

TOKOPLASMOVIS

UNLOCKING THE SECRETS OF A MYSTERIOUS PARASITE



University
of Glasgow

Wellcome Centre
for Molecular
Parasitology



'TOXOPLASMOSES: UNLOCKING THE SECRETS OF A MYSTERIOUS PARASITE' IS ©
WELLCOME CENTRE FOR MOLECULAR PARASITOLOGY, JAMIE HALL AND EDWARD ROSS,
2017.

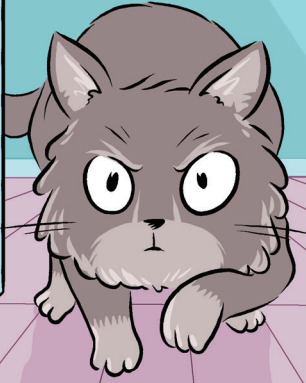
A COMIC WRITTEN BY JAMIE HALL AND EDWARD ROSS. ILLUSTRATED BY EDWARD ROSS.
SCIENTIFIC ADVISOR: DR. LILACH SHEINER.

ALL RIGHTS RESERVED. NO PART OF THIS PUBLICATION MAY BE REPRODUCED OR
TRANSMITTED IN ANY FORM OR BY ANY MEANS, INCLUDING PHOTOCOPYING, RECORDING
OR BY ANY INFORMATION AND STORAGE RETRIEVAL SYSTEM, WITHOUT PRIOR WRITTEN
CONSENT OF WELLCOME CENTRE FOR MOLECULAR PARASITOLOGY OR THE AUTHORS.

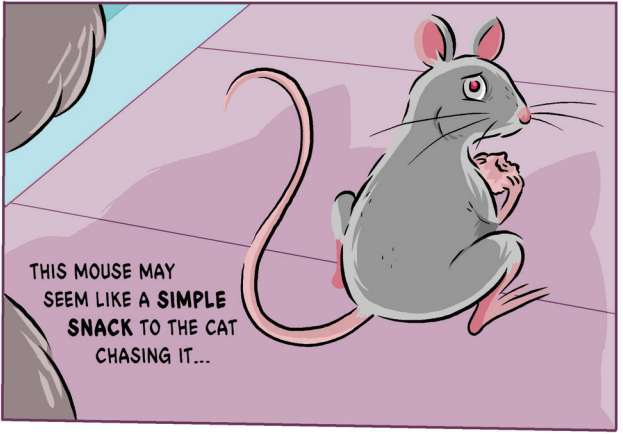
PUBLISHED BY WELLCOME CENTRE FOR MOLECULAR PARASITOLOGY, SIR GRAEME DAVIES
BUILDING, UNIVERSITY OF GLASGOW, 120 UNIVERSITY PLACE, GLASGOW G12 8TA.

PRINTED ON 100% RECYCLED PAPER.

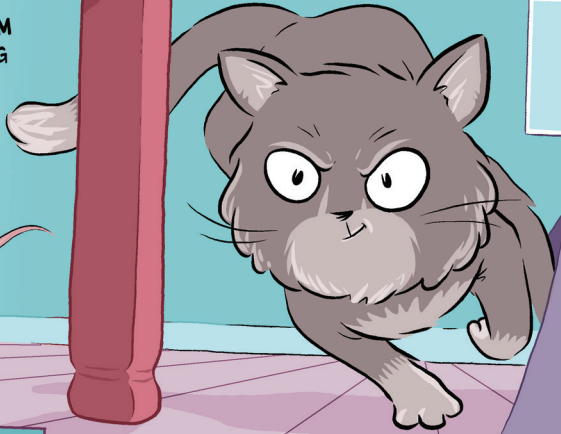
THE HUNT IS ON...



THIS MOUSE MAY SEEM LIKE A SIMPLE SNACK TO THE CAT CHASING IT...



BUT INSIDE ITS BODY LIE A SWARM OF PARASITES THAT ARE ITCHING TO SPREAD TO THEIR NEXT HOST.



YOINK



SILLY KITTY, DIDN'T YOU HEAR ANYTHING I WAS JUST SAYING TO YOU?

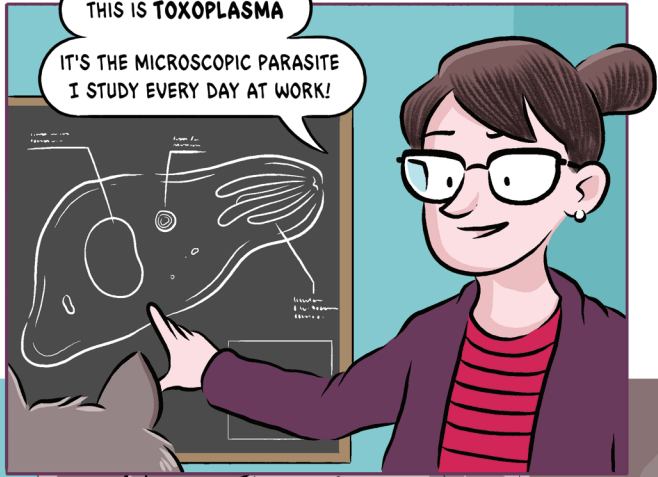


SIT DOWN. I THINK IT'S TIME WE HAD A CHAT ABOUT **TOXOPLASMOSIS**.

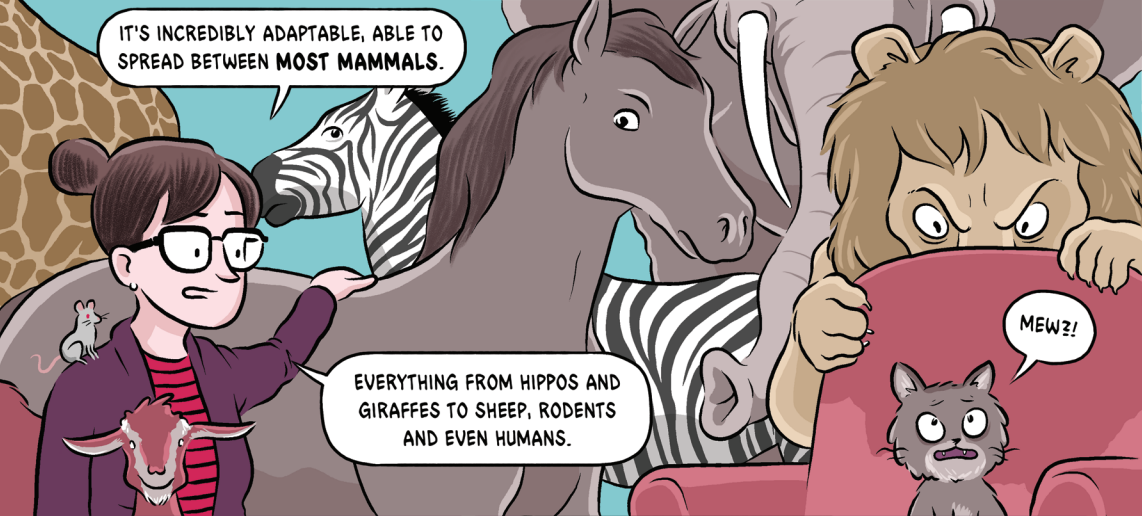


THIS IS **TOXOPLASMA**

IT'S THE MICROSCOPIC PARASITE I STUDY EVERY DAY AT WORK!



IT'S INCREDIBLY ADAPTABLE, ABLE TO SPREAD BETWEEN **MOST MAMMALS**.



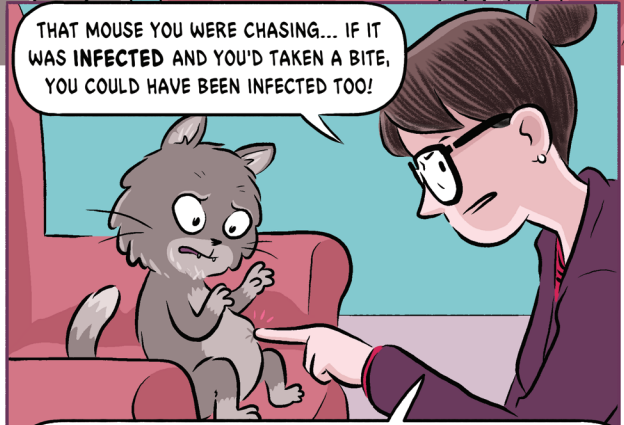
EVERYTHING FROM HIPPOS AND GIRAFFES TO SHEEP, RODENTS AND EVEN HUMANS.

MEW?!

HOWEVER, ITS NORMAL HOME IS INSIDE **CATS**, AND IT IS USUALLY SPREAD BACK AND FORTH BETWEEN CATS AND THE UNFORTUNATE ANIMALS THAT THEY HUNT.

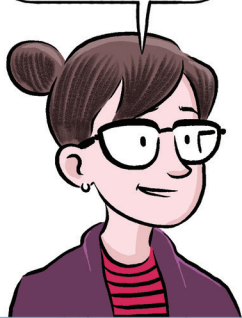


THAT MOUSE YOU WERE CHASING... IF IT WAS **INFECTED** AND YOU'D TAKEN A BITE, YOU COULD HAVE BEEN INFECTED TOO!

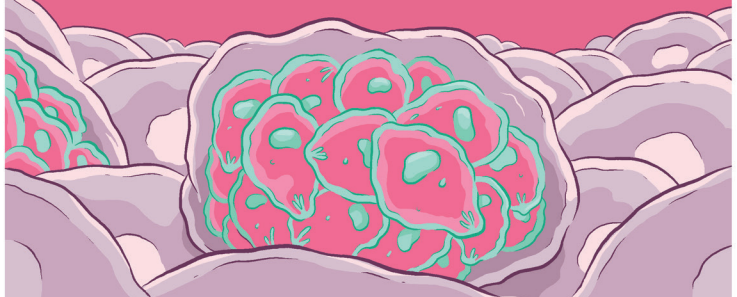


TOXOPLASMA WOULD HAVE MADE A HOME IN YOUR GUT, MULTIPLYING AND SPREADING ON TO NEW HOSTS! MAYBE EVEN ME!

TOXOPLASMA DOESN'T NEED TO RELY ON ITS HOST GETTING EATEN TO SPREAD. IT HAS ANOTHER TRICK TO SPREAD FAR AND WIDE.



INSIDE CATS' GUTS, TOXOPLASMA FORMS TINY AND INCREDIBLY TOUGH **CYSTS** - CLUSTERS OF PARASITES THAT ARE THEN POOPED OUT OF THE BODY.



A **PARASITIC TRAP** FOR OTHER ANIMALS, CYSTS CAN REMAIN ON FUR OR IN THE ENVIRONMENT FOR YEARS - RELEASING THEIR PARASITIC PAYLOAD IF THEY FIND THEMSELVES INSIDE A NEW HOST.

YOU CAN CATCH THE PARASITE FROM DIRT IN THE GARDEN, ANIMAL FUR, OR EVEN FROM EATING UNDERCOOKED INFECTED MEAT.



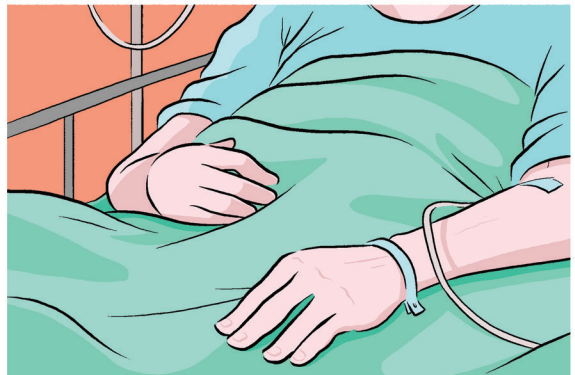
FOR THE MOST PART, TOXOPLASMA ISN'T THAT DANGEROUS TO HUMANS. IN FACT, AROUND 30% OF HUMANS ARE PROBABLY INFECTED, AND MOST OF US **DON'T EVEN KNOW IT.**



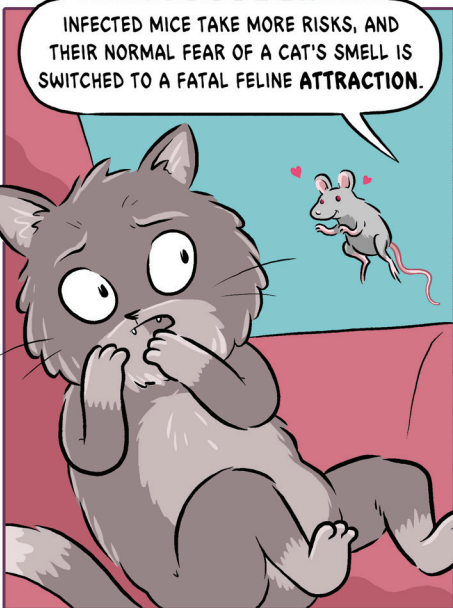
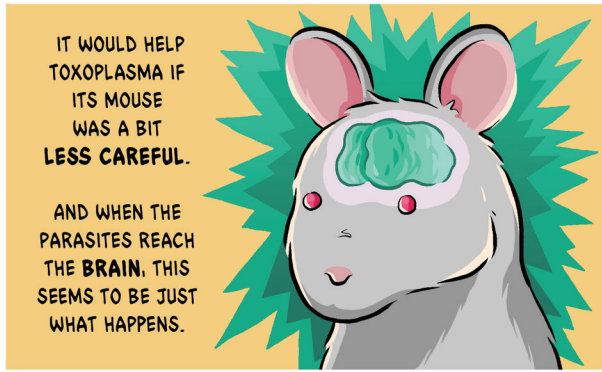
IN RARE CASES, TOXOPLASMA CAN DO REAL DAMAGE, CAUSING A DISEASE CALLED **TOXOPLASMOSIS.**




PREGNANT WOMEN CAN PASS THE PARASITE ONTO THEIR UNBORN CHILD, WHICH CAN BE DEVASTATING.




AND IF A PERSON'S IMMUNE SYSTEM IS DAMAGED - BY CERTAIN MEDICINES OR DISEASES LIKE AIDS OR CANCER - TOXOPLASMA CAN TURN DEADLY, DAMAGING THE BRAIN, HEART, LUNGS OR EYES.

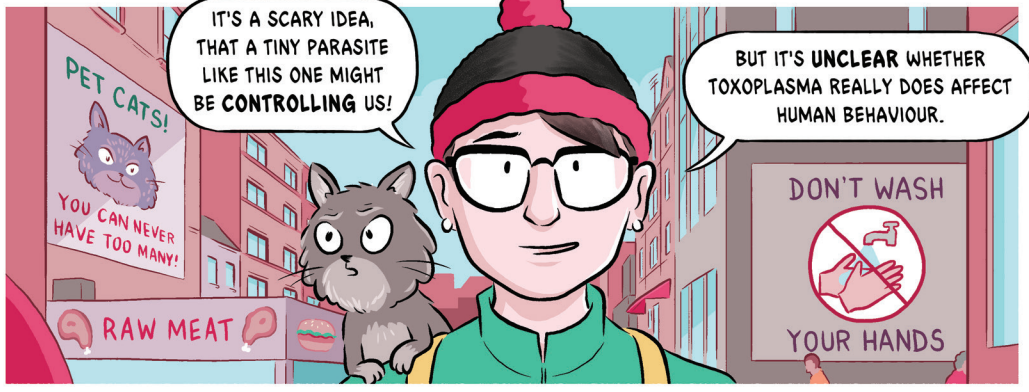




THE DRAMATIC EFFECT THAT TOXOPLASMA HAS ON MOUSE BEHAVIOUR HAS LED SOME RESEARCHERS TO PROPOSE IT CAN CHANGE HUMAN BEHAVIOUR TOO.




RESEARCHERS HAVE CONSIDERED WHETHER HUMAN TOXOPLASMA INFECTION CAN CAUSE MENTAL ILLNESSES SUCH AS SCHIZOPHRENIA, OR PERHAPS INCREASE RISK-TAKING IN HUMANS, CAUSING TRAFFIC ACCIDENTS AND DANGEROUS BEHAVIOUR.



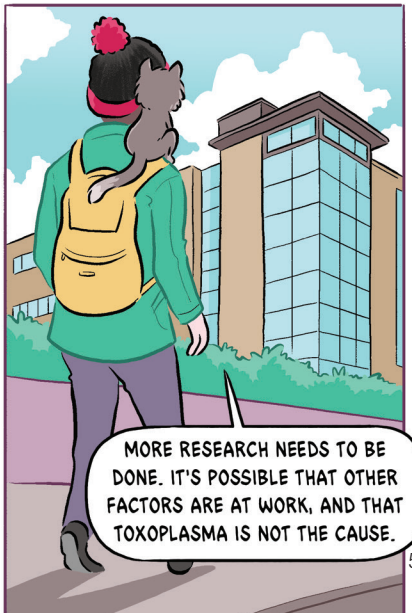
IT'S A SCARY IDEA, THAT A TINY PARASITE LIKE THIS ONE MIGHT BE CONTROLLING US!

BUT IT'S **UNCLEAR** WHETHER TOXOPLASMA REALLY DOES AFFECT HUMAN BEHAVIOUR.



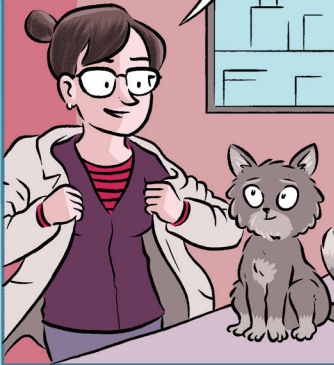
AS SCIENTISTS, IT'S OUR JOB TO QUESTION AND TEST OTHER SCIENTISTS' FINDINGS.

IN THIS CASE, SOME RESEARCHERS HAVE ARGUED THAT THE LINKS BETWEEN TOXOPLASMA INFECTION AND MENTAL ILLNESS OR INCREASED RISK-TAKING ARE **WEAK**.

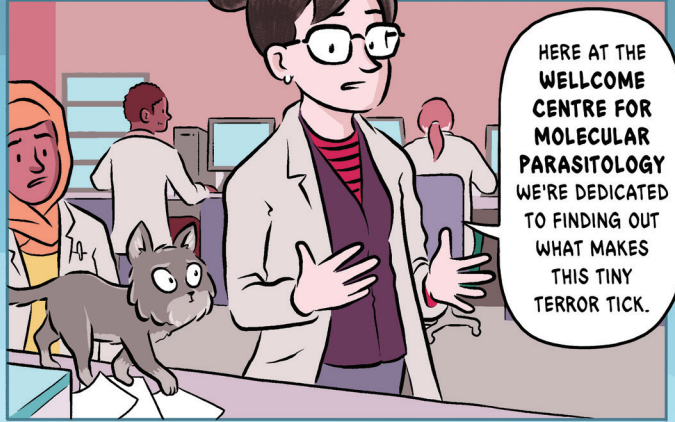


MORE RESEARCH NEEDS TO BE DONE. IT'S POSSIBLE THAT OTHER FACTORS ARE AT WORK, AND THAT TOXOPLASMA IS NOT THE CAUSE.

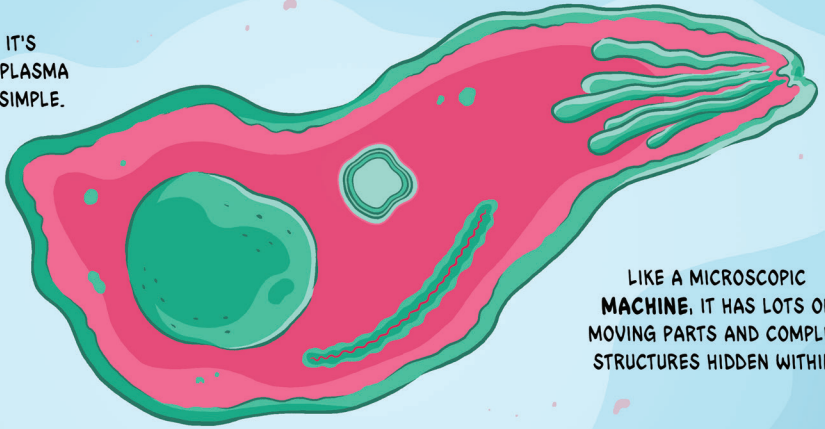
EVEN IF TOXOPLASMA ISN'T TURNING US INTO **ZOMBIES**, IT'S STILL AN AMAZING CREATURE.



HERE AT THE **WELLCOME CENTRE FOR MOLECULAR PARASITOLOGY** WE'RE DEDICATED TO FINDING OUT WHAT MAKES THIS TINY TERROR TICK.



ALTHOUGH IT'S **SMALL**, TOXOPLASMA IS FAR FROM SIMPLE.



LIKE A MICROSCOPIC **MACHINE**, IT HAS LOTS OF MOVING PARTS AND COMPLEX STRUCTURES HIDDEN WITHIN.

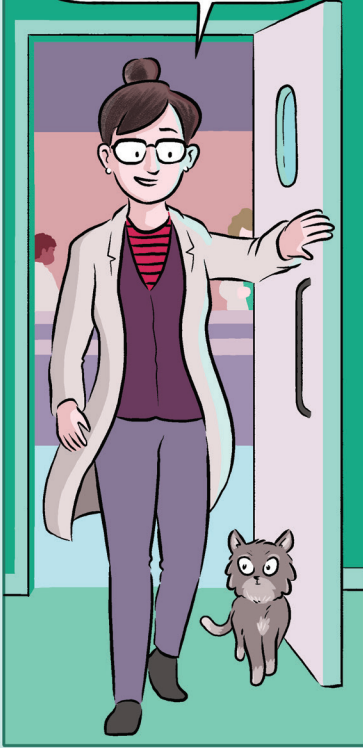
HOW DO THESE PARTS INTERACT TO MAKE IT MOVE, BREAK INTO OUR CELLS, MULTIPLY, BURST OUT, AND COMPLETE ITS LIFE CYCLE?



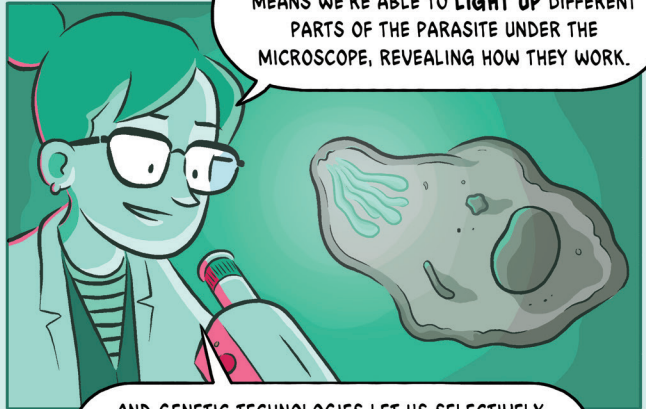
THE ONLY WAY TO FIND OUT IS TO GET UP **CLOSE** AND WORK TOGETHER TO BUILD UP A PICTURE OF THIS COMPLEX ORGANISM.



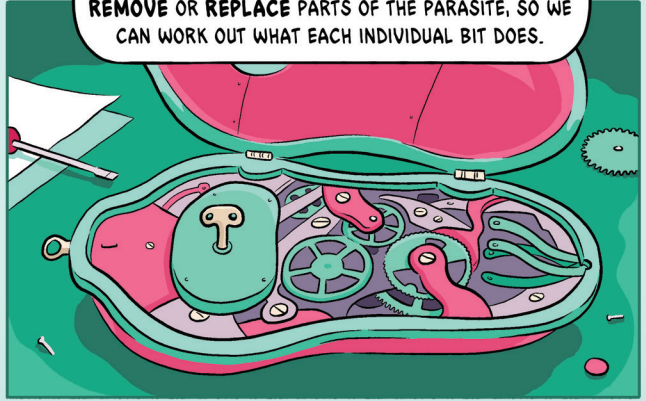
FORTUNATELY WE HAVE **POWERFUL TECHNOLOGIES** THAT LET US SEE WHAT'S GOING ON INSIDE THE PARASITE.



INSERTING DNA FROM **GLOWING JELLYFISH** MEANS WE'RE ABLE TO LIGHT UP DIFFERENT PARTS OF THE PARASITE UNDER THE MICROSCOPE, REVEALING HOW THEY WORK.



AND GENETIC TECHNOLOGIES LET US SELECTIVELY **REMOVE OR REPLACE** PARTS OF THE PARASITE, SO WE CAN WORK OUT WHAT EACH INDIVIDUAL BIT DOES.



TECHNOLOGIES ARE ADVANCING ALL THE TIME. BEFORE, TRYING TO EXAMINE A SINGLE PARASITE GENE COULD TAKE **YEARS**.



NOW, WITH ADVANCED TECHNIQUES WITH **FUTURISTIC NAMES** LIKE TRANSCRIPTOMICS, PROTEOMICS, METABOLOMICS AND GENOMICS, WE CAN QUICKLY GATHER DATA ON AN ALMOST UNIMAGINABLE SCALE.

TOGETHER, THESE TECHNIQUES ARE BUILDING UP AN **INCREASINGLY DETAILED** PORTRAIT OF TOXOPLASMA.



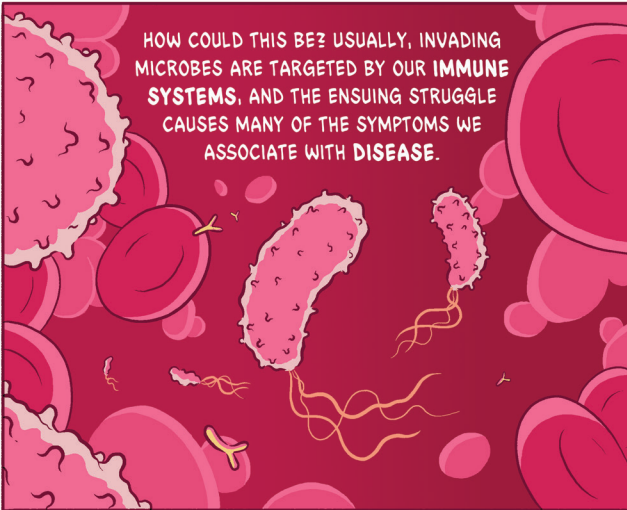
AND IN THE PROCESS, SOME **INCREDIBLE** THINGS HAVE BEEN DISCOVERED.



TOXOPLASMA IS AN ENORMOUSLY SUCCESSFUL PARASITE.

YET, UNLIKE ITS KILLER COUSIN MALARIA, TOXOPLASMA SUCCEEDS WITHOUT KILLING MILLIONS.

IN FACT, PEOPLE CAN BE INFECTED WITH TOXOPLASMA PARASITES FOR YEARS AND NOT EVEN KNOW IT.

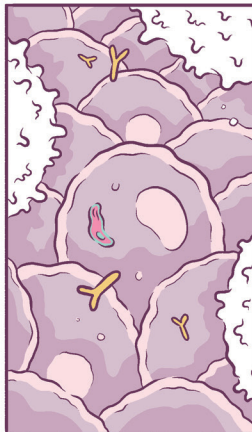
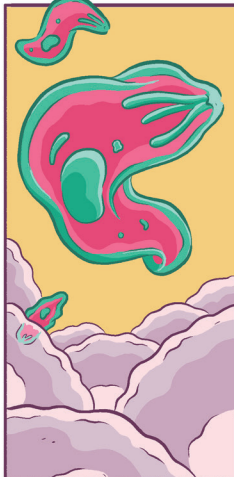


HOW COULD THIS BE? USUALLY, INVADING MICROBES ARE TARGETED BY OUR IMMUNE SYSTEMS, AND THE ENSUING STRUGGLE CAUSES MANY OF THE SYMPTOMS WE ASSOCIATE WITH DISEASE.

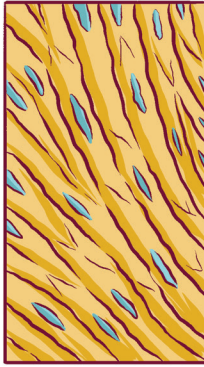
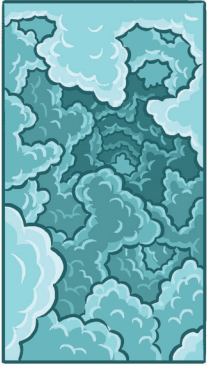


BUT TOXOPLASMA IS A HIDER, NOT A FIGHTER. ONCE WE'RE INFECTED IT HAS A DEVIOUS WAY TO SURVIVE.

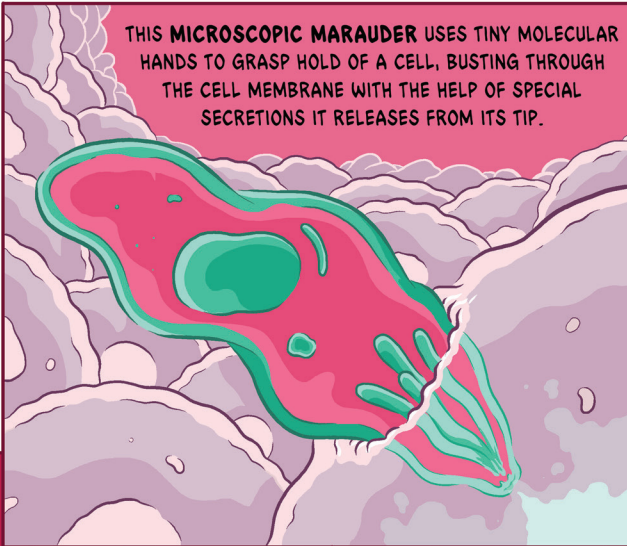
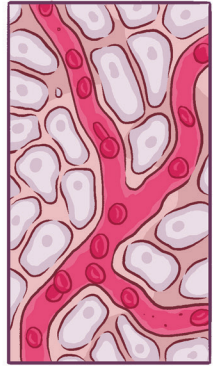
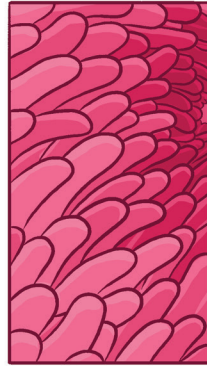
AFTER GETTING INTO THE BODY, TOXOPLASMA AVOIDS DETECTION BY FORCING ITSELF INSIDE OUR CELLS.



OUR CELLS FORM A PERFECT HIDING PLACE! WITH THE PARASITE CONCEALED FROM THE IMMUNE SYSTEM, THE BODY GOES ABOUT ITS USUAL BUSINESS, THE HEALTHY HUMAN HOST TOTALLY UNAWARE OF THEIR PARASITIC STOWAWAY.



BRAIN, EYE, AND MUSCLE CELLS CAN ALL MAKE A GOOD HIDEOUT, BUT TOXOPLASMA CAN INVADE ALL SORTS OF CELLS FROM LOTS OF DIFFERENT SPECIES.



THIS **MICROSCOPIC MARAUDER** USES TINY MOLECULAR HANDS TO GRASP HOLD OF A CELL, BUSTING THROUGH THE CELL MEMBRANE WITH THE HELP OF SPECIAL SECRETIONS IT RELEASES FROM ITS TIP.



SAFE AND SECURE INSIDE OUR CELLS, TOXOPLASMA WAITS FOR ITS HOST TO GET EATEN SO IT CAN CONTINUE ITS LIFE CYCLE.



ALTHOUGH TOXOPLASMA CAN OUTMANOEUVRE OUR DEFENCES, THE IMMUNE SYSTEM STILL PLAYS A **CRUCIAL ROLE** IN KEEPING TOXOPLASMA UNDER CONTROL.

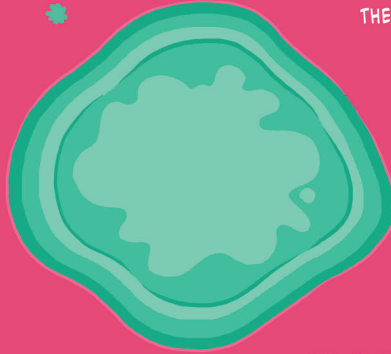
WHEN IMMUNITY IS **COMPROMISED**, THE PARASITE HAS NO REASON TO HIDE AND CAN RUN RAMPANT THROUGH THE BODY, CAUSING **LIFE-THREATENING** ILLNESS THAT REQUIRES MEDICINE TO TREAT.

THE MYSTERIES LOCKED INSIDE THIS TINY ORGANISM COULD OPEN THE DOOR NOT JUST TO TREATING TOXOPLASMOISIS, BUT OTHER DISEASES TOO.

WE'RE GETTING SOME USEFUL CLUES FROM STUDYING SOME OF THE MORE **UNUSUAL** PARTS OF TOXOPLASMA.



ONE OF THE **WEIRDEST** FEATURES OF TOXOPLASMA IS A STRANGE ORGAN CALLED THE **APICOPLAST**.

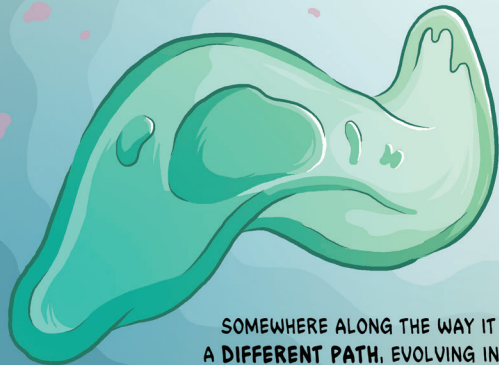


THE APICOPLAST NOT ONLY LOOKS WEIRD, BUT IT HAS A **BIZARRE** AND FASCINATING HISTORY.

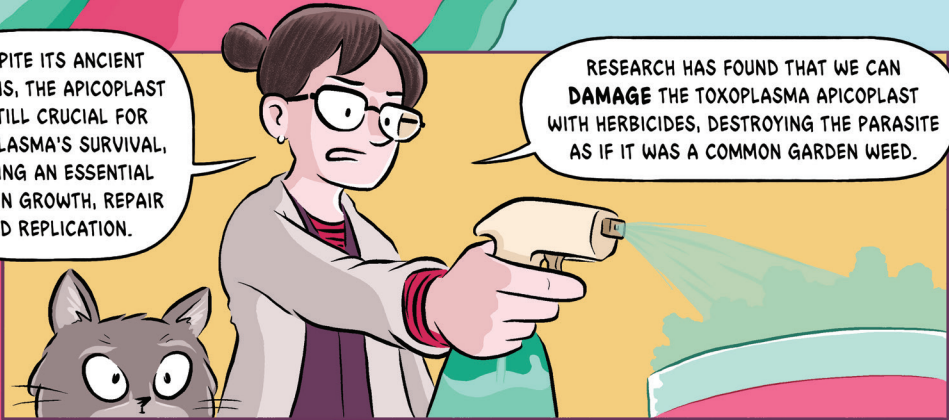
IT TURNS OUT THE APICOPLAST HAS A LOT IN COMMON WITH A **CHLOROPLAST** - THE PART OF A PLANT'S CELLS USED TO HARVEST ENERGY FROM THE SUN. THE VERY THING THAT MAKES PLANTS GREEN.



IT'S POSSIBLE THAT IN THE DISTANT PAST, TOXOPLASMA'S ANCESTOR LED A LIFE QUITE LIKE THAT OF A PLANT, COLLECTING ENERGY THROUGH **PHOTOSYNTHESIS**.




SOMEWHERE ALONG THE WAY IT TOOK A **DIFFERENT PATH**, EVOLVING INTO THE PARASITE WE KNOW TODAY.

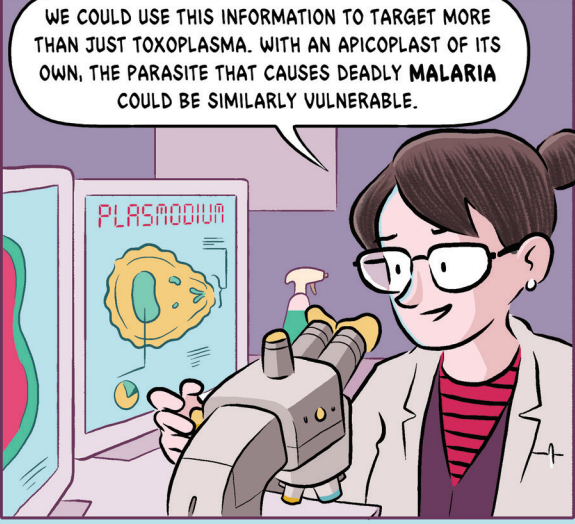


DESPITE ITS ANCIENT ORIGINS, THE APICOPLAST IS STILL CRUCIAL FOR TOXOPLASMA'S SURVIVAL, PLAYING AN ESSENTIAL ROLE IN GROWTH, REPAIR AND REPLICATION.

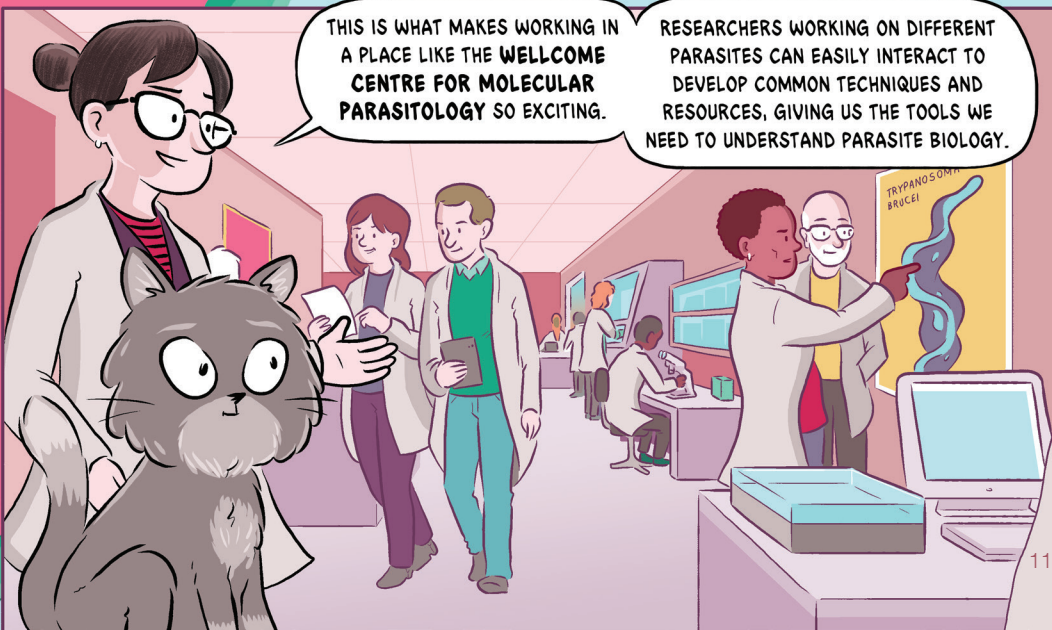
RESEARCH HAS FOUND THAT WE CAN **DAMAGE** THE TOXOPLASMA APICOPLAST WITH HERBICIDES, DESTROYING THE PARASITE AS IF IT WAS A COMMON GARDEN WEED.



UNDERSTANDING HOW THE APICOPLAST WORKS, AND HOW WE MIGHT BREAK IT, COULD BE VERY USEFUL.



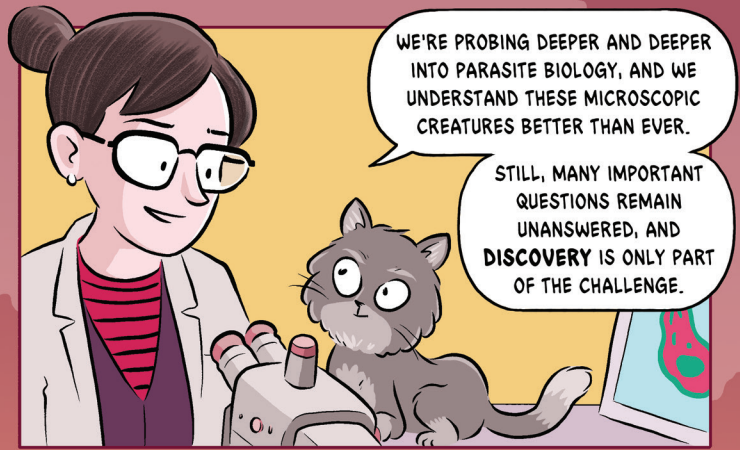
WE COULD USE THIS INFORMATION TO TARGET MORE THAN JUST TOXOPLASMA. WITH AN APICOPLAST OF ITS OWN, THE PARASITE THAT CAUSES DEADLY **MALARIA** COULD BE SIMILARLY VULNERABLE.



THIS IS WHAT MAKES WORKING IN A PLACE LIKE THE **WELLCOME CENTRE FOR MOLECULAR PARASITOLOGY** SO EXCITING.

RESEARCHERS WORKING ON DIFFERENT PARASITES CAN EASILY INTERACT TO DEVELOP COMMON TECHNIQUES AND RESOURCES, GIVING US THE TOOLS WE NEED TO UNDERSTAND PARASITE BIOLOGY.

FROM MALARIA TO SLEEPING SICKNESS TO TOXOPLASMOIS, THE CENTRE IS A BASE FOR KNOWLEDGE SHARING BETWEEN OUR DIFFERENT SPECIALITIES. IT ALSO FORMS A HUB FOR COLLABORATIONS ACROSS THE GLOBE.



WE'RE PROBING DEEPER AND DEEPER INTO PARASITE BIOLOGY, AND WE UNDERSTAND THESE MICROSCOPIC CREATURES BETTER THAN EVER.

STILL, MANY IMPORTANT QUESTIONS REMAIN UNANSWERED, AND **DISCOVERY** IS ONLY PART OF THE CHALLENGE.

WE ALSO WANT TO **SPREAD THE WORD** ABOUT THESE PARASITES, TO INFORM PEOPLE OF THE DANGERS AND GIVE A BETTER UNDERSTANDING OF THE SCIENCE BEHIND PARASITES LIKE TOXOPLASMA.



SO, WHAT DO YOU SAY, ARE YOU GOING TO STOP CHASING MICE?



MREW?



AT THE VERY LEAST, STOP LEAVING THEM AS LITTLE GIFTS FOR ME!

THE **WELLCOME CENTRE FOR MOLECULAR PARASITOLOGY** IS BASED AT THE UNIVERSITY OF GLASGOW. OUR MISSION IS TO DEVELOP A DEEPER UNDERSTANDING OF MOLECULAR PROCESSES AND PATHWAYS IN PARASITES IN ORDER TO DEVELOP NEW APPROACHES TO TREATMENT.

FOR MORE INFORMATION ABOUT OUR WORK PLEASE VISIT:
GLA.AC.UK/CENTRES/WCMP/

OR CHAT WITH US **@WCMPGLASGOW** ON TWITTER.

WITH THANKS TO DR. LILACH SHEINER, DR. VICKIE CURTIS, AND ALL OF OUR PROOFREADERS FOR THEIR HELP IN MAKING THIS BOOKLET.

MORE ABOUT THE CREATORS AT:

WWW.EDWARDROSS.CO.UK

WWW.JPJHALL.NET



University
of Glasgow

Wellcome Centre
for Molecular
Parasitology



TOXOPLASMA! IT'S THE MYSTERIOUS PARASITE THAT MAKES A HOME IN CATS, HUMANS, MICE AND OTHER MAMMALS. A THIRD OF PEOPLE ON EARTH COULD BE INFECTED AND YET IT RARELY KILLS.

FIND OUT ABOUT THESE FASCINATING MICROBES, HOW THEY SPREAD, AND WHY SOME SCIENTISTS BELIEVE THEY COULD INFLUENCE THE WAY THEIR HOSTS BEHAVE.

PART OF AN AWARD-WINNING SERIES ABOUT PARASITES!



University
of Glasgow

Wellcome Centre
for Molecular
Parasitology

