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The Wide World of Chemical Engineering





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“The Wide World of Chemical Engineering”

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...WHAT SHOULD I DO
IN THE FUTURE?



SORRY, I COULDN'T
HELP BUT OVERHEAR!

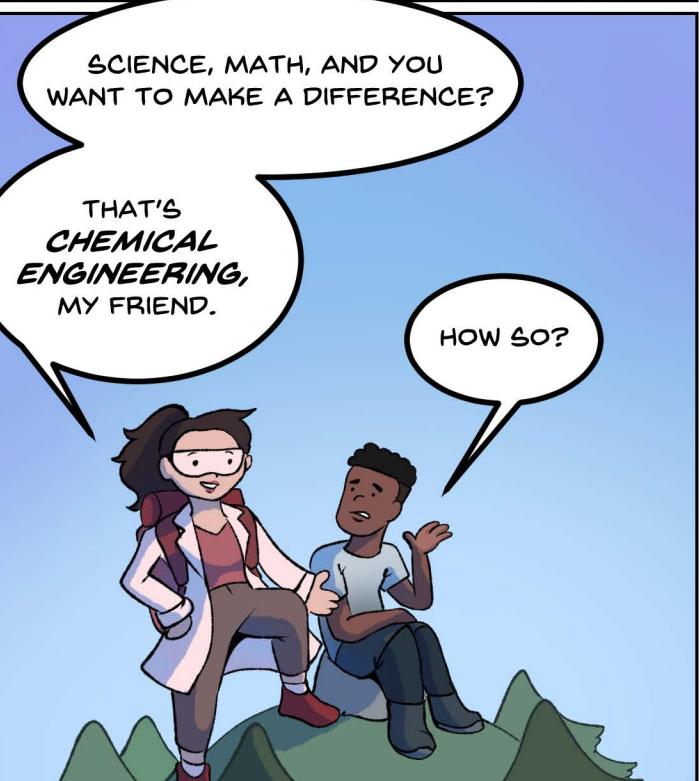
WHAT DO YOU
WANT TO DO?



I DON'T KNOW...

I TOOK A CAREER TEST
THE OTHER DAY AT SCHOOL,
AND IT HAD SOME SUGGESTIONS
BECAUSE I KIND OF LIKE
SCIENCE AND MATH.

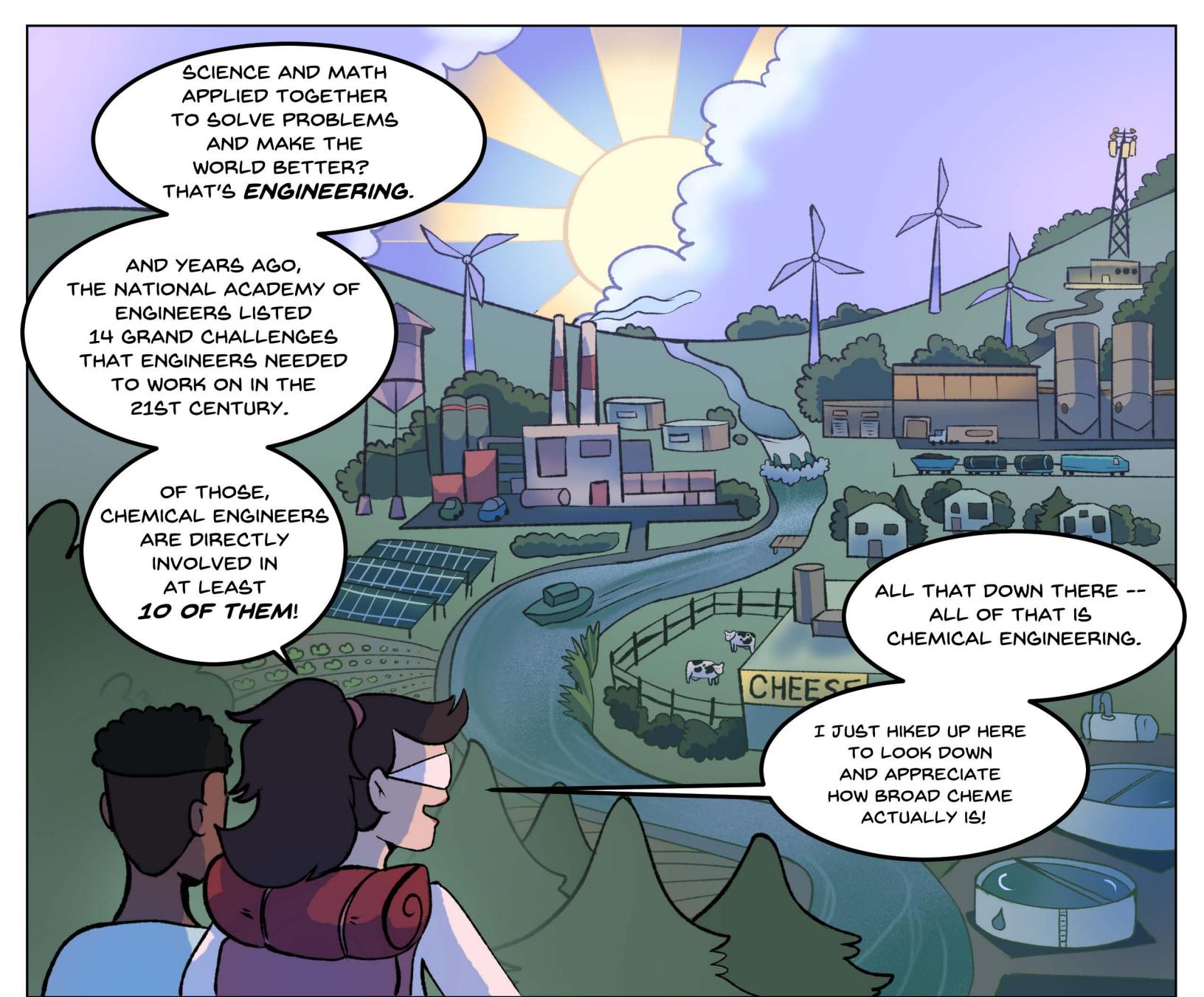
BUT REALLY,
I JUST WANT TO
DO SOMETHING THAT
MAKES A DIFFERENCE!



SCIENCE, MATH, AND YOU
WANT TO MAKE A DIFFERENCE?

THAT'S
**CHEMICAL
ENGINEERING**,
MY FRIEND.

HOW SO?



SCIENCE AND MATH APPLIED TOGETHER TO SOLVE PROBLEMS AND MAKE THE WORLD BETTER? THAT'S ENGINEERING.

AND YEARS AGO, THE NATIONAL ACADEMY OF ENGINEERS LISTED 14 GRAND CHALLENGES THAT ENGINEERS NEEDED TO WORK ON IN THE 21ST CENTURY.

OF THOSE, CHEMICAL ENGINEERS ARE DIRECTLY INVOLVED IN AT LEAST 10 OF THEM!

ALL THAT DOWN THERE -- ALL OF THAT IS CHEMICAL ENGINEERING.

I JUST HIKED UP HERE TO LOOK DOWN AND APPRECIATE HOW BROAD CHEM ACTUALLY IS!



YEAH!!

DO YOU WANT ME TO SHOW YOU?



THEN LET'S GO IN AND TAKE A LOOK!

SO MOST PEOPLE ASSUME THAT CHEMICAL ENGINEERING IS THE PLACE TO BE IF YOU LIKE MATH AND CHEMISTRY. AND THAT'S PARTLY BECAUSE THEY DON'T REALIZE EVERYTHING THAT CHEMES ACTUALLY DO, BUT THERE'S SOME TRUTH TO IT, TOO.

FOR EXAMPLE, THERE ARE A LOT OF CHEMICALS WE NEED TO PRODUCE IN MASS QUANTITIES TO MEET PUBLIC DEMAND OR TO BE ABLE TO MAKE OTHER IMPORTANT PRODUCTS.



SO CHEMES MIGHT USE A GIANT DISTILLATION COLUMN TO PURIFY OIL FOR GAS CONSUMPTION, OR SEPARATE NITROGEN FROM LIQUID AIR SO WE CAN MAKE STEEL ...



OR MAYBE THEY'LL MAKE SULFURIC ACID THROUGH A FURNACE AND OTHER DEVICES, FOR USE IN FERTLIZERS OR TO MAKE OTHER CHEMICALS!



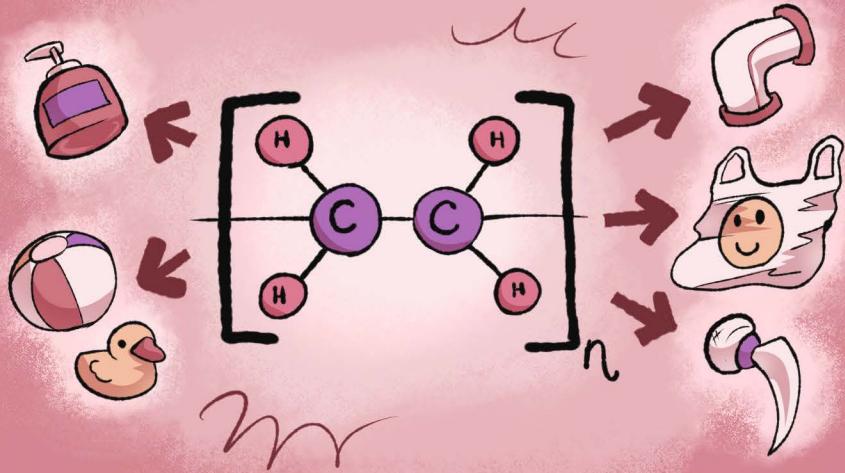
OVER 250 BILLION TONS OF CHEMICALS ARE PRODUCED EVERY YEAR -- AND CHEMES HAVE TO FIGURE OUT HOW TO BOTH MEET DEMAND AND DO IT SAFELY!



...BILLION TONS?
THAT'S A LOT OF
CHEMISTRY.

DON'T JUST FOCUS
ON THE CHEMISTRY,
THOUGH. IT'S THE
PROPERTIES OF THE
MATERIALS
THEMSELVES THAT
MATTER JUST AS
MUCH IF NOT MORE
TO CHEMES.

LIKE PLASTICS! CONSIDER THE POLYMER CALLED
POLYETHYLENE. DEPENDING ON HOW IT'S MADE, IT
CAN BE USED IN PLASTIC BAGS, SOAP BOTTLES, TOYS,
PIPES, OR EVEN HIP REPLACEMENTS! IT'S THE SAME
BASIC CHEMICAL, BUT CHEMES CHANGE THE
PROPERTIES SO IT HAS A WIDE RANGE OF USES!



MATERIAL SCIENCE, SUCH
AS POLYMER SCIENCE, IS
AN IMPORTANT FIELD
THAT CHEMES PLAY A
MASSIVE ROLE IN
DEVELOPING, AND THE
PRODUCT OF THEIR WORK
IS ALL AROUND US!

IN OUR CLOTHES AND THE
SYNTHETIC FIBERS THAT ARE WOVEN
INTO THEM, THE METAL IN OUR
APPLIANCES AND TECHNOLOGICAL
DEVICES, EVEN THAT SLIME THAT
SOME KIDS PLAY AROUND WITH WHEN
THEY DON'T FEEL LIKE DOING
HOMEWORK.

THAT'S A
LOT MORE
THAN JUST
CHEMISTRY.

ANY MATERIAL YOU
USE EVERY DAY WAS
PROBABLY MADE OR
TESTED BY A
CHEMICAL ENGINEER.
AND THIS GOES EVEN
FOR THINGS THAT
AREN'T PLASTIC OR
MAN-MADE TOO!

WAIT, YOU SAID HIP
REPLACEMENTS
BEFORE. ISN'T
THAT MEDICAL
SCIENCE?

OH, CHEMES
CAN DO A LOT
OF GOOD
MEDICALLY AND
BIOLOGICALLY,
TOO. HERE, LET
MY FRIEND
SHOW YOU!

CHEMES ARE HEAVILY INVOLVED IN MEDICINE AND BIOLOGICAL FIELDS!

LIKE HIP REPLACEMENTS, OR OTHER MATERIALS THAT GO INSIDE SOMEONE'S BODY -- CHEMICAL ENGINEERS CAN FOCUS ON PRODUCING BIOMATERIALS THAT CAN INTERACT WITH THE HUMAN BODY AND WON'T BE CONTAMINATED OR REJECTED BY THE BODY.

AND ANY GOOD ENGINEER NEEDS GOOD TOOLS TO MEASURE WITH -- SO CHEMES ALSO WORK TO DEVELOP NEW SENSORS AND DEVICES THAT CAN DETECT EVEN SMALL TRACES OF DIFFERENT CHEMICALS FROM BLOOD OR OTHER SAMPLES.

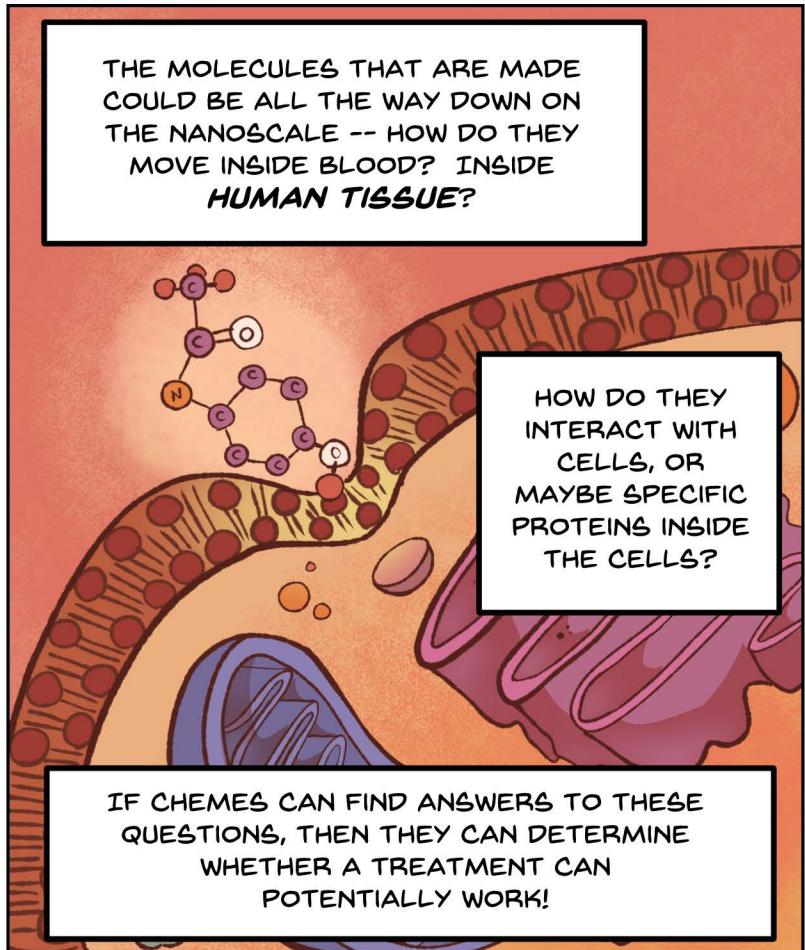


AND THAT LEADS TO A BIG PART OF CHEMICAL ENGINEERING WORK IN MEDICINES THEMSELVES! WE CALL IT '**DRUG DISCOVERY**' -- TRYING TO DETERMINE WHAT MEDICINES CAN PROVIDE TREATMENT, CURE DISEASES, FIGHT CANCER, AND MORE.

THE MOLECULES THAT ARE MADE COULD BE ALL THE WAY DOWN ON THE NANOSCALE -- HOW DO THEY MOVE INSIDE BLOOD? INSIDE HUMAN TISSUE?



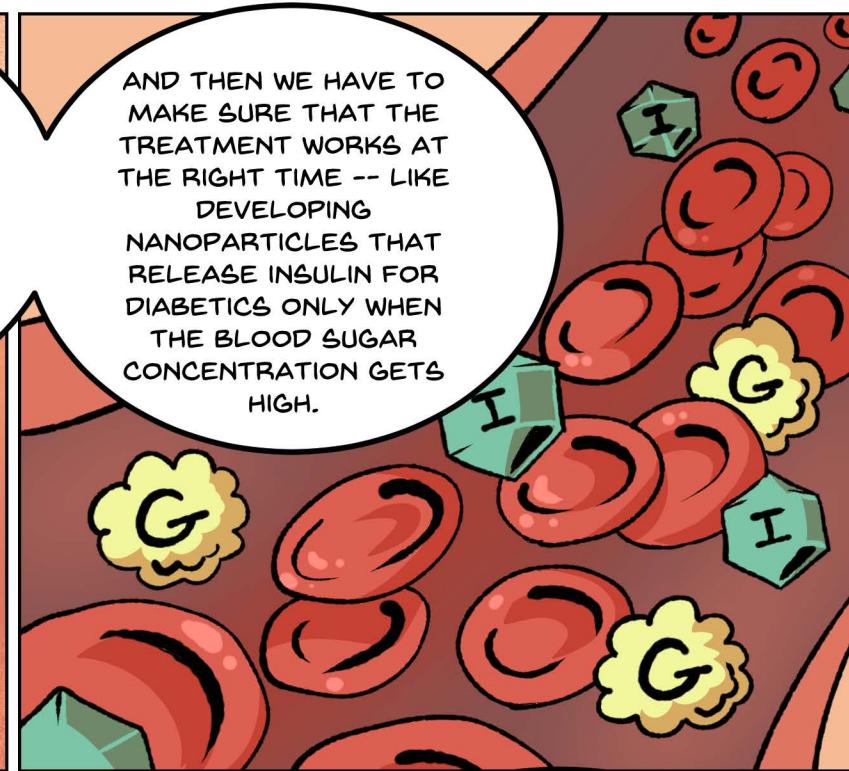
HOW DO THEY INTERACT WITH CELLS, OR MAYBE SPECIFIC PROTEINS INSIDE THE CELLS?



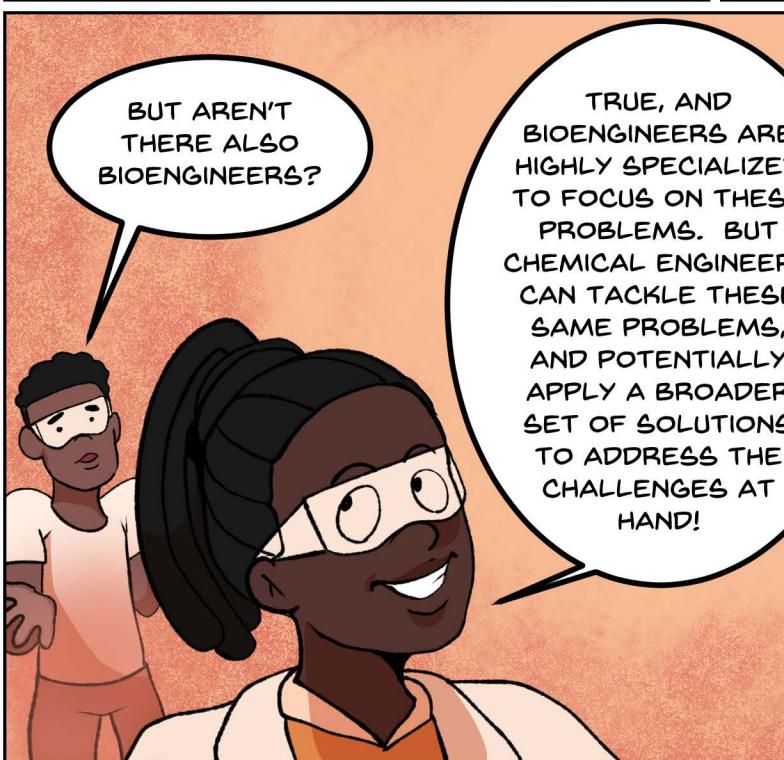
IF CHEMES CAN FIND ANSWERS TO THESE QUESTIONS, THEN THEY CAN DETERMINE WHETHER A TREATMENT CAN POTENTIALLY WORK!



ALL THAT LEADS TO THE NEXT STEP -- WHAT WE CALL '**DRUG DELIVERY**'. HOW DO WE TARGET CERTAIN SPECIFIC AREAS INSIDE THE BODY FOR TREATMENT? HOW DO THEY EVADE THE BODY'S NATURAL IMMUNE RESPONSE?

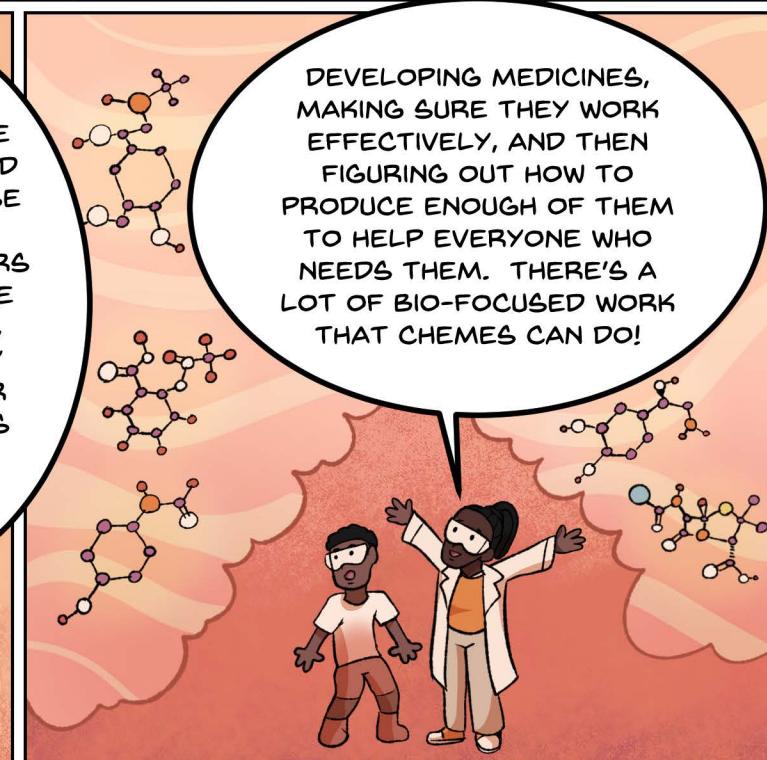


AND THEN WE HAVE TO MAKE SURE THAT THE TREATMENT WORKS AT THE RIGHT TIME -- LIKE DEVELOPING NANOPARTICLES THAT RELEASE INSULIN FOR DIABETICS ONLY WHEN THE BLOOD SUGAR CONCENTRATION GETS HIGH.



BUT AREN'T THERE ALSO BIOENGINEERS?

TRUE, AND BIOENGINEERS ARE HIGHLY SPECIALIZED TO FOCUS ON THESE PROBLEMS. BUT CHEMICAL ENGINEERS CAN TACKLE THESE SAME PROBLEMS, AND POTENTIALLY APPLY A BROADER SET OF SOLUTIONS TO ADDRESS THE CHALLENGES AT HAND!



DEVELOPING MEDICINES, MAKING SURE THEY WORK EFFECTIVELY, AND THEN FIGURING OUT HOW TO PRODUCE ENOUGH OF THEM TO HELP EVERYONE WHO NEEDS THEM. THERE'S A LOT OF BIO-FOCUSED WORK THAT CHEMES CAN DO!



AND WE'RE JUST GETTING STARTED ON THE MATERIALS THAT CHEMICAL ENGINEERING WORKS WITH!

CHEMICAL MATERIALS, BIOMATERIALS... AND THEN THERE'S **ELECTROMATERIALS**. AND ENERGY! AND BATTERIES! A WHOLE OTHER FIELD WITHIN CHEMICAL ENGINEERING!



BATTERIES ARE BASICALLY JUST CHEMICAL PROCESSES -- AND INSIDE EACH BATTERY IS PRACTICALLY A MINIATURE FACTORY, WITH ALL THE PROCESSES GOING ON INSIDE!

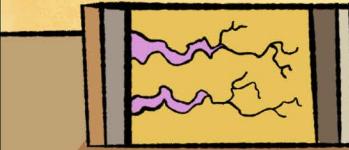
WAIT, BATTERIES? HOW IS THAT A CHEMICAL ENGINEERING CONCERN?

AND THEY'RE A HUGE CONCERN TO MAKE SURE THAT WE CAN MEET THE DEMAND TO POWER ALL OUR EQUIPMENT AND DEVICES.

USUALLY, MOST BATTERIES ARE LITHIUM-ION OR LEAD-ACID BASED, BUT THOSE CAN BE EXPENSIVE OR HAVE TOXIC CHEMICALS. WE NEED SOLUTIONS THAT CAN PROVIDE MORE POWER AT A LOWER COST WITH SAFER CHEMICALS.



AND CHEMICALLY, THIS IS ALSO A STABILITY CONCERN. LITHIUM IS SO REACTIVE THAT IT CAN FORM **MICROFIBERS** WHICH CAN SHORT-CIRCUIT THE BATTERY -- SO ALTERNATIVES NEED TO BE ABLE TO HOLD UP TO LONG-TERM USE, TOO.



BUT CHEMICAL ENGINEERS ARE HARD AT WORK, RESEARCHING NEW MATERIAL COMBINATIONS AND TESTING THEM OUT!



AND IT'S NOT JUST PROVIDING POWER THAT'S AN ENGINEERING CHALLENGE -- BUT ALSO HAVING A PLACE TO STORE IT!

THINK ABOUT THE RENEWABLE RESOURCES AVAILABLE TO US -

- HYDROPOWER CAPTURED BY TURBINES TURNED IN DAMS, GEOTHERMAL POWER CAPTURED FROM HEAT WITHIN THE EARTH -

- WIND POWER CAPTURED BY WINDMILLS, SOLAR POWER CAPTURED BY SOLAR PANELS -

IT'S GREAT TO HAVE ALL THESE RESOURCES AVAILABLE SO WE CAN CUT DOWN ON OUR USE OF FOSSIL FUELS, BUT WE NEED A WAY TO STORE ALL THAT ENERGY TO MAKE THEM PRACTICAL SOLUTIONS.

LARGER CAPACITY BATTERIES -- AND WAYS TO TRANSMIT ALL THAT POWER -- ARE CRITICAL TO SOCIETY'S NEEDS AND TO THE PLANET!

AND CHEMICAL ENGINEERS ARE WORKING EVERY DAY TO PRODUCE BATTERIES EXACTLY FOR THAT PURPOSE!

ALONG WITH A NUMBER OF OTHER ENVIRONMENTAL CHALLENGES!



CHEMICAL
ENGINEERS DO
ENVIRONMENTAL
WORK, TOO?

THERE ARE A LOT OF
CHEMICAL PROCESSES AND
CHALLENGES THAT IMPACT
PEOPLE OUT HERE FOR US
TO WORK ON!

CONSIDER THIS
RIVER. EVERYBODY
NEEDS DRINKING
WATER, RIGHT? BUT
NOT EVERYONE HAS
A RELIABLE OR
CLEAN SOURCE OF
WATER TO DRAW
FROM!

IN AREAS WHERE SALT WATER IS MOST PREVALENT,
CHEMICAL ENGINEERS USE A PROCESS CALLED
REVERSE OSMOSIS THAT ALLOWS THEM TO SEPARATE
OUT SALT AND PROVIDE POTABLE WATER. IN SOME AREAS
OF THE WORLD, THERE ARE GIANT FACILITIES THAT CAN
PRODUCE MILLIONS OF GALLONS OF WATER PER DAY!



AND IN OTHER CASES, THE
WATER MAY HAVE BEEN
POLLUTED WITH TRASH
AND CHEMICALS AND
CARRY DISEASE WITHIN.
OR POLLUTION SEEPED
INTO THE GROUND, AND
GROUNDWATER CARRIED IT
ONWARD FROM THERE.

SO CHEMICAL ENGINEERS
DEVELOP FILTRATION
PROCESSES TO BE ABLE
TO SEPARATE OUT THE
HARMFUL MATERIALS,
BOTH **BIG** AND
MICROSCOPIC, NOT ONLY
TO HELP HUMANS BUT
ALSO THE GREATER
ENVIRONMENT.

AND THEN THERE ARE CHEMICALS IN THE AIR THAT NEED SEPARATION, TOO. AND CHEMES CAN USE SYSTEMS LIKE **GAS ABSORBERS** OR FILTRATION TO REMOVE THOSE CONTAMINANTS.

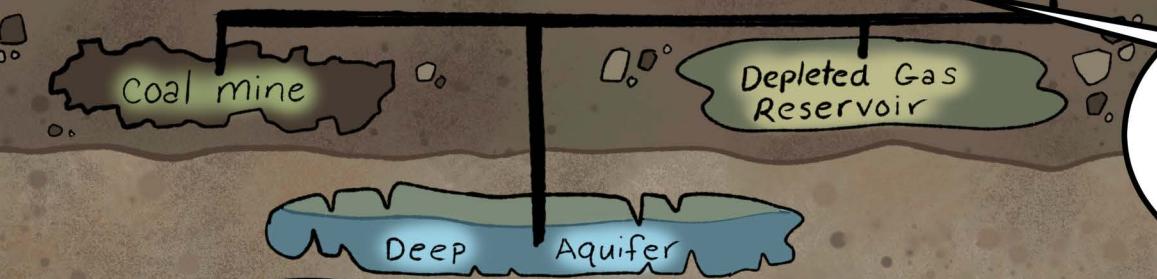
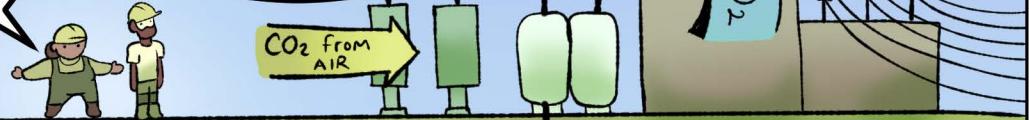


BYPRODUCTS FROM DIFFERENT INDUSTRIAL PROCESSES LIKE SULFUR DIOXIDE, BUT THE EVEN BIGGER CHALLENGE ARE CARBON-BASED GASES, LIKE **CARBON DIOXIDE** AND **METHANE**.



CARBON DIOXIDE IS A NATURAL PRODUCT OF COMBUSTION, WHICH HAS BEEN OUR MAJOR MEANS OF ENERGY PRODUCTION FOR DECADES -- BUT IT ALSO IS CHIEFLY RESPONSIBLE FOR HEATING THE PLANET AND INDUCING CLIMATE CHANGE.

CHEMICAL ENGINEERS ARE WORKING TO DEVELOP CARBON CAPTURE SYSTEMS THAT WILL SEPARATE CARBON DIOXIDE FROM THE AIR WHEN IT IS PRODUCED, AND THEN STORE IT DEEP UNDERGROUND.



THIS IS A TREMENDOUS CHALLENGE, BUT CHEMICAL ENGINEERS ARE UP FOR THE TASK!

SO CHEMICAL ENGINEERS ARE HEAVILY INVOLVED IN TAKING CARE OF THE ENVIRONMENT--

AS WELL AS ALL THE FOOD WE DRAW FROM IT!



CHEMICAL
ENGINEERS
WORK WITH
FOOD, TOO?

LIKE WHAT?

OF COURSE!
IN A BUNCH OF
DIFFERENT
WAYS!

HERE TAKE
SOME GUM.

THIS IS A
WEIRD
FLAVOR,
WHAT IS IT?

NOT SURE, A
CHEMICAL
ENGINEER FRIEND
OF MINE MADE IT,
AND THEY TEND TO
HAVE STRANGE
TASTES IN THINGS.

BUT WHY IS A
CHEMICAL
ENGINEER
INVOLVED IN
FOOD?

WELL FIRST, WE
NEED TO MAKE
SURE WE CAN
GROW THE FOOD
SOCIETY NEEDS,
IN BOTH QUALITY
AND QUANTITY.

SO CHEMICAL
ENGINEERS
WORK HARD TO
PRODUCE
FERTILIZERS
TO HELP
CROPS GROW.

WHAT ABOUT
PESTICIDES TO
PROTECT THE
CROPS FROM
BUGS?

THERE CERTAINLY
HAVE BEEN SOME
INCREDIBLY TOXIC
CHEMICALS
PRODUCED IN THE
PAST, HURTING
BOTH PEOPLE AND
BEES.

SO CHEMISTS TRY
TO PRODUCE
VERSIONS THAT
ARE BETTER
CONTROLLED.

AND AFTER
THE CROPS
ARE GROWN?

WELL, YOU CERTAINLY
DON'T JUST EAT RAW
PLANTS, RIGHT? ALL OF
THAT GETS TURNED INTO
DIFFERENT FOOD
PRODUCTS -- AND FINDING
THE PROCESSES ARE
CRITICAL FOR EACH FINAL
PRODUCT!

Cabbag

PROCESSING

POTATO

THINK CHOCOLATE.

CHEMICAL ENGINEERS HAVE TO FIND THE RIGHT MIXTURE OF INGREDIENTS, AND MIXED AT THE RIGHT SPEED AND TEMPERATURE, TO MAKE SURE THAT THE CHOCOLATE HAS THE RIGHT TEXTURE AND FLAVOR.



OR ICE CREAM!

CHEMICAL ENGINEERS WORK OUT THE PROCESS TO ENSURE IT CAN BE FROZEN AND PACKAGED AND LAST UNTIL IT IS EATEN!



OR EVEN CEREAL -- SO MUCH ENGINEERING GOES INTO MAKING SURE EACH SQUARE CAN BE PRODUCED AT HIGH TEMPERATURES AND HIGH SPEEDS AND STILL HAVE THE RIGHT COATING OF CINNAMON ON TOP.



OR MAKING POTATO CHIPS OF ALL DIFFERENT FLAVORS.

OR THE POWDERED FOODS THAT YOU JUST ADD WATER TO LATER.



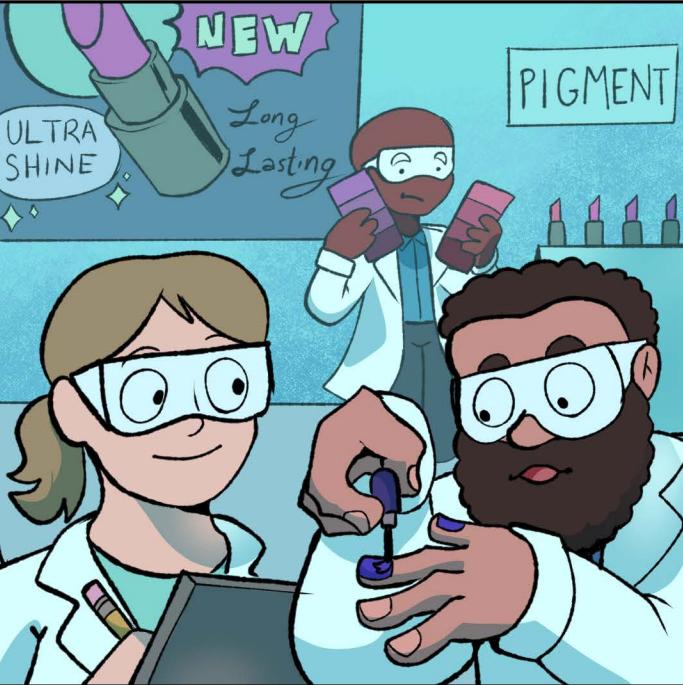
OR THAT GUM I TRIED!

JUST ONE OF SO MANY FIELDS THAT CHEMISTS ARE PART OF!

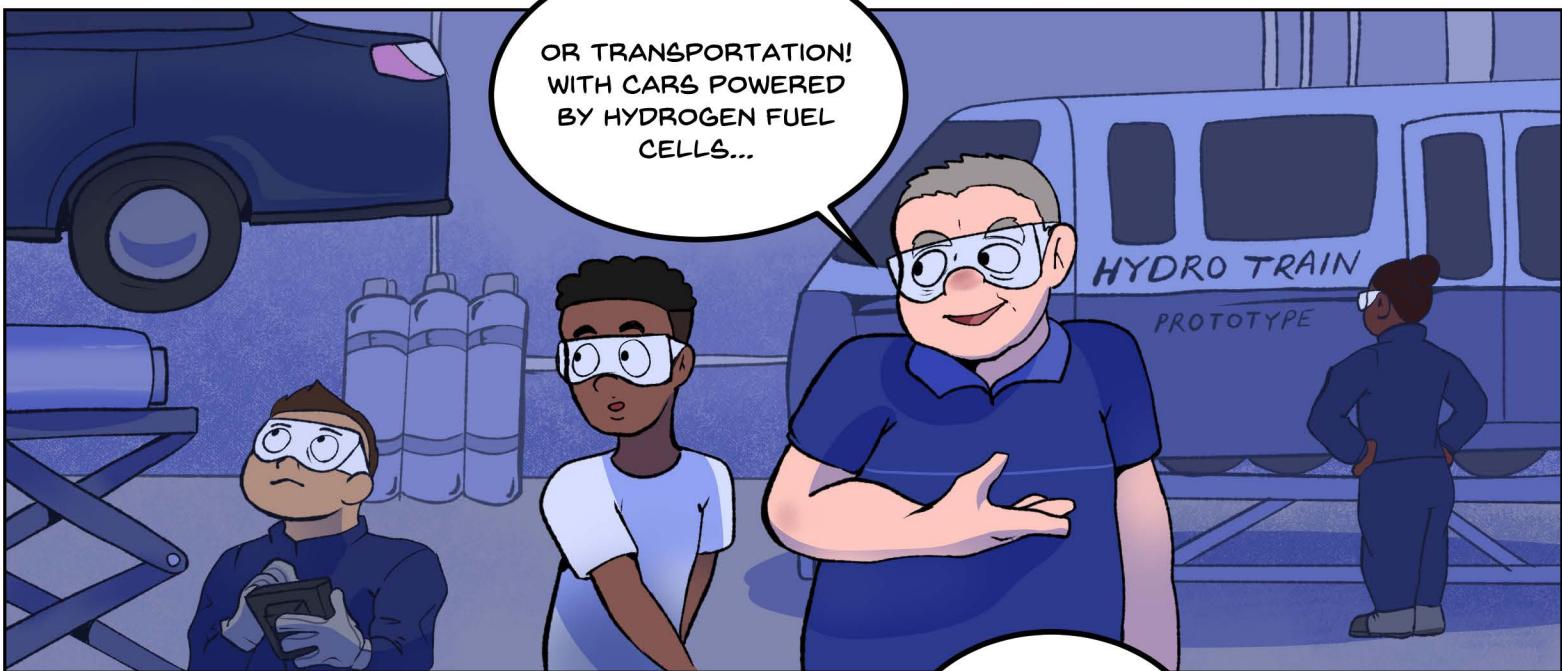
EXACTLY! SO MUCH OF FOOD SCIENCE IS CHEMICAL ENGINEERING.



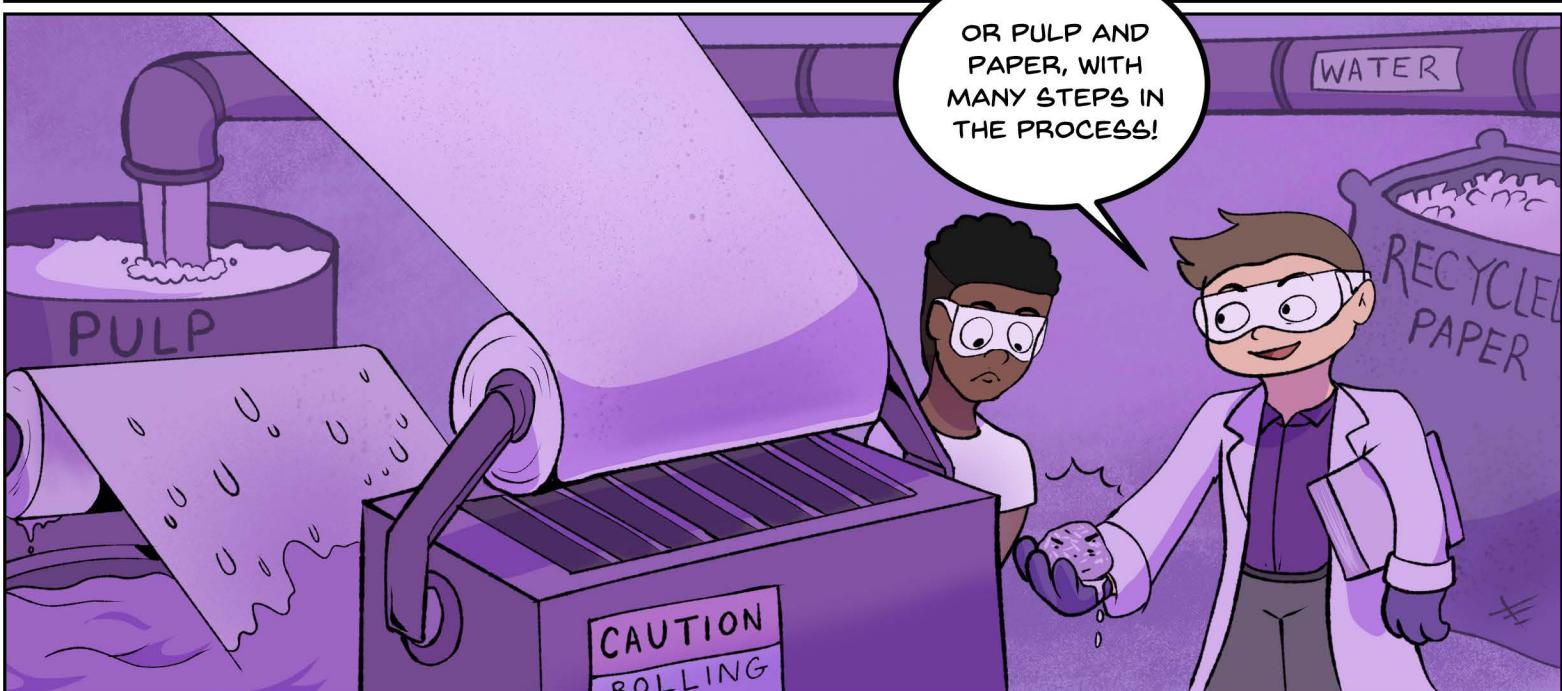
AND THERE ARE OTHER FIELDS TOO. LIKE COSMETICS -- PRODUCING MAKE-UP POWDERS AND CREAMS, AND MOISTURIZERS -- AND SIMILARLY, NAIL POLISH TOO...

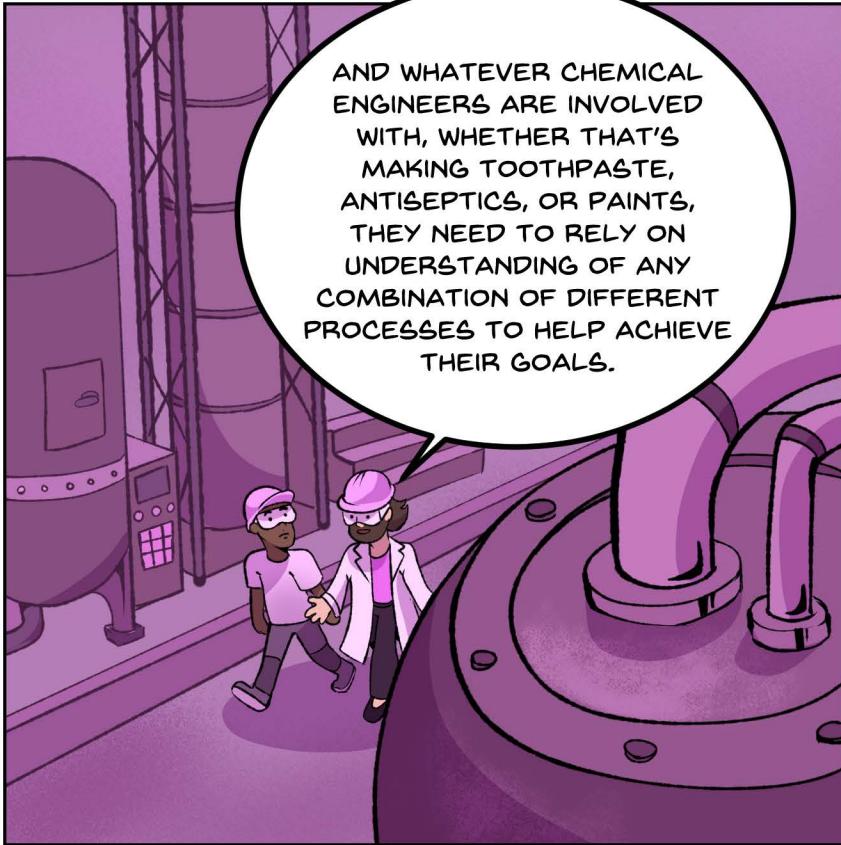


OR TRANSPORTATION! WITH CARS POWERED BY HYDROGEN FUEL CELLS...

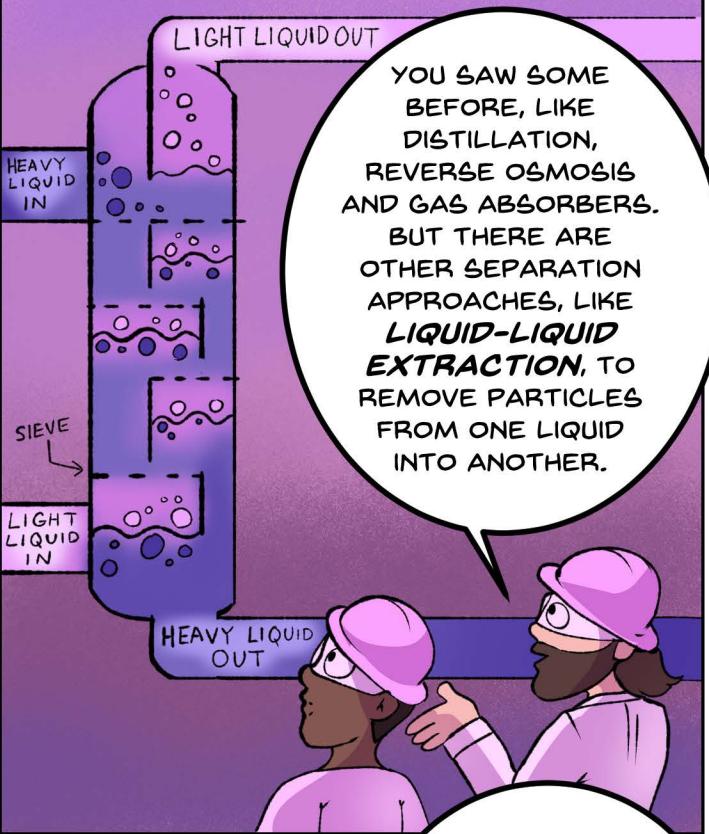


OR PULP AND PAPER, WITH MANY STEPS IN THE PROCESS!

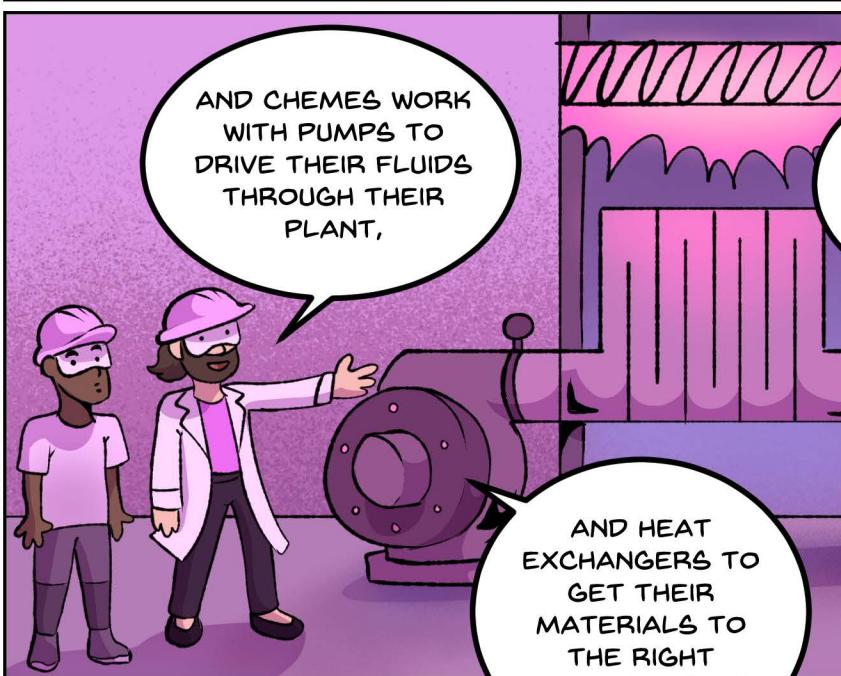




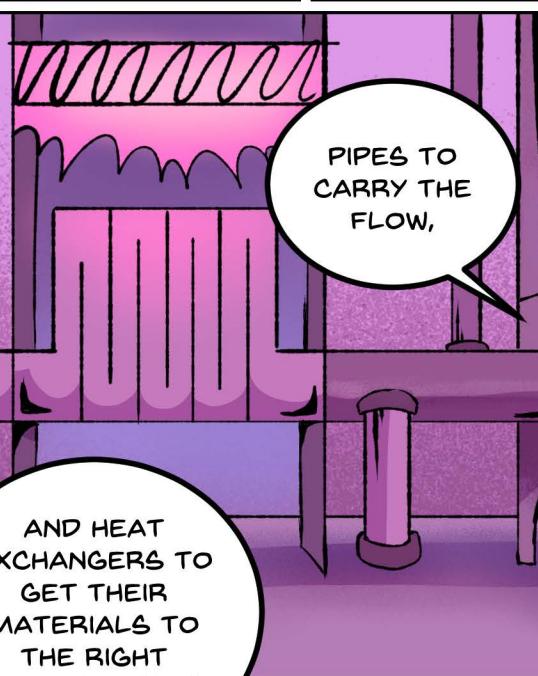
AND WHATEVER CHEMICAL ENGINEERS ARE INVOLVED WITH, WHETHER THAT'S MAKING TOOTHPASTE, ANTISEPTICS, OR PAINTS, THEY NEED TO RELY ON UNDERSTANDING OF ANY COMBINATION OF DIFFERENT PROCESSES TO HELP ACHIEVE THEIR GOALS.



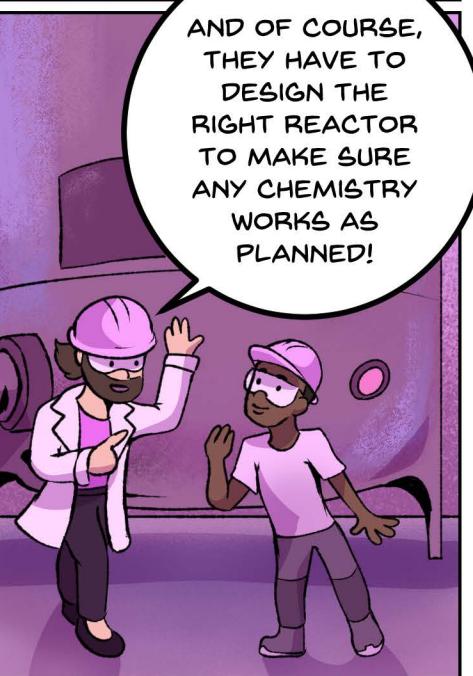
YOU SAW SOME BEFORE, LIKE DISTILLATION, REVERSE OSMOSIS AND GAS ABSORBERS. BUT THERE ARE OTHER SEPARATION APPROACHES, LIKE **LIGHT-LIQUID EXTRACTION**, TO REMOVE PARTICLES FROM ONE LIQUID INTO ANOTHER.



AND CHEMES WORK WITH PUMPS TO DRIVE THEIR FLUIDS THROUGH THEIR PLANT,



PIPES TO CARRY THE FLOW,



AND OF COURSE, THEY HAVE TO DESIGN THE RIGHT REACTOR TO MAKE SURE ANY CHEMISTRY WORKS AS PLANNED!



AND HEAT EXCHANGERS TO GET THEIR MATERIALS TO THE RIGHT TEMPERATURES.



DO YOU THINK YOU GET THE PICTURE NOW?



YEAH!

THAT WAS A LOT TO TAKE IN!

TRUE -- BUT YOU CAN SEE NOW HOW CHEMICAL ENGINEERING IS MUCH MORE THAN JUST 'MATH AND CHEMISTRY', RIGHT?

OH, ABSOLUTELY!

AND BEYOND THOSE GRAND CHALLENGES, LIKE BETTER MEDICINES OR ECONOMICAL SOLAR ENERGY OR CLEAN WATER OR CARBON CAPTURE

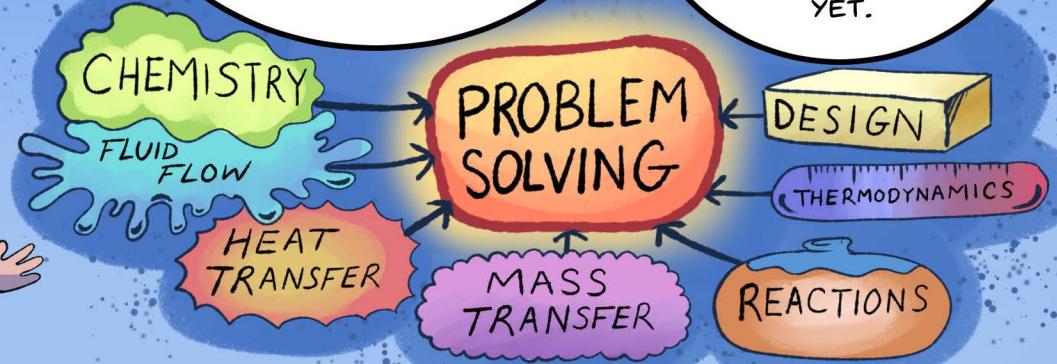
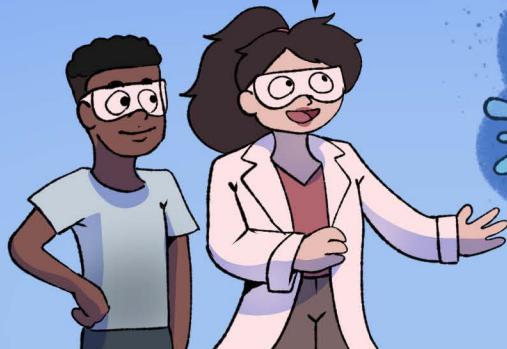
AND BEYOND ALL THOSE AREAS CHEMES ARE CURRENTLY WORKING IN-

THERE WILL STILL BE MORE NEW FIELDS AND PROBLEMS FOR CHEMES TO WORK ON!

THIS IS WHAT CHEMICAL ENGINEERING IS.

IT'S USING SKILLS AND UNDERSTANDING FROM **MANY** DIFFERENT CONCEPTS AND APPLYING THEM TO BE PROBLEM SOLVERS FOR WHATEVER CHALLENGES THEY NEED TO FACE.

CHEMICAL ENGINEERS TODAY NOT ONLY MEET CURRENT NEEDS, THEY'RE ALSO TRAINING TO BE ABLE TO SOLVE PROBLEMS THAT DON'T EVEN EXIST YET.



AND YOU CAN BE
A PART OF ALL
OF THAT.

NOW, DOES
THAT SOUND
LIKE MAKING A
DIFFERENCE?

YEAH.
YES, IT
DOES.

I DON'T KNOW
WHICH OF THOSE
FIELDS I
EXACTLY WANT
TO BE A PART OF
JUST YET...BUT
I'VE GOT TIME
TO FIGURE IT
OUT.

SOLVING
CHALLENGES AND
HELPING MAKE
PEOPLE'S LIVES
BETTER, IN ALL OF
THOSE WAYS?



CHEMICAL
ENGINEERING
SOUNDS **PERFECT**
FOR ME!

THE WIDE WORLD OF CHEMICAL ENGINEERING

WRITTEN BY: IRA HYSI AND LUKE LANDHERR

DRAWN BY: MONICA KESZLER

This comic was produced through the support of the American Institute of Chemical Engineers (AIChE) Foundation and their Doing A World Of Good initiative.

The creative team was an undergraduate student, a teaching professor, and an alum, all from the Northeastern University Chemical Engineering Department.

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The mission of the Department of Chemical Engineering at Northeastern University is to educate and train students in chemical engineering practice through integrating an inclusive classroom environment with hands-on and co-op experiences while solving research problems that impact our world.

Our vision: We lead in discovery and innovation to educate diverse chemical engineers who will solve tomorrow's *global* grand challenges.

Cooperative education enables students to integrate practical workplace knowledge with classroom learning so the educational experiences are synergistic and deepen the learning process. The chemical engineering community encourages professional development through active participation and leadership in student organizations, professional societies, and departmental activities. As a result, the chemical engineering program prepares students for industrial careers, graduate programs, or professional medical, law, and business schools.