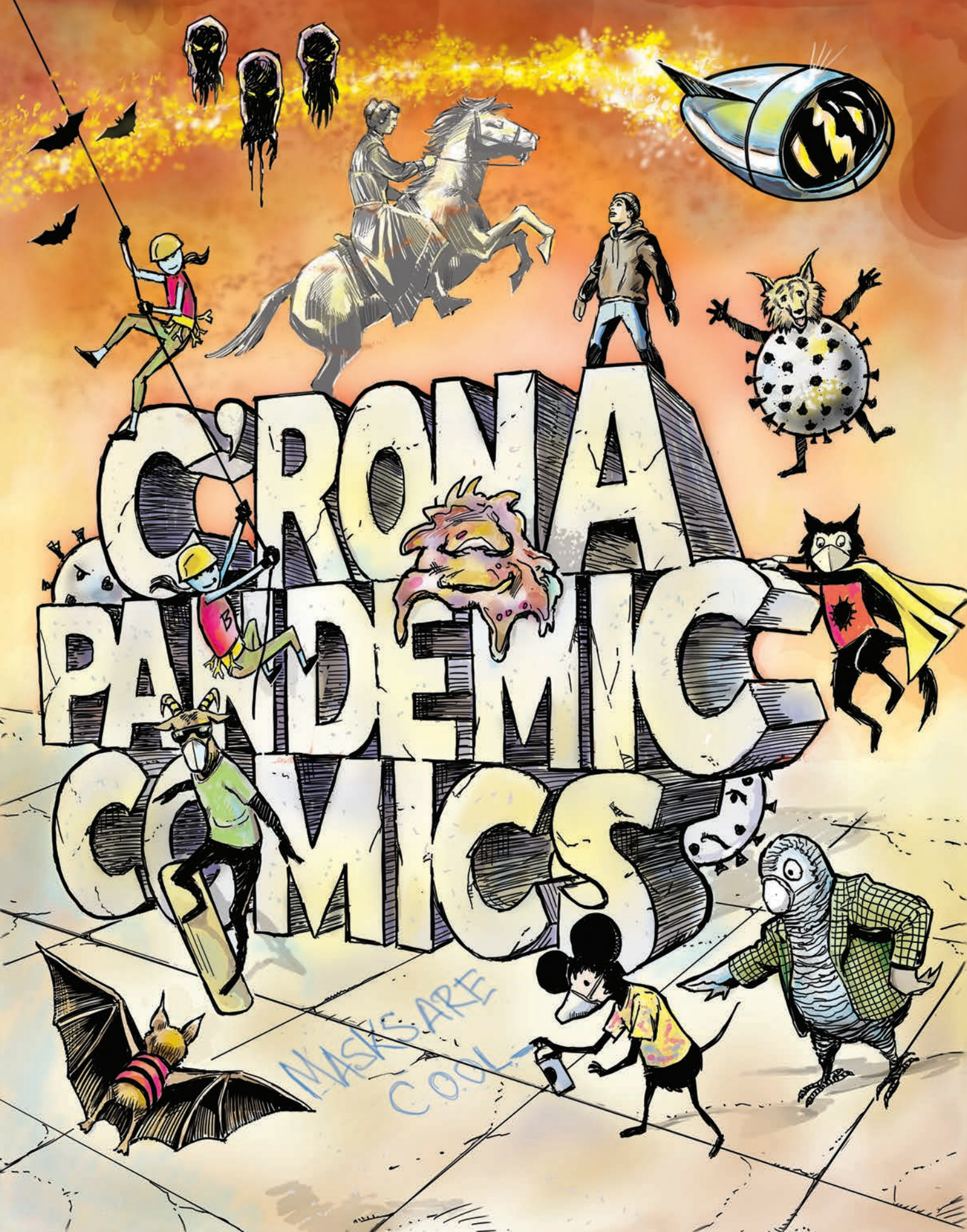
C'RONA
PANDEMIC
COMICS
MASKS ARE
COOL

C'RONA PANDEMIC COMICS

by Bob Hall, Judy Diamond, Liz VanWormer, Judi gaiashkibos

Art by Bob Hall, Henry Payer, Bob Camp

Production Design by Aaron Sutherlen

We dedicate this book to Hadasa, Luca & Soren, Meghan & Ben,
Rowan, Sophia, Rose, Evan & Jacob.

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Foreword

My life in science started with looking up to the clouds, literally. My first scientific study was to maintain a cloud journal. This required me to learn about all the different kinds of clouds in the sky. On my way to school I would document the morning clouds and later that afternoon, on my way home, I would document those clouds as well. Today, as a virologist I spend most of my time looking down into a microscope. I admit I still look at the clouds every so often.

My journey from “cloud chaser” to virologist began in Brooklyn, New York, where I was first introduced to the world of microbes, those tiny creatures that exist out of our eyes’ reach. Although very tiny in stature, the profound impact microbes have on our lives is inescapable. In general, the tiniest of those creatures are viruses. Viruses are microscopic infectious microbes that reproduce inside our cells. Viruses are fascinating because there are viruses that can infect and replicate in all types of life forms, from us all the way down to bacteria. Wanting to understand how these creatures work led me to enter the field of virology and study for many years to attain a PhD in virology from Mount Sinai School of Medicine in Manhattan, New York City.

So what exactly is a virologist? On a basic level, a virologist is someone who studies viruses. However, when you peel back the curtain, a virologist can do many things. These all come back to understanding how viruses work. There are virologists like me who spend most of their time in the lab using tools like microscopes and cells to understand how viral infections work and how to stop an infection. There are virologists who spend most their time in the digital world, using computers to determine the shape and structure of a virus and even the genetic sequence of viruses. There are virologists who go into a forest or jungle or even a city to hunt for viruses. This is important fieldwork especially when there is an outbreak and people are sick and dying. Knowing which specific virus is responsible for the outbreak and where it came from is very important to controlling and stopping the outbreak.

When an outbreak spreads to multiple countries, it is called a pandemic. Unfortunately, we currently find ourselves in the midst of one such pandemic caused by a virus called SARS-CoV-2. This virus causes a disease called COVID-19. The main way to be infected with this virus is through the droplets that are released when you cough, sneeze or just talk or breathe. This is why wearing a mask is so important.

The stories in this book introduce readers to the biology of the COVID-19 virus and the impact the pandemic has on communities. Enjoy this wonderful collection, and stay safe!

St Patrick Reid
Department of Pathology and Microbiology
University of Nebraska Medical Center

Introduction
by Judy Diamond

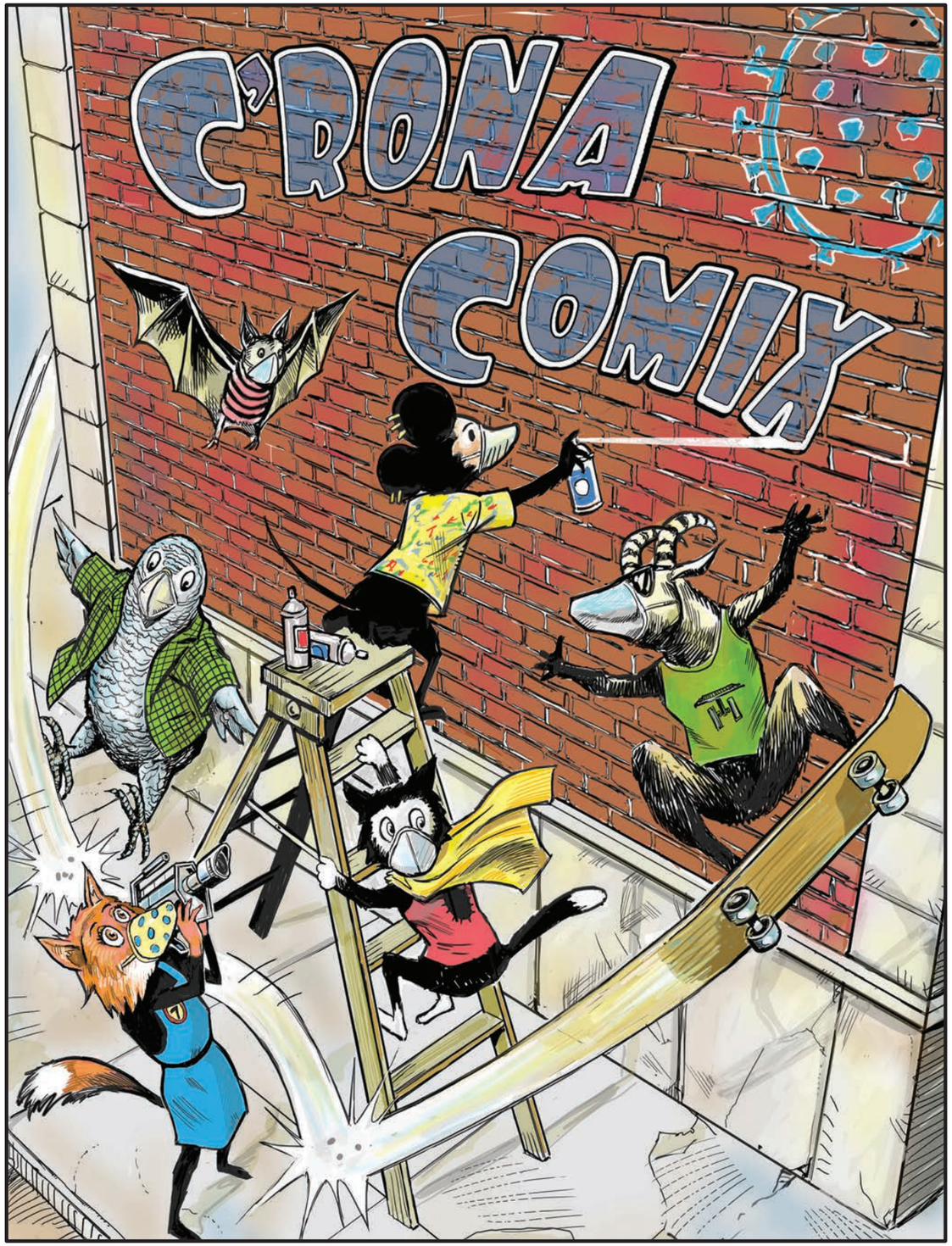
In the early months of 2020, schools, businesses, and houses of worship around the world shut their doors in order to protect people from the effects of a new coronavirus, SARS-CoV-2, that was sweeping across the globe. Since then nothing has been normal or easy. Schools and businesses reopened only to experience viral outbreaks; days or weeks later they were forced to close again. In the chaos of their changed lives, youths and adults are trying to make sense of the COVID-19 pandemic: How does the virus work? Why is it more deadly for some people than others? What can be done to protect people from its impacts? How do we make sense of a threat we cannot see?

Normally viruses cause little harm because our body's defense systems have adapted to them sufficiently. But as the world's population grows and we continue to change the environment to suit our needs, new viruses are emerging at a faster pace. Each time we confront a new virus we run the risk that it will cause an unfamiliar disease that will spread through the human population.

The virus that caused the COVID-19 pandemic is not an equal opportunity microbe. Black and Hispanic communities have been hit particularly hard, and Native American communities have been devastated. The COVID-19 vaccine will remove the most immediate dangers of the pandemic, but we will continue to face disruptive changes to our lives, our security, and our well-being.

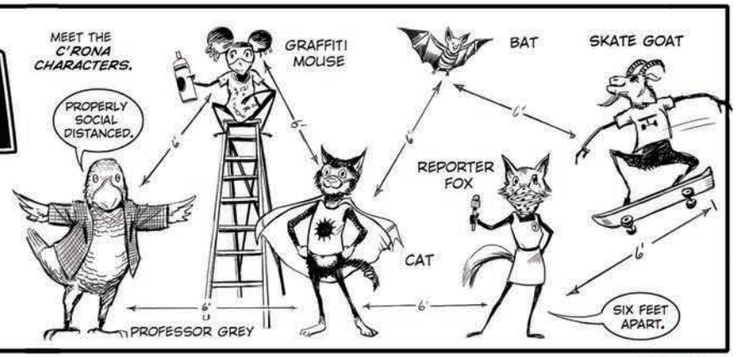
Our group of educators and scientists were funded by the Rapid Response Research program of the National Science Foundation. We worked with artist Bob Hall to create tools for young people to learn about the COVID-19 pandemic. We built on a decade of expertise in creating comics that focus on the biology of viruses.

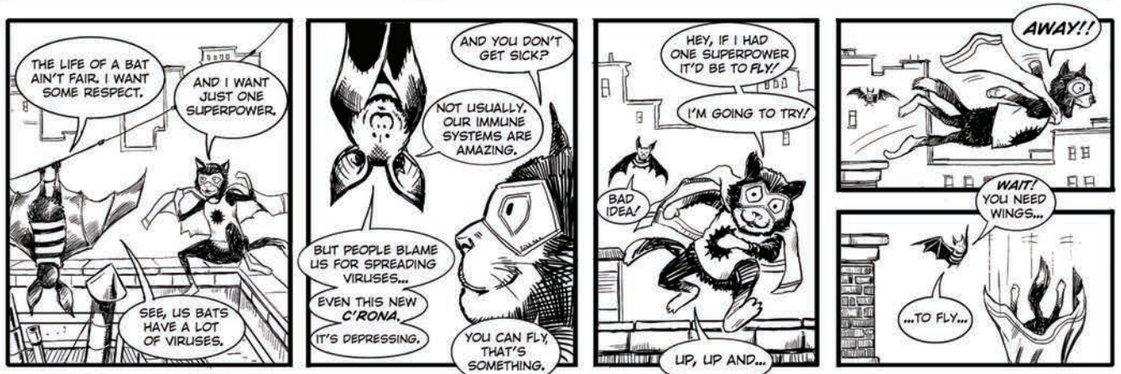
These comics help readers understand the complexities of living through a viral pandemic. They focus on three themes: the biology of the COVID-19 virus; the relationship of wild animals, particularly bats, to the pandemic; and the impact of the pandemic on Tribal communities. These stories were initially posted on the World of Viruses website (worldofviruses.unl.edu) and are now published here as a book by the University of Nebraska Press.

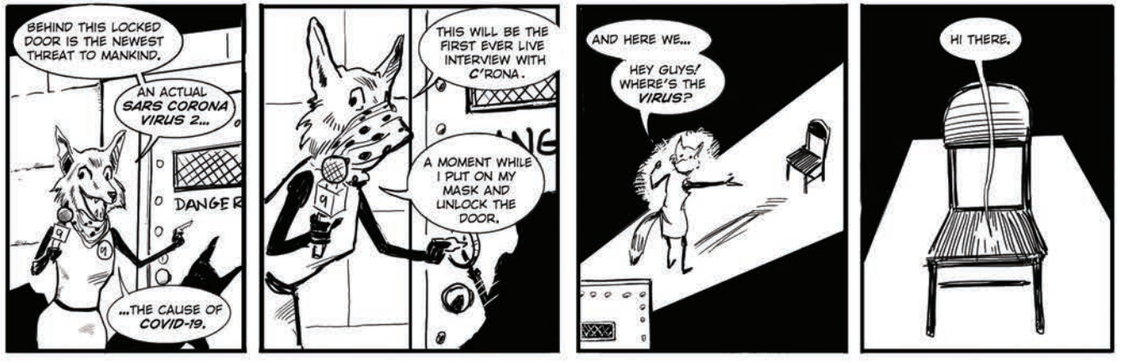


C'RONA COMIX

BY BOB HALL







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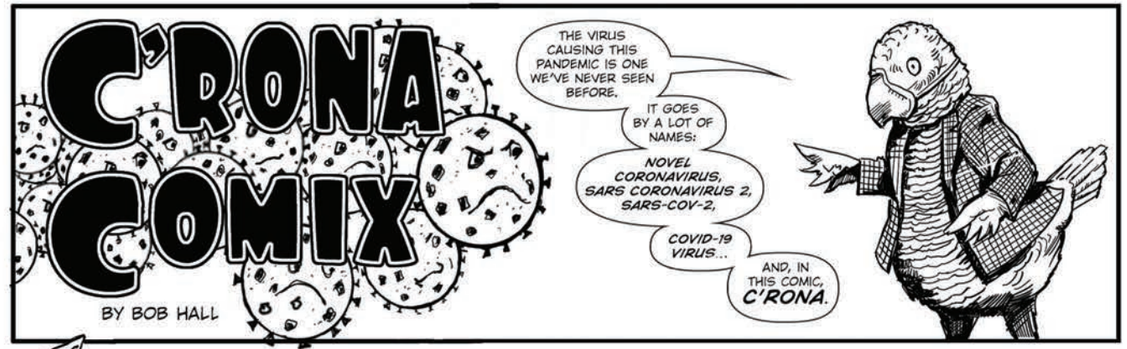

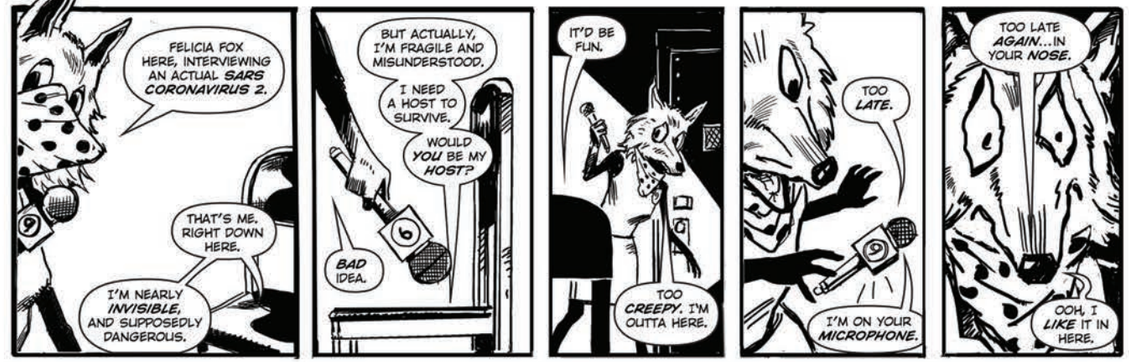

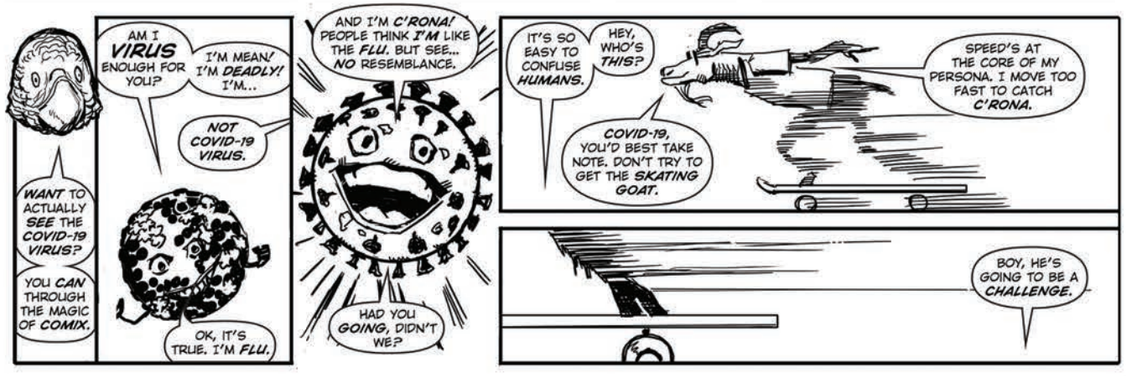

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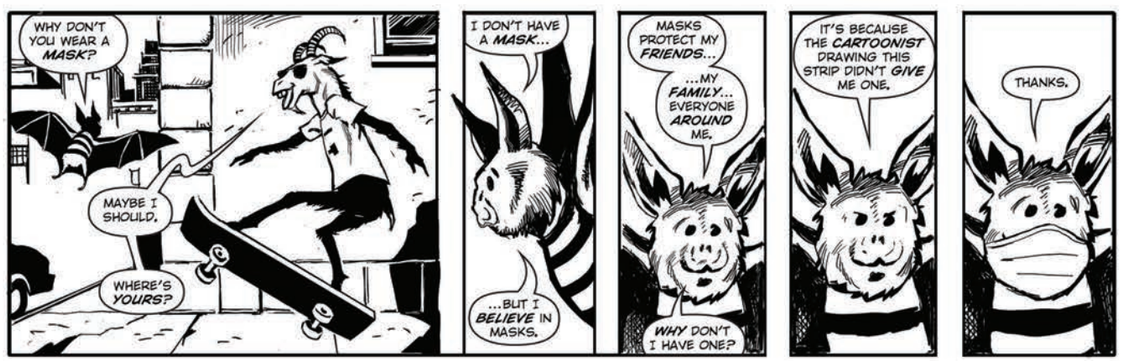

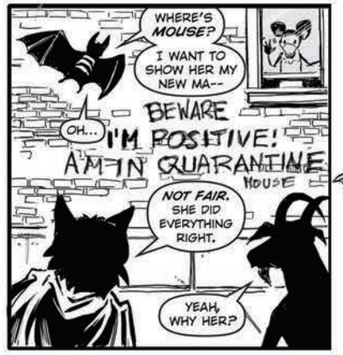

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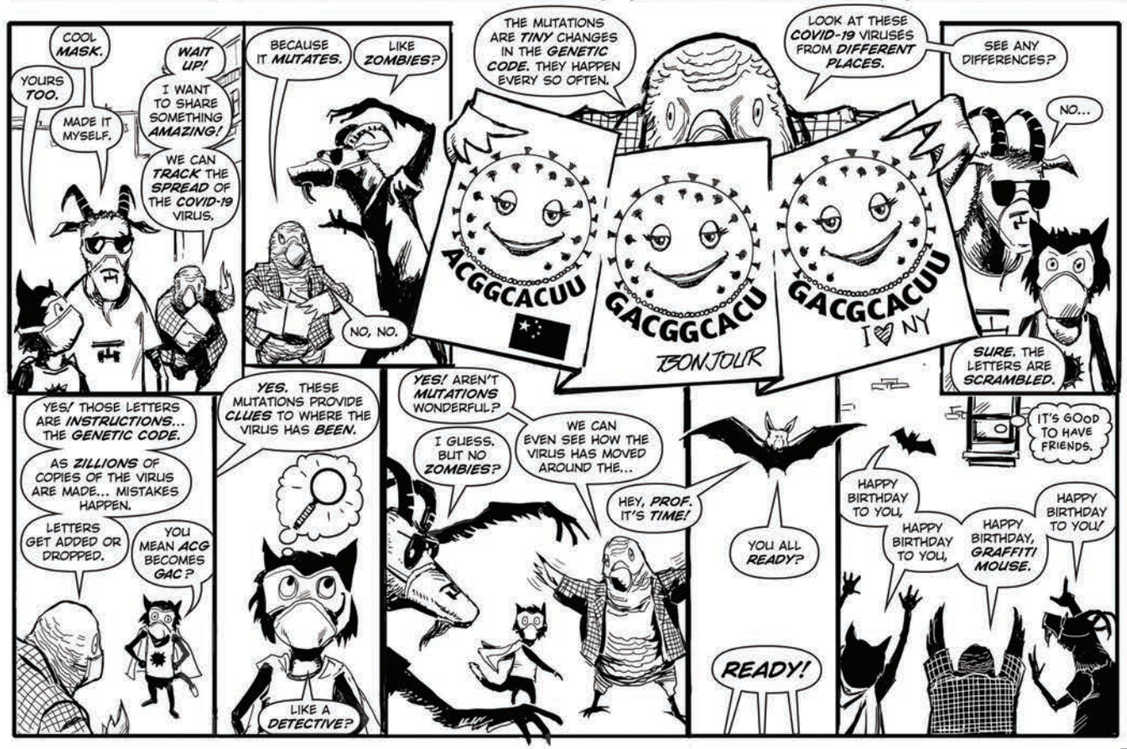


C'RONA COMIX

BY BOB HALL

FELICIA FOX HERE.

THIS PANDEMIC ISN'T GOING AWAY...AND IT'S SPREADING.

COULD YOU *SHOW* MY TV VIEWERS WHAT'S HAPPENING?

SOMETHING VISUAL?

HMM. I'LL SEE WHAT I CAN COME UP WITH.

YOU GIVING UP ON YOUR SUPERHERO OUTFIT?

I THOUGHT I WAS *INVULNERABLE.*

TURNS OUT *NO ONE* IS.

I HEAR VOICES ON MY ROOF.

MOUSE, HOW YOU *FEELING?*

BETTER. *MUCH* BETTER.

STILL IN *QUARANTINE* FOR A WHILE THOUGH.

BETTER IS *GOOD.*

YO, GUYS!

I'M MEETING THE *PROF* HERE.

WANTS TO TRY SOMETHING OUT ON ME.

SKATE GOAT!

HERE I AM.

HELP ME UNROLL THIS *STENCIL.*

NOW *LOOK.*

YOU'RE SPRAYING A MAP OF THE WORLD?

COVID-19 VIRUS AFFECTS THE WHOLE PLANET.

PAN...DEMIC. GOT IT.

REMEMBER, WE CAN *TRACE* THE VIRUS BY ITS MUTATIONS.

THE FIRST *COVID-19* VIRUS TO HIT THE USA SEEMS TO HAVE COME FROM...

...*CHINA*...

...*TO SEATTLE.*

BUT THE VIRUSES IN *NEW YORK* SEEMED TO HAVE FIRST COME FROM *EUROPE.*

SINCE THEN THE VIRUSES HAVE MOVED *HERE*...

...*THERE*...

...AND *EVERYWHERE.*

IT'S A *MESS.* GET IT?

YEAH, WE GOTTA KEEP WEARING THESE *MASKS.*

AND *DISTANCING.*

AND WAIT FOR A *VACCINE.*

AND LEARN HOW TO *LIVE* WITH THIS VIRUS.

C'RONA COMIX

BY BOB HALL

:COF: CAN'T BREATHE... :COF: HELP...

911? THE WOMAN DOWNSTAIRS NEEDS *HELP.*

DON'T KNOW HER *REAL* NAME. WE JUST CALL HER *GRANDMA.*

THEY'RE ON THEIR *WAY.*

VIRUSES

:COF: :COF:

WHAT *HAPPENED?*

OUR *HOST* COUGHED US *OUT.*

WHAT DO WE *DO???*

RELAX... *FLOAT* AROUND IN THE *AIR*...

...WAIT FOR A NEW HOST...

...WE GOT NOTHING BUT *TIME.*

WHO HAS IT THIS TIME? *GRANDMA.*

WHAT HOSPITAL? *ROOSEVELT?*

FULL. GOTTA DO *QUEENS.*

PROBABLY TALKED TOO *CLOSE* TO SOMEONE.

PEOPLE CAN GIVE IT TO YOU WHO DON'T EVEN HAVE *SYMPTOMS.*

PROFESSOR, I HAD *C'RONA.* NOW GRANDMA DOES.

WHAT *DOES* THE VIRUS DO *INSIDE* US?

COME TO MY *LAB.*

CLIMB IN MY *TRANSPORTER POD.*

IT WILL TAKE US RIGHT *INSIDE* GRANDMA.

IS THIS *SAFE?*

IT'S *COOL.*

WE'RE GETTING *SMALLER.*

ISN'T IT *AMAZING?*

IS THIS *SCIENCE?*

NO, NO. PURE *COMIC BOOK.*

HERE'S *GRANDMA.*

AND WE'RE *IN!*

LOOK! AN ARMY!

INVADING *VIRUSES!*

DON'T WORRY. THEY CAN'T *SEE* US.

AWRIGHT.

YOU'VE HAD YOUR TRAINING!

NOW FOR THE REAL THING!

TODAY WE ARE GOING TO NAVIGATE THE MOST *DANGEROUS* PART OF OUR HOST'S *DEFENSE* SYSTEM.

KEYS OUT AND FORWARD MARCH!

THEY'RE SCARY.

VERY!

AND *EXACTLY* WHAT WE CAME TO *SEE.*

C'RONA COMIX

BY BOB HALL

HERE WE ARE, *MINIATURIZED* AND *INSIDE GRANDMA.*

WANT TO SEE *MORE?*

OH *YEAH!*

OMIGOSH! THAT'S REALLY *SCARY!*

ESPECIALLY IF YOU'RE AN INVADING *VIRUS.*

THAT *MACROPHAGE* IS AN IMMUNE CELL...

AND COULD *SUCK* YOU RIGHT IN.

WILL IT GO AFTER *US?*

CAN'T *SEE* US... WE'RE INTERDIMENSIONALLY *TRANSMOGRIFIED.*

SAY WHAT?

NEVER MIND. LOOK...

...A *TRAINING* SQUAD OF *VIRUSES.*

THIS IS... *WHAT?*

CELL!

KIND?

LUNG!

AND SOMEWHERE UP THERE IS A *LOCK!*

BONA! KEY OUT! GO!

YESSIR!

LOOK OUT!

AAHHRG

BONA

HEEEELP

THE *MACROPHAGE* AT WORK.

THIS AIN'T NO *PICNIC!*

AWK!

MONA! YOUR TURN!

KLIK

IT'S *OPENING.*

I'M GOING *IN.*

THE VIRUS NEEDS TO *UNLOCK* GRANDMA'S *CELL...*

...TO *CREATE* MORE *VIRUSES.*

THAT'S HOW IT'S *DONE!*

YAAAAY

WOW!

HOW DO WE FIGHT *THAT?*

WAIT TILL YOU SEE WHAT COMES *NEXT!*

C'RONA COMIX

BY BOB HALL

WE'RE SOMEWHERE INSIDE GRANDMA.

ARE WE *SAFE?*

ABSOLUTELY...

...JUST NEVER *LEAVE* THIS *POD!*

THE VIRUSES ARE MAKING MORE AND MORE OF *THEMSELVES!*

CAN'T WE *DO* SOMETHING?!

WE CAN'T...BUT LOOK WHAT'S *COMING.*

GRANDMA'S *CYTOKINES* ARE SOUNDING THE ALARM TO HER *IMMUNE SYSTEM.*

ZRDDR RNNZNRZ

THEY'RE CALLING IN THE *T-CELLS.*

"NOW THEY HAVE TO FIND A *T-CELL* WILLING TO TAKE ACTION."

BZKRDD

KKBZDK

"T-CELLS CAN BE VERY PICKY."

T-1

I *SPECIALIZE,* AND IT'S NOT ON MY *LIST.*

ZZK

BLKQQRZ

KRRK

KRKL

T-2

NOT ON MY *HIT LIST* EITHER.

GLKK

BR BRKK

K KKRZ

T-3

YESSS. THIS ONE'S ALL *MINE.*

SPLOOSH

HOW *MANY* ARE THERE?

BZQQRR

MILLIONS AND MILLIONS?

I'M *ON* IT.

OH DEAR, THE CYTOS ARE *FREAKING OUT.*

BZRKKNNG

IS THAT BAD?

BRKKNZ

BKRRZ

CAN BE... IF THEY GET *OVEREXCITED.*

BZZK

LOOK *THERE!*

RCKA

T-CELLS!

YAY!

THEY'RE *VICIOUS ASSASSINS!*

ARE THEY GOING TO *RESCUE* GRANDMA?

THEY'LL *TRY.*

BUT IF THINGS GET *OUT OF HAND...*

...THAT COULD BE VERY *BAD.*

BZRNGZ

BZRNG

C'RONA COMIX

BY BOB HALL

OH BOY! T-CELLS!

ARE THEY COMING TO THE *RESCUE?*

WHAT'S GOING *ON?*

THE MACROPHAGES ARE DOING THEIR *THING,* AND THE CYTOS HAVE CALLED IN MORE *T-CELLS.*

"THE VIRUSES ARE *UNLOCKING* GRANDMA'S CELLS...

...TO GET INSIDE AND *MULTIPLY."*

GET BUSY MAKING MORE *VIRUSES!*

HURRY!

DANGER! INCOMING T-CELLS!

"THE CELLS HAVE BEEN TURNED INTO *VIRUS-MAKING FACTORIES,* AND ARE SIGNALING FOR HELP."

YOU'RE INFECTED. EXTERMINATE!

THEY'RE KILLING OFF *GRANDMA'S* CELLS.

GRANDMA'S *INFECTED* CELLS *NEED* TO BE DESTROYED.

"T-CELLS ARE LIKE *FIRE FIGHTERS* WHO TEAR DOWN BLAZING BUILDINGS SO *OTHERS* DON'T CATCH FIRE."

WHAT'S UP WITH THE *CYTOKINES?*

IF THEY DON'T CALM DOWN, *TOO MANY* OF GRANDMA'S CELLS WILL GET *DESTROYED!*

GRKKKK

BZZKKRR

BZZRRKN

HOLD ON *TIGHT!* IT'S GOING TO BE A *BUMPY RIDE!*

C'RONA COMIX

BY BOB HALL

BZZKKR

CYTOS ARE CALMING DOWN.

FINALLY.

ZZRRKN

HEY! WHO ARE *THESE* GUYS?

THERE'S MORE THAN *ONE* WAY TO *STOP* A VIRUS.

MACROPHAGES... T-CELLS... AND NOW... *B-CELLS!*

"TOOK THEM A WHILE TO *GET* HERE, BUT *NOW...*

HUH?

...CHECK OUT THEIR *ANTIBODIES!"*

"ANTIBODIES *COVER* THE *VIRUS KEYS...*

HEY! WHAT'S THIS?

... AND THE *LOCKS* ON *GRANDMA'S CELLS."*

FALL BACK!

TAKE COVER!

AND *THAT,* AS THEY SAY, IS *THAT!*

HEY *MAC,* GET T' *WORK!*

WHY DO I ALWAYS GOTTA *CLEAN UP* THE *MESS?*

VIRUSES, WE KNOW YOU *NOW!*

COME ON... WE ARE *READY!*

BURP.

CRISIS IS OVER FOR NOW.

TIME TO GO *HOME.*

CAN WE STOP FOR ICE CREA--

TEN DAYS LATER.

GOOD TO HAVE YOU *BACK,* GRANDMA.

WELCOME HOME!

YO, GRAMMA.

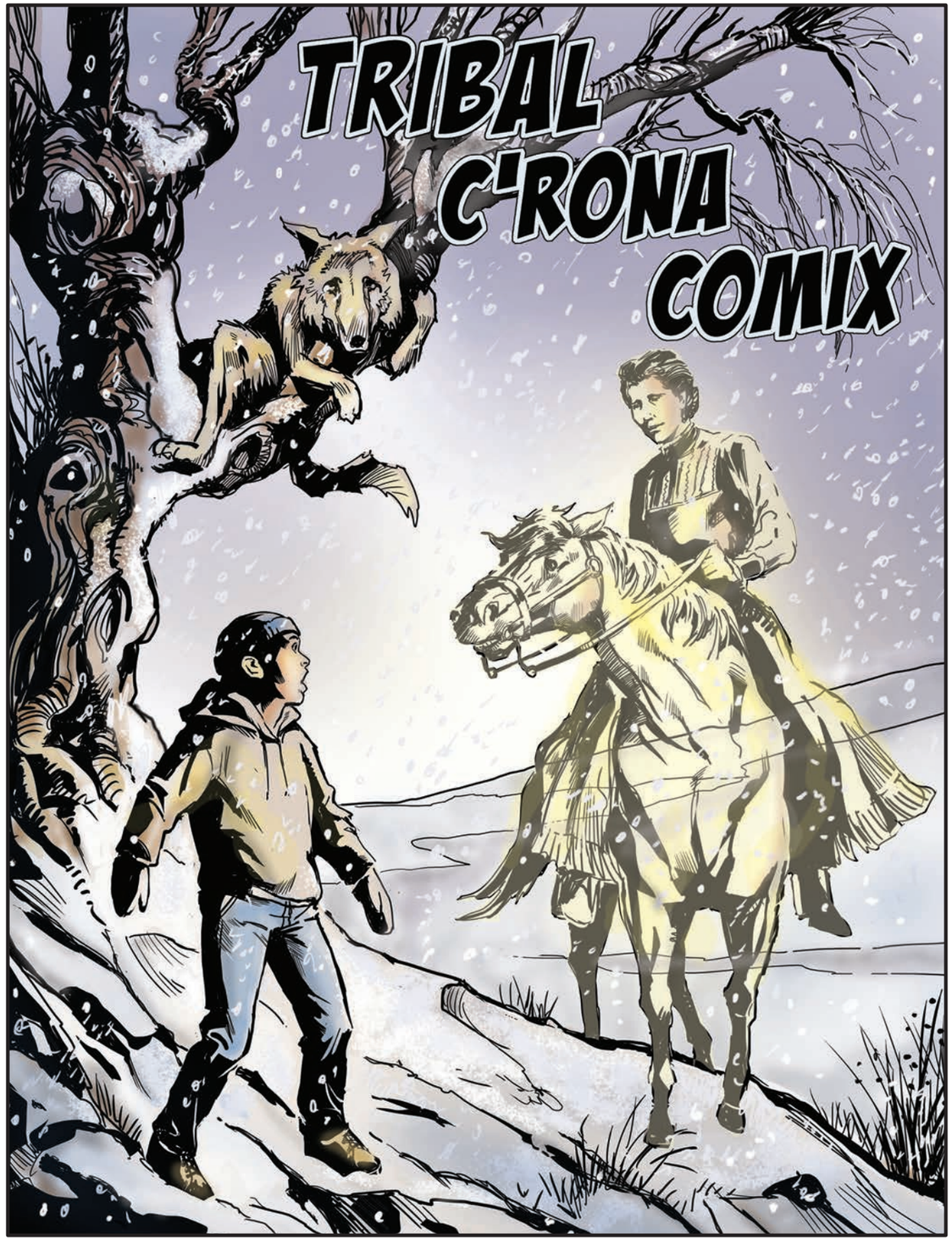
VIRUSES

ICE CREA

DO THEY KNOW *SOME OF US* ARE STILL *AROUND?*

NAH, WE CAN HANG OUT IN THE *AIR* FOR A *WHILE.*

AS LONG AS THERE'S NO *VACCINE,* WE'RE *A-OK.*



TRIBAL C'RONA COMIX

BY HENRY PAYER AND BOB HALL

BRRR

IT'S TOO *COLD* FOR THIS COYOTE.

WHO AM I *WAITING* FOR?

STOP WHINING!

I'M ON A MISSION.

ME TOO.

MINE IS TO KEEP FROM *FREEZING*. WHAT'S YOURS?

YOU'RE QUITE THE *SASSY* COYOTE.

NOW SHOW ME THE WAY TO TOWN.

THIS WAY.

IF YOU SAY *THAT* WAY THEN IT HAS TO BE *THIS* WAY.

OK, OK... NO MORE *TRICKS*...

...*THIS TIME*.

CLINIC

YOU WORK SO HARD.

COMES WITH BEING A DOCTOR...

...BUT THIS *COVID PANDEMIC* IS TOUGH ON EVERYONE.

WISH I COULD HELP.

WASH YOUR *HANDS*.

KEEP WEARING YOUR *MASK*.

AND STAY *DISTANCED*.

WHAT CAN I DO?

WOOF

WHAT THE *HECK*?

I'M HERE TO SEE MY *GREAT-GRANDNIECE*.

THIS IS THE *CLINIC*?

SHOW ME WHERE THE *DOCTOR* IS.

MARY LA FLESCHE? SHE'S MY AUNT.

BUT I'M NOT ALLOWED IN.

I AM.

OH!

I GOTTA *TRY* THIS.

OW!

DEFINITELY A *GHOST*!

TRIBAL C'RONA COMIX

BY HENRY PAYER AND BOB HALL

DID I JUST SEE A *GHOST* WALK THROUGH A WALL?

WHO WAS THAT?

SUSAN LA FLESCHE... AMERICA'S FIRST *NATIVE DOCTOR.*

WOW! SHE LIVED LIKE A *HUNDRED* YEARS AGO!

WHAT'S MAKING SO MANY PEOPLE *SICK?* MEASLES? TUBERCULOSIS?

AY HEALTHY ACCINAT

SHE MUST BE THE DOCTOR.

I WANTED SO MUCH TO BE LIKE YOU.

I WISH YOU COULD *HEAR* ME...

YOU ARE AMAZING.

Susan La Flesche

WHAT'S THAT THING?

BEEP BEEP

TIME FOR *HOME VISITS.*

AH, JUST LIKE I DID.

WE DIDN'T VISIT THIS FAMILY LAST WEEK.

THE *COVID-19 VIRUS* IS HITTING EVERYONE HARD.

WHAT SHOULD I DO?

COVID-19? HMMM. SOMETHING NEW.

STAY IN THE JEEP, WILL. AND BE READY.

WELCOME, DOCTOR MARY.

GOOD TO SEE YOU AGAIN, CLARA.

I WAS HOPING YOU'D COME.

MY DAUGHTER HAS A FEVER AND COUGH.

EVERYTHING LOOKS OK.

...AND NOW WE TEST FOR *COVID.*

WHERE'S THE *REST* OF THE FAMILY?

CLARA, LET ME *SEE* GRANDFATHER.

I LIKE THIS FINGER THING-A-MA JIG.

GRANDFATHER'S OXYGEN IS VERY LOW.

CLARA, HE'S VERY SICK.

PLEASE TELL WILL TO CALL AN *AMBULANCE.*

SNORE

YOUR DAUGHTER'S OK FOR NOW.

I'LL LET YOU KNOW ABOUT GRANDFATHER.

WE GOTTA DO *SOMETHING!*

WELL, I'M *FULL* OF IDEAS.

LIKE *WHAT?*

VIRUS SLAYER

TRIBAL C'RONA COMIX

BY HENRY PAYER AND BOB HALL

TOO MANY SICK.

TOO MANY DYING.

I CAN'T SAVE THEM ALL.

YOU SAVE WHO YOU CAN.

I KNOW YOU'RE *RIGHT* AND...

OH!

FINALLY... YOU CAN HEAR ME.

YOU LOOK LIKE...

ARE YOU...?

SUSAN LA FLESCHE.

YOU'RE GOING?

WE'LL TALK AGAIN SOON...

...AFTER THEY BURY GRANDFATHER.

WE HONOR CLARA'S GRANDFATHER, A SPECIAL ELDER OF OUR COMMUNITY...LOST TO *COVID-19.*

HIS *STORIES* LIVE ON...HIS *SPIRIT* WILL STAY WITH US ALWAYS.

OH!

DR. SUSAN... THIS IS CLARA'S *GRANDFATHER!*

I KNEW I'D SEE YOU ON THE OTHER SIDE.

WE NEED YOUR HELP.

WE'VE SURVIVED PANDEMICS BEFORE.

COME WALK WITH ME.

HEY KID!

THIS PANDEMIC IS PULLING OUR *PEOPLE* APART.

I WISH I COULD DO SOMETH...

OW!!!

WHAT?

REMEMBER THE ANCESTORS' VILLAGE *OF MAKE-BELIEVE?*

NOPE.

A LONG TIME AGO PEOPLE BUILT *A MAKE-BELIEVE VILLAGE* TO SAVE THEIR LAND.

THINK WE COULD MAKE THE *VIRUSES* GO TO A MAKE-BELIEVE VILLAGE?

GREAT IDEA!

FEARLESS VIRUS CATCHER

NEXT DAY.

STORE

THIS IS A *NUTTY* IDEA!

BUT THINGS ARE SO BAD... I'LL TRY *ANYTHING.*

THIS BOY WILL BE A *LEADER* SOMEDAY.

SOMETIMES TO LEAD YOU MUST FIRST *FAIL.*

TRIBAL C'RONA COMIX

BY HENRY PAYER AND BOB HALL

IT'S *BEAUTIFUL!!*

REALLY? YOU DON'T THINK IT LOOKS KINDA *DUMB?*

IT'S A PERFECT *VIRUS TRAP.*

HARDW

YOU HONESTLY THINK THIS'LL *LURE* THE VIRUSES AWAY FROM THE *REAL* TOWN?

LEAVE THAT TO ME.

VIRUSES WELCOME

COME ON IN

STEP RIGHT UP!

WHAT ARE THEY DOING?

MAYBE IT'S A PLAY... YOU KNOW, *TRAGEDY?*

SO THERE'LL BE AN *AUDIENCE?*

SHAKESPEARE IN THE SNOW

YEAH! PEOPLE TO *INFECT!* LET'S HANG AROUND.

I'M *STOPPING THE PANDEMIC!*

THREE CHEERS FOR COYOTE!

HOW DO WE EVEN KNOW THIS IS WORKING?

NOBODY'S COMING.

YEAH. THIS IS A *WASTE.*

LET'S GET *OUTTA* HERE.

HEY! THAT KINDA *WORKED!*

DIDN'T LOOK LIKE IT TO ME.

THIS NEW WORLD OF SCIENCE...

...ALONG WITH OUR TRADITIONAL WAYS...

...WILL GET US THROUGH THESE TIMES.

TRIBAL C'RONA COMIX

BY HENRY PAYER AND BOB HALL

WE TRIED OUR BEST TO *TRICK* THE VIRUSES.

BUT *NONE* CAME TO OUR *MAKE-BELIEVE* VILLAGE.

NO WORRY.

VIRUSES WELCOME

I'VE GOT *ANOTHER IDEA.*

NO *WAY!*

IT'S TIME TO *MOVE ON.*

THANKS FOR *ANSWERING* MY CALL.

NOW WE STAND A *CHANCE.*

WE ARE HERE TO *HELP!*

I'M *PROUD* OF THEM.

THEY LIGHTEN THE LOAD.

OUR PEOPLE GET *TRAINED...*

AND COME HOME TO HELP THE *TRIBE.*

LIKE *YOU* DID.

HEY LOOK!

WHAT DO YOU *THINK?*

THIS'LL *FOOL 'EM!*

HA HA HA HA

WHERE ON *EARTH* DID YOU GET *THAT?*

YOU *DON'T* WANNA *KNOW.*

LET 'EM LAUGH.

THE VIRUSES WILL CLING TO THIS LIKE A *MOTHER SHIP.*

LATER.

SORRY YOU'RE *DEFLATED.*

NEVER MIND.

I'M STILL FULL OF *HOT AIR.*

GONNA HANG AROUND?

CLINIC

DON'T *THINK* SO, KID.

I'VE GOT *NEW* PLACES TO GO.

ARE YOU LEAVING, TOO?

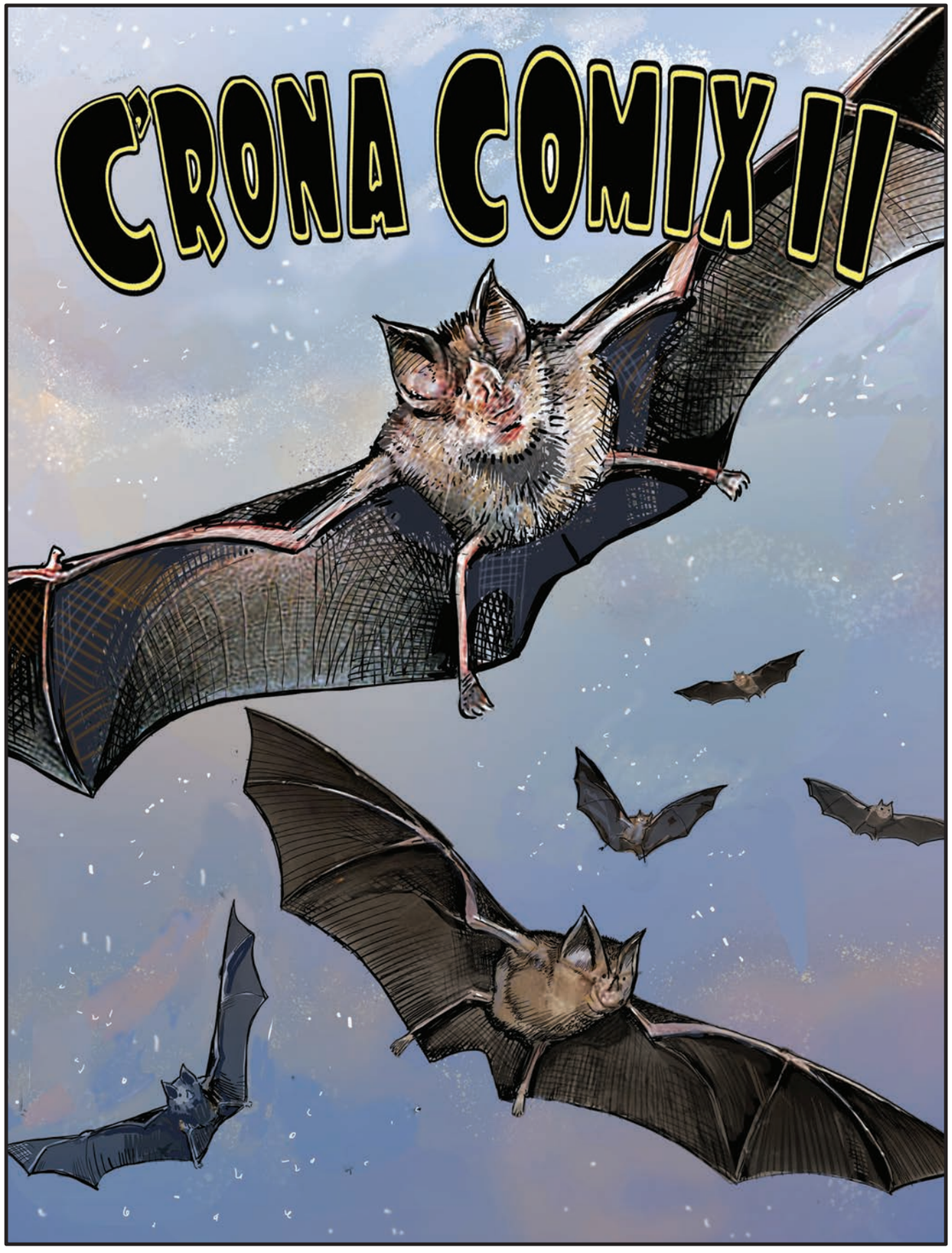
YES, BUT DON'T WORRY.

OUR PEOPLE WILL *SURVIVE* THIS PANDEMIC.

OUR *SPIRIT* WILL BE WITH YOU ALWAYS.

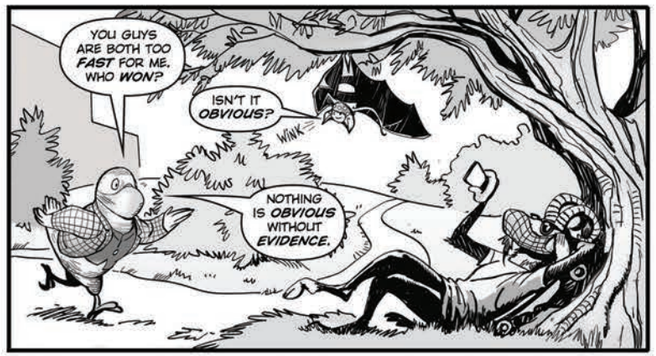
THAT'S GOOD. YOU GIVE US *HOPE.*

NOW WHERE DID I LEAVE MY *HORSE?*


C'RONA COMIX II

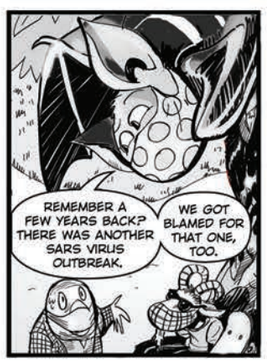

C'RONA COMIX II
ART BY BOB CAMP
I AM THE GREATEST, THE COOLEST, AND THE FASTEST.
UH... NOT THE FASTEST. NO WAY.
AM! AM! AM!
MIGHT I PROPOSE ... WE RACE?
YOU'RE ON... VIRUS BREATH.
START
BATS EAT INSECTS
1400 KINDS OF BATS CAN'T BE WRONG
#WE POLLINATE PLANTS!
BATS RULE - GOATS DROP!
TWO DAYS LATER.
GONNA WIN THIS.
I'M NO SCAPE GOAT.
I'M THE SKATE GOAT!
IF YOU'RE BOTH DONE TALKING...
GET SET...
YOU READY?
I'M READY!
GOATS
YAY 4 GOATS!
GOAT MILK IS GOOD FOR YOU!
BATS
GOATS
GO!
LIP AND AWAY!!
HERE I COME!
WOOSH!
HOW 'BOUT THAT, BAT?
CUTE!
BUT NOT FAST!
YOU'RE STILL A VIRUS BREATH!
WHOOSH
OK!!
THAT DOES IT!!
NO HURRY.
TAKE YOUR TIME.
WE'LL WAIT...
YAY BATS!
YOU WON...
...BUT I GOT YOUR GOAT, DIDN'T IT HEE HEE.
THAT IS SO LAME.
HEY, YOU TWO!
MASK UP!
HONK
VIRUS BREATH? REALLY?
SORRY... I'M JUST TIRED OF ALWAYS BEING THE GOAT.
YEAH.
YOU ARE THE GOAT.
GOATS


C'RONA COMIX II
ART BY BOB CAMP

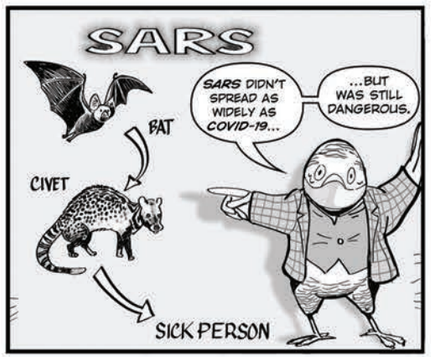

YOU GUYS ARE BOTH TOO FAST FOR ME. WHO WON?
ISN'T IT OBVIOUS?
WINK
NOTHING IS OBVIOUS WITHOUT EVIDENCE.

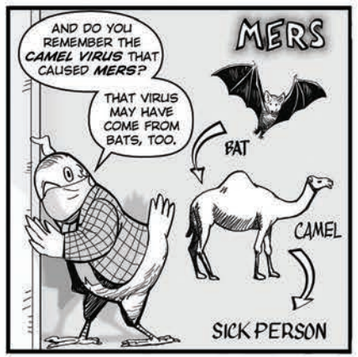

HEY PROFESSOR, IS THIS TRUE?
COVID-19 LINKED TO BATS.


WELL, WE KNOW SOME BATS HAVE VIRUSES SIMILAR TO THE COVID-19 VIRUS...
...BUT WE DON'T KNOW IF PEOPLE CAUGHT THE DISEASE DIRECTLY FROM BATS.

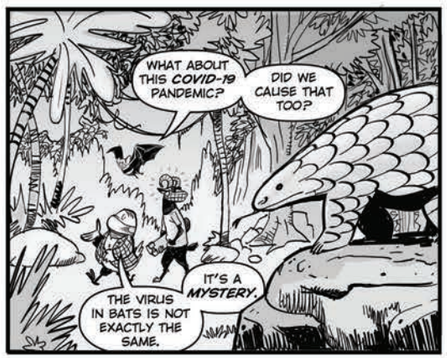

REMEMBER A FEW YEARS BACK? THERE WAS ANOTHER SARS VIRUS OUTBREAK.
WE GOT BLAMED FOR THAT ONE, TOO.


I THINK WE COULD USE A GOOD VISUAL.


SARS
BAT
CIVET
SARS DIDN'T SPREAD AS WIDELY AS COVID-19...
...BUT WAS STILL DANGEROUS.
SICK PERSON


AND DO YOU REMEMBER THE CAMEL VIRUS THAT CAUSED MERS?
THAT VIRUS MAY HAVE COME FROM BATS, TOO.
MERS
BAT
CAMEL
SICK PERSON


OPEN THE LAST PANEL...
...AND WE WALK INTO A RAINFOREST.
COME ON.

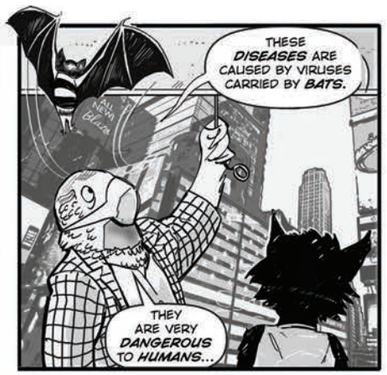

WHAT ABOUT THIS COVID-19 PANDEMIC?
DID WE CAUSE THAT TOO?
IT'S A MYSTERY.
THE VIRUS IN BATS IS NOT EXACTLY THE SAME.


US PANGOLINS GET BLAMED FOR BRINGING THE VIRUS FROM BATS TO PEOPLE.
THAT'S A MYSTERY TOO.


SO HOW DO WE FIGURE IT OUT?
SCIENTISTS ARE LOOKING FOR ANSWERS RIGHT NOW.
ME, TOO.


C'RONA COMIX II
ART BY BOB CAMP
WHY DO PEOPLE BLAME US BATS FOR BAD STUFF?


LIKE CAUSING A FOREST FIRE?
NO, THAT'S SILLY...
...LIKE SPREADING DISEASE TO PEOPLE!


THESE DISEASES ARE CAUSED BY VIRUSES CARRIED BY BATS.
THEY ARE VERY DANGEROUS TO HUMANS...


MARBURG
RABIES
NIPAH
...PEOPLE GET THEM FROM DIRECT CONTACT WITH BATS
...OR OTHER ANIMALS INFECTED BY BATS.
NIPAH?


COME WITH ME.


THIS IS AMAZING!
BEAUTIFUL!
IT WAS.


THEN THIS HAPPENED.
BUT I SEE BATS.
YIKES!

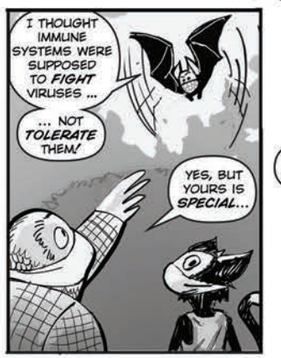

HEY, THIS LOOKS BAD.
IT IS.
OUR HOME WAS CUT DOWN...
OUR FOOD IS GONE.


NOW WE FEED ON THE TREES IN A PIG FARM.
THAT BRINGS YOU AWFULLY CLOSE TO WHERE HUMANS ARE.
FRUIT GETS CONTAMINATED...
...WITH BAT SALIVA THAT HAS THE NIPAH VIRUS.


"THE FRUIT FALLS INTO THE CORRAL..."
"...AND PIGS BECOME INFECTED."


SO FARMERS GET THE VIRUS FROM THE PIGS?
YES.
BUT WHY DON'T THE VIRUSES MAKE BATS SICK?

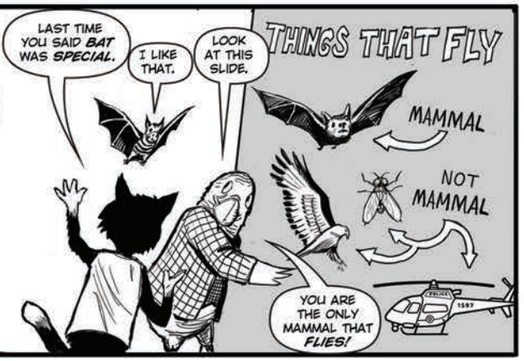

YOU BATS ARE MAMMALS... JUST LIKE PEOPLE.
... SO YOU TOO HAVE AN IMMUNE SYSTEM.
REALLY? WOW.
AND SCIENTISTS THINK YOURS IS MORE TOLERANT OF VIRUSES.

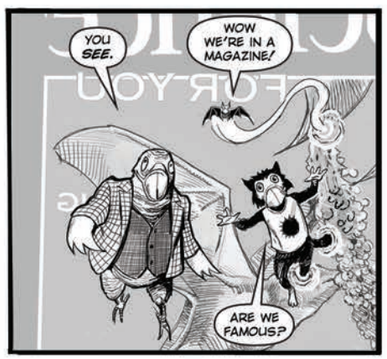

I THOUGHT IMMUNE SYSTEMS WERE SUPPOSED TO FIGHT VIRUSES ...
... NOT TOLERATE THEM!
YES, BUT YOURS IS SPECIAL...

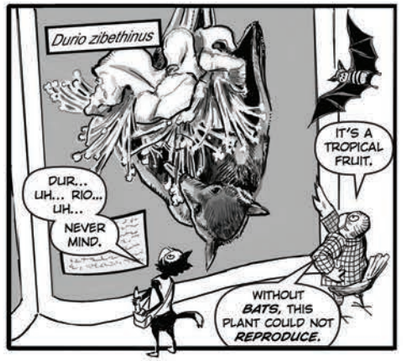

HEY! I'M SPECIAL!!!
...BECAUSE YOU CAN FLY!
WISH I COULD FLY.

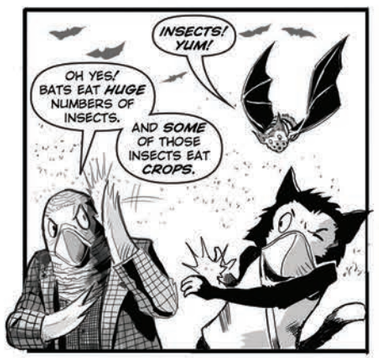
C'RONA COMIX II

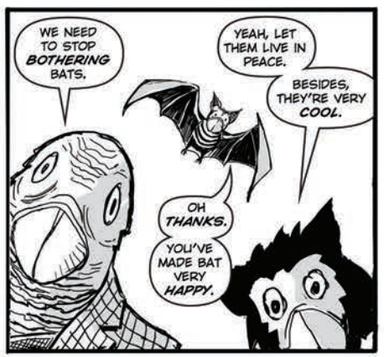
BY BOB HALL





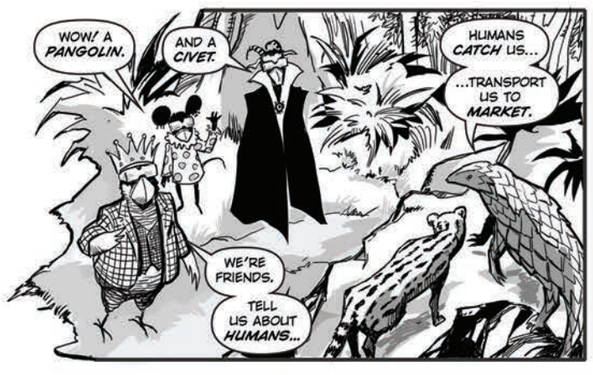


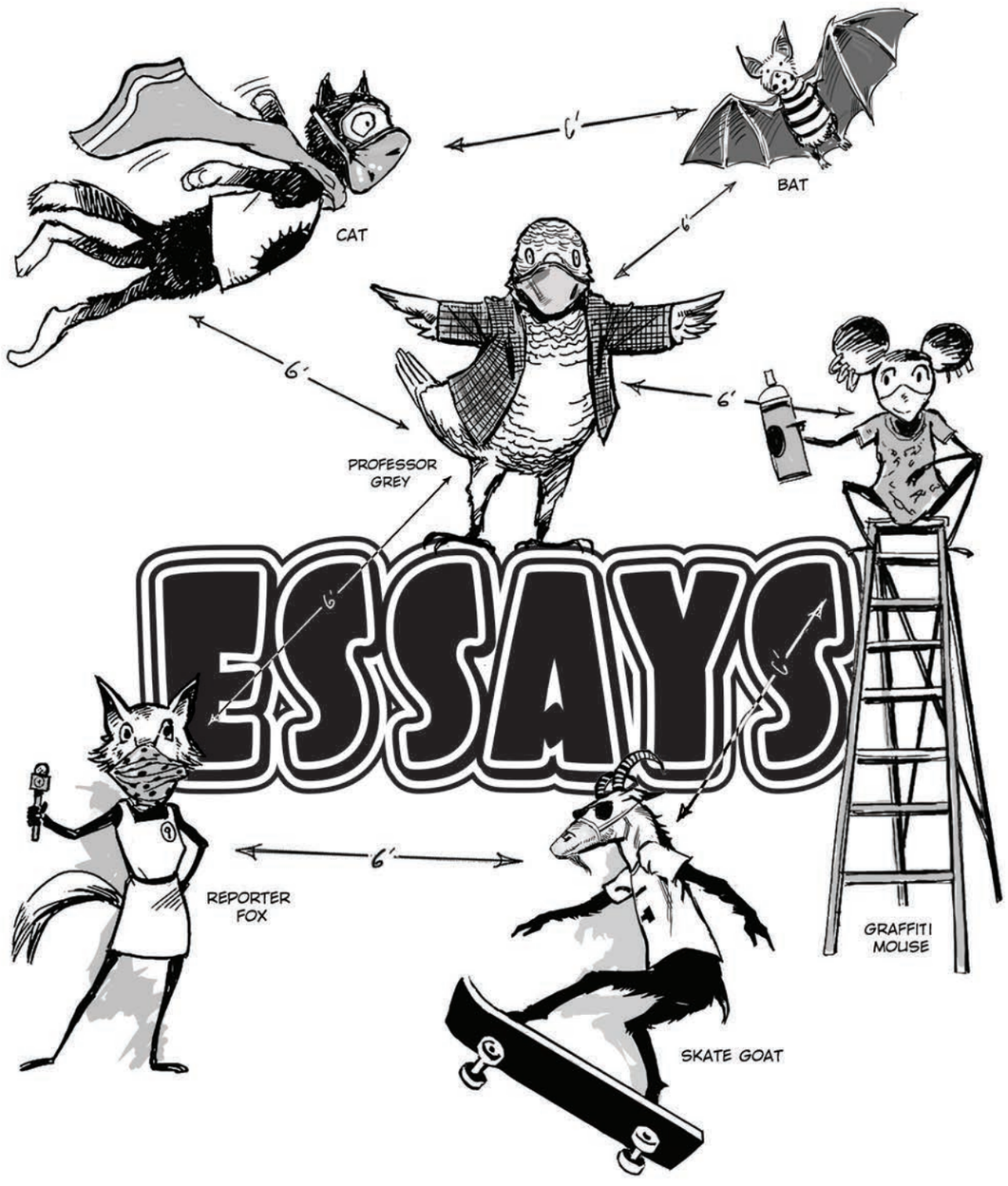




C'RONA COMIX II

BY BOB HALL





COVID-19 is Something New

Peter C. Angeletti

The novel coronavirus disease (COVID-19) first emerged in January 2020 and quickly spread around the world. Scientists believe the virus may have originally come from bats and then somehow spread to people. Doctors quickly discovered that COVID-19 is easily transmitted from person to person by breathing in particles of the virus, and that in older people in particular the infection can cause severe illness and even death.

COVID-19 is caused by a virus with the impossible name “novel severe acute respiratory syndrome” or SARS-CoV-2. It is closely related to another SARS virus that in 2003 infected more than eight thousand people across the globe. COVID-19 appears to be much more easily transmitted from person to person than was the earlier SARS disease.

The cause of COVID-19 is a tiny virus whose genetic materials are made of RNA. The virus is about one thousand times smaller than the thickness of a human hair. It has spikes that allow it to stick to a lung or other cell and infect it. The virus sets up a factory inside the cell and then produces thousands more virus particles, which are then spread to other people by coughing and breathing.

How is this virus different from other viruses? It is an entirely new strain of virus, so the human population has no previous immunity to COVID-19. For this reason it has spread unchecked around the world.

This disease is nothing like a cold or the flu. COVID-19 seems similar to the flu because both diseases are transmitted by droplets when someone coughs or sneezes. But COVID-19 is caused by a virus that moves more slowly than the virus that causes influenza. You can catch the flu within three days of being exposed to the influenza virus. But with the COVID-19 virus, it can take five or six days to show symptoms. Influenza usually lasts seven to ten days, whereas COVID-19 can last from days to months. Since COVID-19 is caused by a new virus, researchers have had to rush to develop new vaccines against it.

What will it take to end the global COVID-19 pandemic? To beat COVID-19 we all need to listen to the recommendations from health experts. Everybody needs to be sure to wash hands, wear masks, and keep distant from others. Following these simple public health rules will help stop COVID-19 in our schools and neighborhoods. With the courage and dedication of our health workers and the creativity of our researchers we have every reason to be optimistic about defeating COVID-19.

Tribes and the Pandemic

by Judi gaiashkibos

“Dear St. Nicholas: I am a little Indian girl twelve years old. I go to school at the Omaha Agency. I study geography, history, grammar, arithmetic, and spelling.”

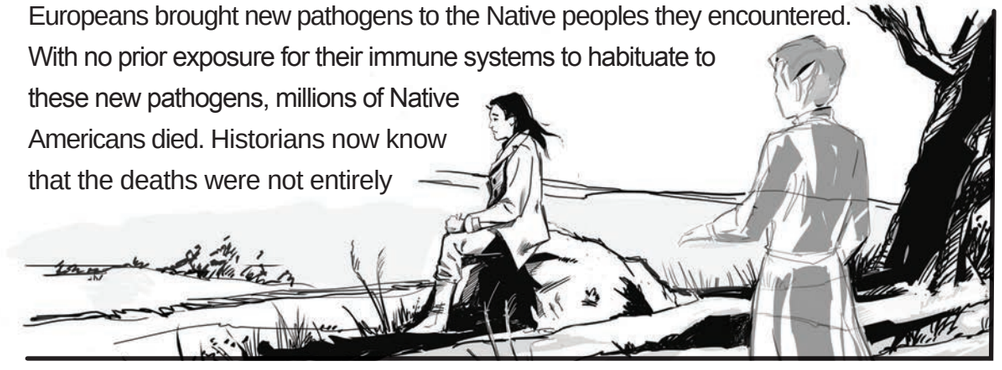
—Written by Susan La Flesche in 1877

The young girl Susan La Flesche eventually went on to study medicine and became America’s first Native American doctor. She was a tireless and caring physician who never stopped helping those in need. Susan passed on her legacy to generations of young doctors who work to heal people in the communities where they live.

In 2020 a new virus that struck the United States resulted in sickness for tens of millions of people and death for over three hundred thousand. The COVID-19 virus impacts communities of all kinds, filling hospitals and challenging health systems. But nowhere is the virus more deadly than in American Indian communities.

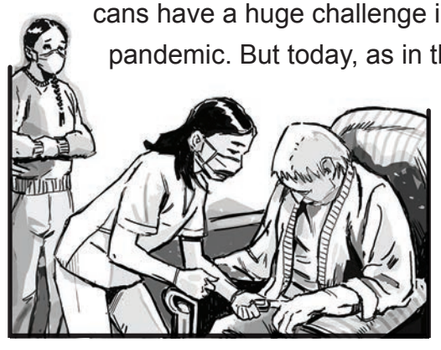
Across the United States today, Native Americans live in cities and towns, on reservations, and in rural lands. Five hundred years ago, when European settlers first arrived to North America, Native American communities were spread across the land. The growth of the United States resulted in the devastation of Tribal communities, sometimes forcing entire peoples to move from their homelands to distant regions.

It has been said that disease has never been “just disease” for Native Americans. Europeans brought new pathogens to the Native peoples they encountered. With no prior exposure for their immune systems to habituate to these new pathogens, millions of Native Americans died. Historians now know that the deaths were not entirely accidental. The U.S. Army actively tried to sicken many Indians. Army troops gave family members blankets that intentionally exposed them to smallpox. Again and again pandemics have ravaged Native American communities. And still they have survived.



Is this the worst pandemic that Native peoples have had to face? It certainly is not. This pandemic is, however, terrifying and destructive. Native Americans, Black Americans, and Hispanic Americans are more likely than other people to die from COVID-19. Many Native communities lack adequate resources to fight the pandemic. Some families live in remote areas where water is scarce, so they don’t have the opportunity to wash their hands many times each day. Despite such hardships, Native communities have joined forces to protect their well-being. Tribal communities have restricted travel from outsiders onto their lands, and they have set up active testing stations to screen people for the virus. Tribal medical professionals visit families living in remote areas to test and determine who might have the virus, and they get medical treatment to those who need it.

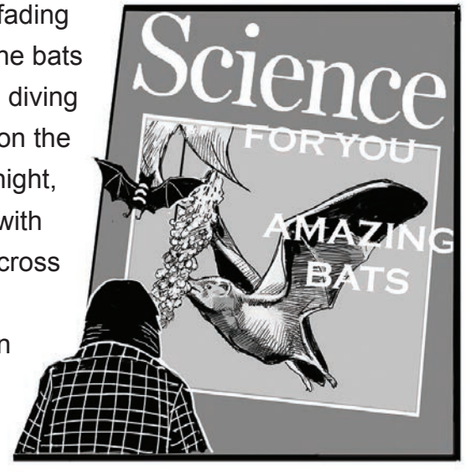
Today many young Native Americans are pursuing careers in medicine, law, engineering, and education. They are becoming active and influential professionals who will use their expertise to build strong communities. Native Americans have a huge challenge in the face of this most deadly COVID-19 pandemic. But today, as in the past, Native peoples gain strength from the memories of their ancestors. And the memory of the young girl Susan, who grew up to become the extraordinary doctor and leader Dr. Susan La Flesche Picotte, gives us all pride to know that the challenges of today can be met and can lead us forward.



Bats and the Virus

Liz VanWormer

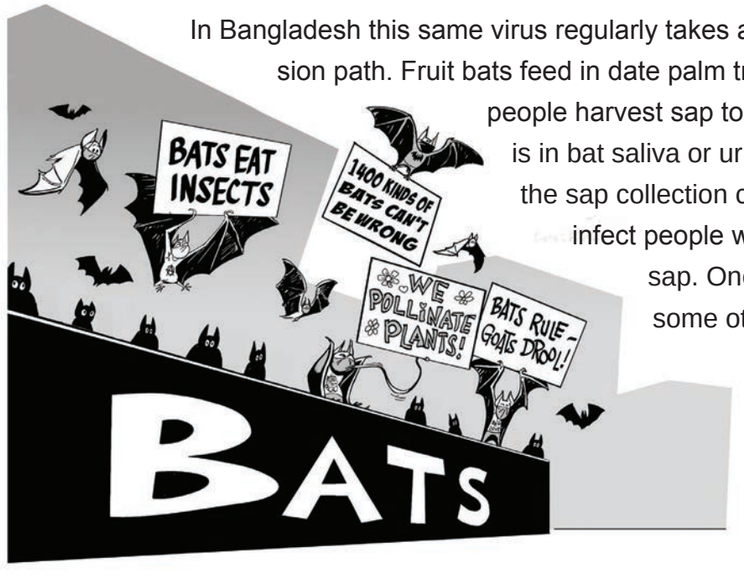
Step outside into the warm dusk as the light is fading and the sounds of the world shift. Pause, and the bats begin to emerge: one or two silhouettes at first, diving past rooftops and from branch to branch while on the path of their prey. And then, as day slides into night, the air feels full and the slice of wings mingles with the songs of insects and the rustle of leaves. Across the world the night is alive with bats. From the mouths of caves, the limbs of high tree roosts in cities and forests, and the shelter of houses or bridges, they set out alone or by the thousands into the fascinating lives they lead.



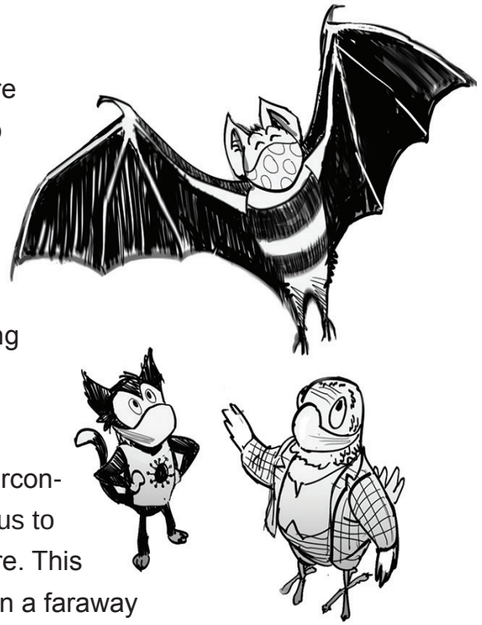
Bats are found throughout the world, except in the coldest environments of the Arctic and Antarctic. More than fourteen hundred different species of bats make their homes in habitats ranging from deserts and jungles to cities and farms. Most bats eat insects, fruit, or nectar, but some bats hunt frogs, fish, or other small animals. Though some stories link bats to vampires, only three species of bats in the world feed on blood. Unfortunately, populations are declining among the many types of bats, from the tiny cave-dwelling bumblebee bat to the large flying fox bat, whose body is bigger than your head. Disappearing habitat, too much hunting, and climate change are impacting bats and other wildlife across our planet.

Bats are often the target of frustration and anger. You might have heard COVID-19 called a “bat disease.” But are bats to blame? Bats can sometimes carry viruses that make people sick. Some viruses, like rabies, are transmitted directly when a bat bites a person or another animal. Other viruses are more commonly spread indirectly, as when people or other animals come into contact with bat saliva, bat urine, or bat droppings. Viruses can also take more than one path between bats and people.

In Malaysia, where Nipah virus was first identified in people, deforestation forced fruit bats to find new homes and feeding areas. With their forest resources reduced, the bats fed on the fruit of the trees on pig farms, dropping leftover fruit pieces below. When the pigs ate pieces of fruit that had been chewed by the bats, Nipah virus infected the pigs. From pigs the virus spread to farmers, making many people sick.



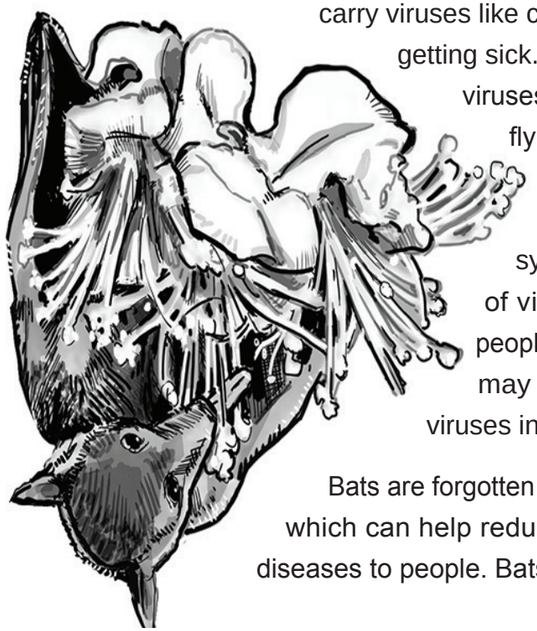
In Bangladesh this same virus regularly takes a different transmission path. Fruit bats feed in date palm trees, from which people harvest sap to drink. If Nipah virus is in bat saliva or urine and it gets into the sap collection containers, it can infect people when they drink the sap. Once Nipah virus and some other viruses make it to a human host, the virus can then be spread from person to person.



Did COVID-19 come from bats? Scientists are still searching for the answer. Viruses similar to SARS-CoV-2, the virus that causes COVID-19, have been found in some bats, but they are not an exact match. An earlier outbreak caused by SARS-CoV-1, a closely related virus, was linked from bats to wild civets being sold for food in markets.

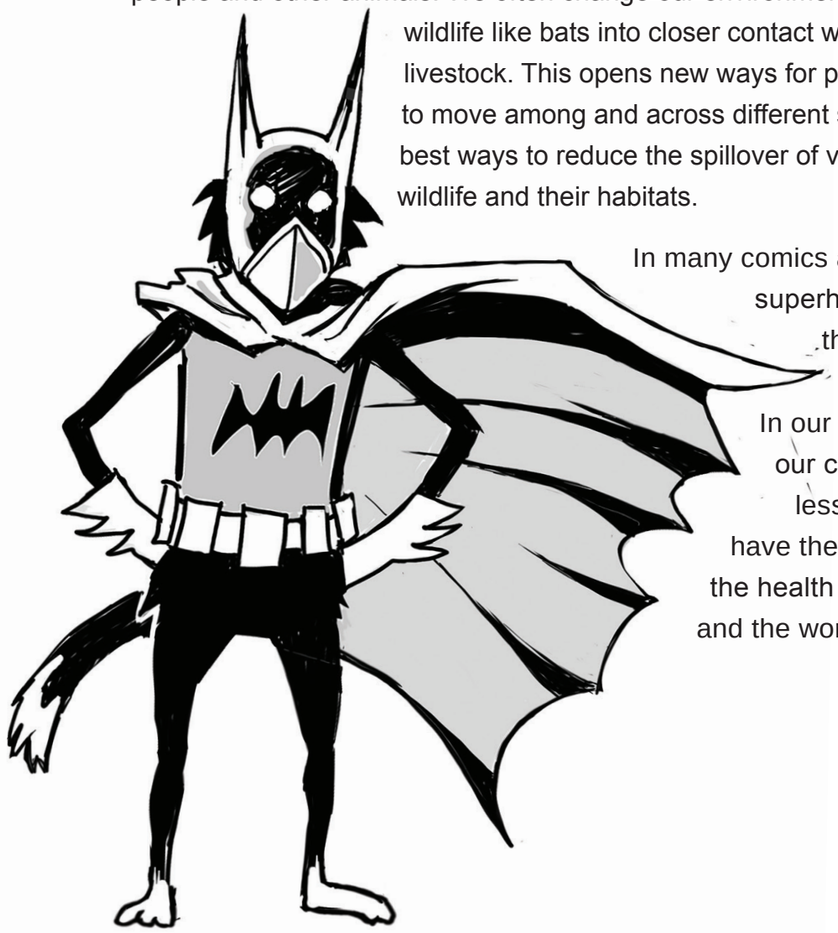
The rapid spread of the COVID-19 pandemic reminds us that health is a key part of our interconnected world. Planes, trains, and boats allow us to travel around the planet faster than ever before. This means a virus moving from wildlife to people in a faraway location can impact our lives within just a few weeks or months.

Do bats get sick? Some pathogens can have big impacts on bats. In many parts of the United States bats die from white-nose disease, which is caused by a fungus. Bats get sick from some viruses, too. But bats seem to be able to carry viruses like coronaviruses or Nipah viruses without getting sick. Scientists are investigating why these viruses aren't deadly for bats. Bats are the only flying mammal, and some scientists think a clue might be in how bats have adapted to flight. Special features of bat immune systems seem to make them more tolerant of viruses that can make other animals or people sick. Learning from bat immune systems may help us understand how to better treat viruses in people.



Bats are forgotten heroes. Many bats feed on mosquitoes, which can help reduce the risk of mosquitoes spreading diseases to people. Bats benefit agriculture too, because they eat insects that damage crops. Bats also pollinate hundreds of kinds of plants, including many we grow for food, like cashews and guava. Fruit bats carry seeds to new places, often distributing them over long distances. These bats are flying architects of the forest, even helping trees take root in new places.

Scientists are learning every day how viruses are shared between people and other animals. We often change our environment in ways that bring wildlife like bats into closer contact with people, pets, and livestock. This opens new ways for pathogens like viruses to move among and across different species. One of the best ways to reduce the spillover of viruses is to protect wildlife and their habitats.



In many comics and stories, the superhero often saves the day with one dramatic action. In our day-to-day lives our choices might feel less dramatic, but we have the power to protect the health of bats, people, and the world we share.

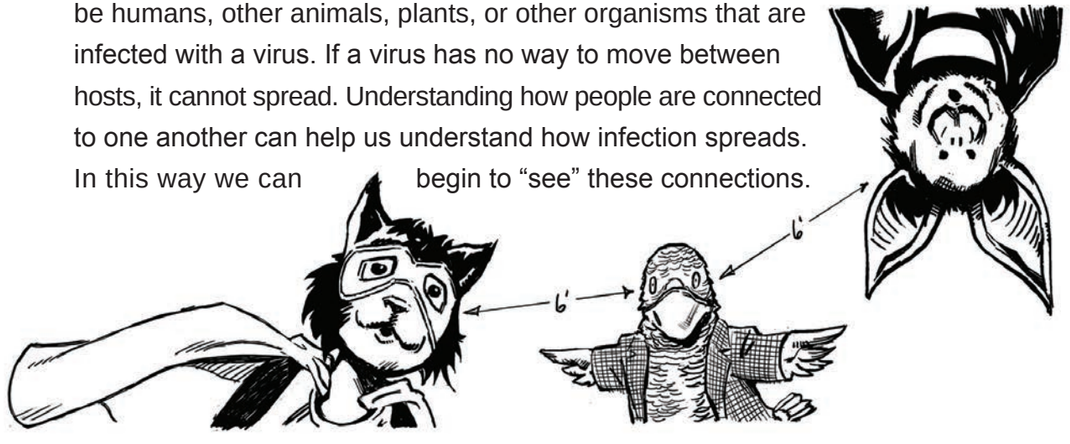
Tracing Connections to Stop a Pandemic

Julia McQuillan, Patricia Wonch Hill, Meghan Leadabrand,
Amy Spiegel, Wendy Smith

Do you need to see something to believe it exists? Have you ever seen someone "catch" a virus? If we can see a pattern or connection, we can understand it better. Have you ever wondered how you "caught" a sickness such as a cold? Because colds are more common when the temperature goes down, it might seem like "catching a cold" is related to the weather. Actually, invisible droplets that are in the air or on surfaces transport viruses like colds from person to person. The COVID-19 pandemic is also caused by invisible viruses. But how do we stop viruses from spreading if we can't see them?

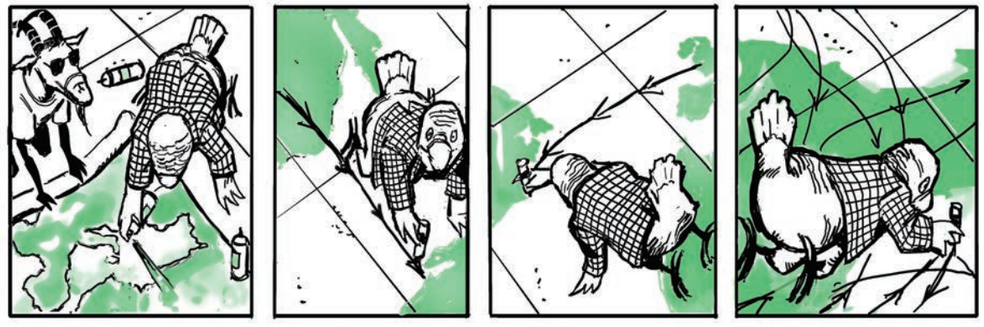
With some infections, like COVID-19, signs of illness like coughing or fever don't show up until days after someone is exposed. Without symptoms, a person needs a laboratory test to see if the virus is in their body. This test usually involves collecting a sample of blood, mucus, or saliva. Without symptoms or a test we might not know who is infected or who can infect others. If we can't tell who has the virus, it is hard to stop it from spreading, like trying to stop a chain of dominoes that is already in motion.

If we do not feel sick, it is hard to imagine we could bring deadly viruses to people we care about. But just like the force that causes a domino to make its neighbors fall down, a virus spreads through connections. Viruses rely on connections between hosts to travel from person to person. Hosts can be humans, other animals, plants, or other organisms that are infected with a virus. If a virus has no way to move between hosts, it cannot spread. Understanding how people are connected to one another can help us understand how infection spreads. In this way we can begin to "see" these connections.



Epidemiologists are scientists who study pandemics. They often use network maps to draw lines between people who are connected in a community, which helps them study how the spread of viruses creates pandemics. Creating network maps shows how people are connected through places such as homes, restaurants, schools, hospitals, and workplaces; through events such as funerals, weddings, and parties; and through activities such as worshipping, sports, or choir practice. Some people have few connections and others have many. We usually know our own connections, but it is harder to know our friends' connections, and very hard to know the connections of our friends' friends.

Can visiting a friend really spread a virus around the world? It depends upon how our friends are connected and who their connections are connected to. A virus can be transported from one host to many other hosts, and then to even more hosts, through a chain that spreads the virus throughout the network. The infection can spread from one person to two people, to four, to dozens, to hundreds in just a few connections. Network graphs reveal that people we do not know can have an impact on our health because we are connected to them through networks that we can't directly see. Network maps can get big and complicated, so possessing many tools for figuring out how the virus can spread is important.



Drawing the connections from each person in a chain of infections helps us see how a seemingly very big world can quickly become very small. Like a busy airport that connects cities all over the world, people with lots of connections are "hubs" of disease spread—the virus can use their connections to travel quickly and widely.

Because a virus needs connections to spread, stopping a pandemic means reducing the number of connections between people. Because the COVID-19 virus spreads mostly through droplets, we can try to stop the spread by blocking the droplets from reaching other people. If the droplets were green and we turned green when they entered us, it would be easy to know who to avoid. But in reality it can take up to two weeks after exposure to COVID-19 for someone to show symptoms of being infected. Because we can't tell for sure who is infectious and who isn't, the best strategy for slowing the virus from spreading through our web of relationships is to act as if we might be a "connector."

How do we know how a virus travels from one place to another? One tool is called contact tracing. When someone is diagnosed with a virus, they may be asked to make a list of all the people they have recently come into direct contact with. Scientists can then "trace" those connections to see how the virus is spreading. When someone tests positive for a virus, that person is asked to "isolate" simply to minimize their contact with other people and contain the spread. Contact tracers also identify the people the infected person came into close contact with, and they may ask them to "quarantine," which just means staying home and limiting their contacts.

Beyond drawing and tracing connections, scientists use mathematical models of networks to predict the spread of viruses and discover how to reduce connections to contain the virus. For example, they can estimate how many people would not get sick if schools were closed, if specific people were vaccinated, or if essential workers were given sick time off if they had a virus. Decades-long studies of social networks have helped people understand disease spread, such as discovering the role of an infected water well or tracing the spread of HIV, the virus that causes AIDS.

A network structure can show how quickly a disease spreads and what to do to stop it from spreading further. The more connections there are in a community, the higher the risk of infectious disease spreading. Viruses spread quickly to major cities with many connections to other places. It may take longer for a virus to reach a small or remote community, but it can spread rapidly once it arrives.

Reducing physical connections between people by staying physically distant—staying the recommended space apart and wearing face masks—is important during a pandemic because it helps prevent the spread of the virus. But staying socially connected with friends and family is also important. You might be thinking that relationships bring many good things, such as support, food, celebrations, and a sense of belonging. You would be correct. In fact, social connections are important for health and life. During hard times it is helpful to check on others in safe ways, like making phone and video calls, sending notes or letters, or masking up before visiting a friend or a family member outdoors. The health of everyone depends on creating physical barriers that stop the spread of disease but also protecting our social connections by caring for one another in new ways.

Network science helps us study complex systems and answer difficult questions, like how to stop a virus from spreading through a global population. Once you start to think about connections, you may notice how network science can help us discover things that are hidden. Often what is in front of us is connected to many things beyond what we can physically see or feel. Networks are everywhere, from Facebook friends to neurons in the brain to solar systems to traffic patterns to tree roots to cancer cells. What networks might you want to map?

Viruses and Giant Viruses

James Van Etten

A virus is like a tiny burglar that sneaks into cells and takes over their controls for making chemical substances. The virus then causes the cell to rapidly make large numbers of new viruses that escape and infect adjacent cells, producing even more viruses. Viruses cause many human diseases, such as COVID-19, AIDS, influenza, and the common cold. But all living organisms are susceptible to viruses. We now know that in every small drop of ocean water there are about ten million virus particles, most of which infect bacteria. If all the virus particles in the ocean were lined up in a row, they would stretch out millions of light years into space.

Viruses are not only abundant and diverse, they also are the biggest source of genes on the planet. We think of viruses as tiny particles that can be seen only with the help of powerful electron microscopes. They easily pass through fine filters and have small genomes that contain only a few of the genes that encode for proteins. The viruses that cause diseases like COVID-19, influenza, and AIDS have about 8 to 12 genes. Most viruses are tiny compared to the smallest free-living bacterium, *Mycoplasma genitalium*, which has just 525 genes. The smallest genome in a eukaryotic cell is in a parasite named *Encephalitozoon cuniculi*, which has about 2,000 genes.

In the last twenty years some viruses have been discovered that do not fit this classical description. These new viruses are much larger than other viruses, and some can even be seen with a light microscope. The majority of these newly discovered giant viruses do not cause disease in humans or plants, so they went undetected over generations of virology research.

The story of the discovery of the first giant virus began in 1992, during an outbreak of pneumonia in Bradford, England. A microbiologist named Timothy Robotham searched for the cause of the outbreak in the warm waters of a cooling tower of a power plant. He suspected that the culprit was a type of bacteria known to cause Legionnaires' disease. Dr. Robotham collected a sample that contained particles that looked like bacteria and sent them to one of the world's experts in recognizing these bacteria. However, none of the standard tests indicated that the particles caused the disease, so the sample was placed in a freezer for several years. Eventually someone remembered the sample and reexamined it with an electron microscope. They discovered that it was a virus that was much larger than anyone had seen before. It had about 1,000 genes and was huge, getting caught in the kinds of filters that usually let regular viruses slip through.

The new giant virus was named Mimivirus, for a microbe-mimicking virus. At the time it was the largest virus known; its genome was three times larger than the previous record holder, a virus that infected algae. However, in the last twenty years many more giant viruses have been discovered. The present record holder, named Pandoravirus, was described in 2013 and contains as many as 2,500 genes. New studies are finding that giant viruses are probably not all that rare and are quite common in aquatic environments.

For viruses to replicate in their host cells they must hijack the replication machinery of the host cell. Virus replication can take place in either the cytoplasm or in the nucleus; some viruses use both locations. To replicate, a virus needs at least three things from the host: energy for replication, enzymes to replicate the virus genome, and the machinery to synthesize the virus proteins. Giant virus genes provide some of this machinery, but even the biggest viruses require that the host provide the energy for replication. The viruses cannot replicate by themselves.

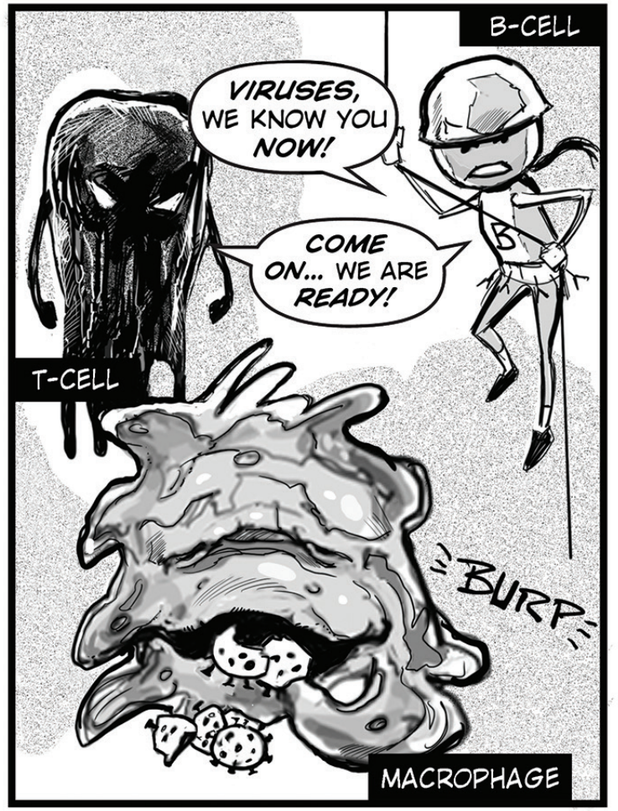
In 2008 a new strain of Mimivirus was isolated from another cooling tower in Paris and was named Mamavirus. However, Mamavirus surprised scientists because it also had a parasite virus or satellite virus, which they called Sputnik. Viral satellites, which occasionally occur, are subviral agents consisting of small amounts of nucleic acid whose replication depends on a viral genome. Sputnik was unusual in that it was an actual parasite of the host virus. When present it interfered with the infectivity of Mamavirus virions, which is not the case for traditional satellite viruses. This unprecedented property and other features of

its lifecycle led to the proposal of a new group and new name for viruses that parasitize giant viruses: virophage. It turns out that many of the newly discovered giant viruses have virophages associated with them.

Giant viruses play an important role in marine ecology. *Emiliania huxleyi* is one of the most abundant and widely distributed algae in the oceans. It is a major contributor to the oceanic carbon cycle and to the flux of carbon dioxide between the atmosphere and the oceans. *E. huxleyi* periodically forms huge blooms that cover hundreds of square miles of open ocean. Giant viruses are largely responsible for ending these blooms. The demise of the algal blooms releases sulfur-containing compounds into the atmosphere, inducing cloud formation and rain and playing an important role in climate.

The evolutionary ancestry of the giant viruses is a source of controversy. Many scientists believe that all giant viruses had a common evolutionary ancestor. However, because giant viruses can differ substantially from one another, other scientists have suggested that some of them may have evolved independently. Some scientists believe that giant viruses arose from smaller viruses by collecting genes from other living organisms and by duplicating their genes. Regardless of their origin, most scientists think that the giant virus ancestor existed hundreds of millions years ago—even before or at about the same time as the first eukaryotic cells appeared.

We know very little about the natural environment, especially the microbial world, and we have much to learn about viruses. As yet we know very little about the giant viruses that have already been discovered. And there may even be larger viruses in nature that still await discovery.



THE END

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