESS OF FATS CAN BECOME FATTY AND END UP WITH CIRRHOSIS...



Character biographies

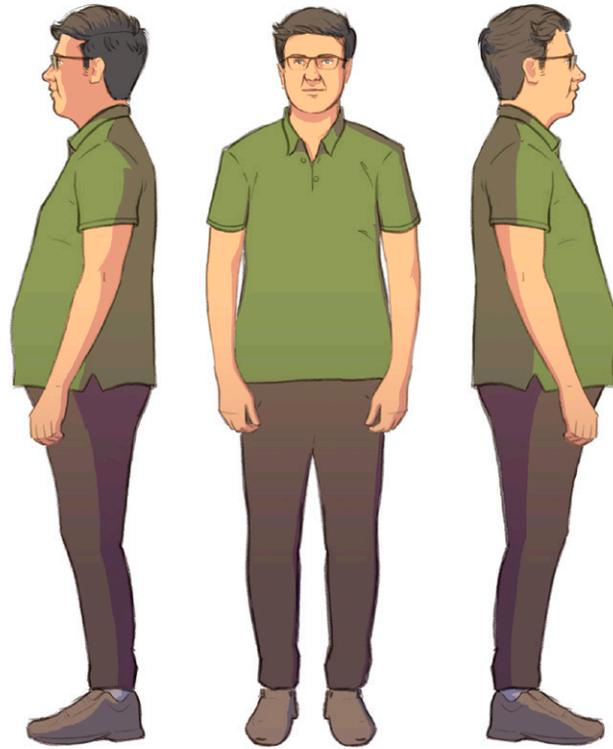


Alice is 70 years old, and is the younger sister of Jaime. She is retired and owns a house where she likes to have the family over for the holidays. Alice has Type 2 Diabetes Mellitus (T2DM), a disease in which the pancreas does not produce enough insulin to adequately regulate the levels of sugar circulating in the blood (glycemia). As a result of this disease, Alice has to take insulin shots and needs to be very careful with her diet and lifestyle. Over the years, she has learned what food products make the glycemia go dangerously high and that exercise makes her feel better because it helps lower the stubbornly high glycemia. As an expert on keeping this balance, Alice is now full of wisdom, tips and tricks that can support other characters on their journey to change the lifestyle.

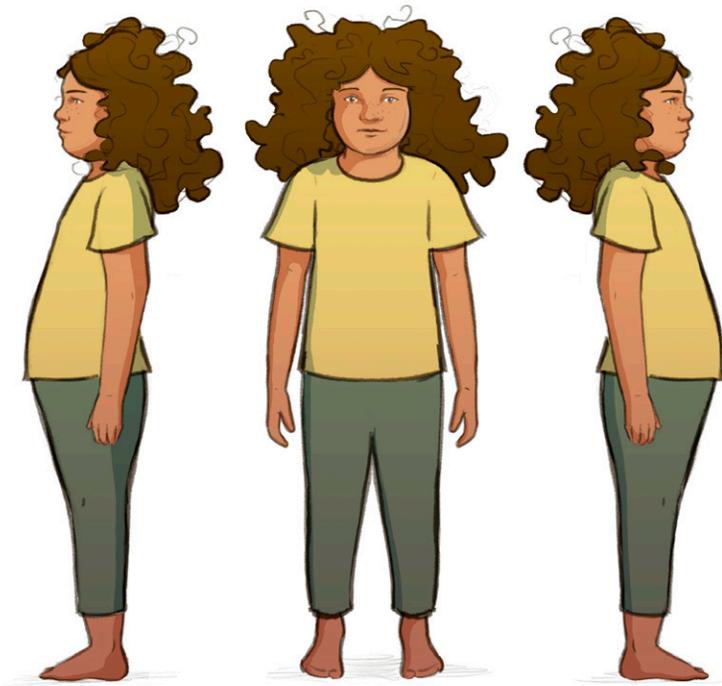


Jaime is 75 years old and is George's father. Jaime was diagnosed with Alcoholic Fatty Liver Disease (AFLD) many years ago when the doctor saw signs of liver injury in his blood test results. He was shocked to be called an alcoholic for drinking more than 2 standard drinks per day and met the doctor's recommendation of ceasing alcohol consumption with skepticism. He also disregarded clinical advice on improving his diet and exercise habits. Bound to his routine, over time, his liver started to scar and now Jaime has a form of liver disease called cirrhosis. This time, the seriousness of the doctor reminded him of some old friends that had died from cirrhosis, but what really scared him was finding himself unable to cut down on his drinking. Embarrassed of his failures, Jaime put up a front of indifference, for others and especially himself, renouncing to change and unintentionally becoming a barrier for others' change.





George is 40 years old and is Jaime's son and Vic's father. George was recently diagnosed with Non-Alcoholic Fatty Liver Disease (NAFLD). He knew that he had started to gain weight a few years back but had never crossed his mind the fact that his diet and exercise habits would have an effect on his liver. After the doctor explained the risks associated with having a fatty liver, he attempted to lose some weight to prevent the development of cirrhosis, T2DM and cardiovascular diseases like heart attacks. The real reckoning came after Vic's overweight diagnosis, when he realized the kinds of environment and the behavior he was providing and modeling for his daughter. Motivated to overcome the dissuasive effect of previous failed attempts, George has now decided to learn how to balance his diet and physical activity habits to defat his liver and regain a healthy lifestyle for his family. He hopes his aunt Alice will help him on this journey.



Vic is 6 years old and is George's daughter. For Vic everything is new. She is still discovering what she likes and doesn't like, what eventually will become her lifestyle habits. She adores her parents and her grandfather Jaime and everything she does with them. Her mom makes her eat vegetables and go to swimming lessons, but when her dad is in charge they order fast food and play videogames. On her last visit to the pediatrician, the doctor said that she is a bit on the heavy side and this caused a big quarrel between her parents. Over the summer, Vic will learn about the importance of a healthy diet and an active lifestyle for maintaining a normal weight, but also for the wellbeing of the liver, the pancreas and the heart. Soon, without realizing it, what once seemed like unappealing meals and activities will become enjoyable experiences that will carve healthy lifestyle habits for life.



This comic is the result of a collaborative academic endeavor aiming at raising Non-Alcoholic Fatty Liver Disease (NAFLD) awareness and promoting healthy lifestyles amongst the general public, with effective and participatory science communication understood as a mandatory effort required of all biomedical researchers involved.

The conceptualization, design and production of this comic emerged from a co-creation process between biomedical researchers, illustration academics and metabolic patients. In fact, the biomedical content was tailored to the information needs and background knowledge shared by type 2 diabetic patients in a formative qualitative research study performed at the Portuguese Diabetes Association (APDP)¹. The narrative structure and imagery of the comic were also strategically selected, designed and co-created combining the results of this empirical research with principles of narrative engagement and persuasion, storytelling, health promotion and models of behavior change.

The comic was developed under the FOIE GRAS project (ID: 722619), a European consortium funded by the European Union's Horizon 2020 – Marie Skłodowska-Curie Actions (MSCA) and coordinated by the Center for Neuroscience and Cell Biology (CNC) at the University of Coimbra, Portugal. Alongside state-of-the-art research to better understand the pathophysiology and treatment of NAFLD, the FOIE GRAS network is deeply committed to science communication and public outreach.

Following the long-lasting dedication of CNC to science communication and to the production of science-based comics, this project was born from the collaboration between two PhD theses on science communication of two students of the Doctoral Program in Experimental Biology and Biomedicine, hosted at the Institute for Interdisciplinary Research of the University of Coimbra (IIIUC). Those students were Mireia Alemany i Pagès (FOIE GRAS early-stage researcher) and Rui Tavares (holder of a PhD scholarship from FCT- SFRH/BD/136900/2018), with the assistance of senior researcher and comic-book expert João Ramalho-Santos, Professor at the Department of Life Sciences, and the additional support of CNC Researcher Anabela Marisa Azul.

¹ Alemany-Pagès M, Moura-Ramos M, Araújo S, Macedo MP, Ribeiro RT, do Ó D, Ramalho-Santos J, Azul AM. Insights from qualitative research on NAFLD awareness with a cohort of T2DM patients: time to go public with insulin resistance?. BMC Public Health. 2020 Jul 20;20(1):1142. <https://doi.org/10.1186/s12889-020-09249-5>.

Title

A Healthy Liver Will Always Deliver!

Concept & story: Mireia Alemany i Pagès

Script: João Ramalho-Santos

Illustration: Rui Tavares

A participatory approach with editorial support by Anabela Marisa Azul

Acknowledgments

The authors thank the participants of the APDP study, Ana Maria, Carlos, Paulo, Ana, Armindo, Luisa, Francisca, Maria, Rui, Maria, Rosa, Laura, Manel, Angelica, Zé, Luis, Liliana and António for sharing their time, their knowledge and experience in living with T2DM.

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Institutional Support



Do you know what your liver is?
Do you know the many important things it does for us, keeping us healthy and alive?

Did you know that our dietary habits can affect the wellbeing of our liver?
Or that a sedentary lifestyle can harm it?

You probably are not aware, but one in every four people in the world has
Non-Alcoholic Fatty Liver Disease (NAFLD),
which can go unnoticed for years and result in severe liver damage,
cirrhosis and even hepatic cancer.
Are you one of them?

The excessive accumulation of fat in the liver
is caused by unhealthy diets and sedentary lifestyles.
Are you at risk?

Although you can have it without being overweight,
people that are obese and those with Type 2 Diabetes
have a higher risk of developing NAFLD.
So, how can we fix this?

Get to know your liver better with this comic and
find out how to treat and prevent this form of liver disease!

Think of your liver the next time you eat,
and don't forget to stay active for its health and your wellbeing.

Remember that a Healthy Liver will Always Deliver!



This project has received funding from the European Union's Framework Programme for Research and Innovation Horizon 2020 under the Marie Skłodowska-Curie Grant Agreement No 722619. This comic reflects only the authors' view and the Commission is not responsible for any use that may be made of the information in contains.