FOREWORD

Science communication is a priority in Botswana’s educational landscape. Beyond schools and colleges, the Ministry of Education and Skills Development has been at the forefront in taking measures to improve the appreciation of science by the general public. This is attested by the broadcast content aired in our national broadcasting media led by the Ministry of Education and Skills Development. Our efforts in this regard are consistent with a key pillar of vision 2016, namely, an informed and educated nation. This ambitious vision cannot be achieved without the cooperation of all stakeholders.

It is with the greatest delight to learn that the Botswana-Baylor Children’s Clinical Centre of Excellence (COE), in trying to fulfill the goals of the Collaborative African Genomics Network (CAfGEN), is already contributing to this course through its flagship community engagement project - Genome Adventures. Funded jointly by Wellcome Trust and the US National Institutes of Health, Genome Adventures is presented in four comic books that seek to communicate and engage Batswana and other African countries on issues of science with a special focus on biomedical research.

In the first book entitled “Blast to the past” Kitso- the young hero of the book series explores heredity and genetics. In this, the second book, entitled “Cracking the code” Kitso with the assistance of several superheroes shrinks to microscopic size to explore how DNA and the genes affect the human body and its functions. Presented in a pictorial and entertaining way using simple language, this book can be enjoyed by all - young and old, less and more educated. I urge all learners to pay attention to the story and compare it to the content from their biology books for their benefit.

Aware that genetics is one of those topics that can be challenging to understand, I am happy to endorse and recommend Genome Adventure Book Two as an opportunity to our students and communities to learn genetics in an easy and more exciting style that combines story-telling comics and analogies to engage and educate its readers.

Significantly, the book features female scientists - an encouragement for our girl children to aspire to take science as a career. This is notable as Botswana is a signatory to the Southern African Development Community Science and Technology Protocol that requires members to close the numerical gap between female and male scientists.

I am informed that Genome Adventures Comic Books will be translated into Setswana, Luganda Swahili, Hausa, Arabic, French, Portuguese and featured in various social media in order to reach as many African People as possible.

On behalf of Batswana, and indeed all Africans, I take this opportunity to thank all those who are involved in bringing this project to fruition and to the Wellcome Trust and National Institutes of Health for providing funding support. We at the Botswana Ministry of Education and Skills Development we are happy to crack the code with Kitso. I invite you all to join.

Honourable Dr Unity Dow
Minister of Education and Skills Development
Republic of Botswana
KITSO

Hi! My name is Kitso! I live in Tlokweng with my aunt. I love adventures! I was born with HIV, but that doesn't slow me down!

DR. MABOKO

I am the leader of the Genome Adventures Squad (no matter what KgosiGadi tells you!). I have amazing powers to go through walls and teleport with my scooter. And that's not all - I am a mind reader, too!

KGOSIGADI

I am an outspoken lady and a true leader of my people, the Batswana! I might look like your average grandmother, but my walking stick contains special powers from my ancestors! With these powers, I can control the weather, direct animals, and do other amazing things!

PHODISO

My name is Phodiso, but you can call me "Aunty". I adopted my sister's child, Kitso, after she passed. But I love Kitso the same as my other children! We live together in Tlokweng, just outside Gaborone - we might even be your neighbours!

XGAO-TCGAI

I'm also a superhero with time-travelling powers! My name literally means "Blade-Vision" because my sight is as sharp as a knife and I can even see into the future!

MARANYANE

Just like my name, Maranyane, I love technology. Check out my body! Part of it is a machine and the other part is human. I am super-smart and I love using the latest gadgets!

MMATLI

My name is Mmatli. I am a researcher! I also have superpowers to shrink things to microscopic size, including humans! I love the amazing things that science helps us discover and I would love to see more young girls in Botswana become scientists, just like me!
MEANWHILE... BACK IN THE CAVENDISH LABORATORY AT THE UNIVERSITY OF CAMBRIDGE.

SO, KITSO, BY THE 1950s, SCIENTISTS HAD DISCOVERED A LOT ABOUT GENETICS, BUT THEY STILL HADN’T CRACKED THE GENETIC CODE OF LIFE.

THOSE DUDES OVER THERE - WATSON AND CRICK - HAD A HUNCH THAT THE CODE WAS LIKE A VINE WITH LEAF-SHAPED NUCLEOTIDES.

WHY ARE THOSE SHAPES LABELED A, T, C, AND G?

NUCLEO-WHATS?

NUCLEOTIDES. THEY’RE THE BUILDING BLOCKS OF THE GENETIC CODE AND HAVE FOUR TYPES OF BASES.

THYMINE (T), CYTOSINE (C), AND GUANINE (G). WATSON AND CRICK USED THESE MODELS TO SEE HOW THE SECRET GENETIC CODE FIT TOGETHER.

THESE ARE THE FOUR BASES. THEY’RE CALLED ADENINE (A).
IS THAT IT? IS THAT THE SECRET CODE? IT LOOKS LIKE A TWISTED LADDER.

THAT'S CALLED DEOXYRIBONUCLEIC ACID, OR DNA FOR SHORT, AND ITS BEAUTIFUL SHAPE IS CALLED A DOUBLE HELIX!

TWO STRANDS OF NUCLEOTIDES TWIST AROUND EACH OTHER, AND EVERY BASE FROM THE FIRST STRAND PAIRS WITH ONE FROM THE SECOND STRAND.

IT'S SO... PRETTY.

A PAIRS WITH T AND C PAIRS WITH G. PRETTY COOL, RIGHT?

HEY, SO WHO IS THAT LADY, AND WHAT IS SHE HOLDING?

WATSON AND CRICK CAN'T TAKE ALL THE CREDIT FOR THE DISCOVERY OF DNA. DON'T YOU KNOW THAT MEN Aren'T THE ONLY ONES WHO CAN BE SCIENTISTS?!

THAT'S MY SISTER-SCIENTIST ROSALIN FRANKLIN, AND SHE'S HOLDING AN X-RAY DIFFRACTION PHOTO OF DNA THAT SHE TOOK.

IF YOU LOOK CLOSELY, YOU CAN MAKE OUT THE SHAPE OF THE DOUBLE HELIX.
SO A LADY DISCOVERED THE SHAPE OF DNA?

BUT I STILL DON’T GET IT. XT SAID THAT THE SECRET CODE IS INSIDE EVERYONE. DOES THAT MEAN THAT I HAVE A FUNNY SHAPED LADDER INSIDE OF ME?

WE’VE GOT A PLAN.

OKAY, SO WHAT’S THE PLAN?

THIS IS THE MOMENT YOU’VE BEEN WAITING FOR, LITTLE YOUNG KITSO.

WHAT’S THE PLAN?

LET’S FIND OUT, SHALL WE? SUPERHERO HUDDLE!

LET’S FIND OUT, SHALL WE? SUPERHERO HUDDLE!

NOW, LET’S GO BACK HOME.

KITSO, OUR ADVENTURE IS FAR FROM OVER.

YOU ARE GOING TO LEARN SO MUCH!

BUT YOU STILL HAVEN’T TOLD ME THE PLAN! WHAT’S THE PLAN?!
IT'S TIME TO SEE WHAT GOES ON IN A REAL HUMAN BODY. TO SEE THE GENETIC CODE WITH YOUR OWN EYES.

WAIT ... YOU DON'T MEAN...

THAT'S RIGHT.

WE'RE GOING TO SEND YOU INTO YOUR BABY COUSIN TUMO'S BLOODSTREAM.

TIME TO SHRINK DOWN A SIZE OR TWO, KITSO.

SHRINK? WOAH, WAIT A SECOND.

YOU CAN'T VERY WELL SEE THE GENETIC CODE LOOKING LIKE THIS, CAN YOU?

AND YOU WANT TO SEE THE CODE, DON'T YOU?

WELL, NO...

WELL, YEAH...

OF COURSE HE DOES! TRUST ME, MELAITI, IT'S PERFECTLY SAFE. WE'LL WALK YOU THROUGH EVERY STEP OF THE WAY. HERE, TAKE THIS.

WE'LL BE ABLE TO COMMUNICATE USING THIS. TESTING, TESTING, 1-2-3. CAN YOU HEAR ME?

YEAH, AND SEE YOU.

GREAT! SO... WHAT DO YOU SAY? READY FOR ANOTHER ADVENTURE?
OKAY, LET'S DO THIS! HOLD ON TIGHT!

PIZZ!

SHHNNIIIIIZZZ!

BLING!

KITSO, CAN YOU HEAR US?

GUYS? WHERE AM I?

ACCORDING TO MY GPS MAP, IT LOOKS LIKE YOU'RE IN A BLOOD VESSEL.

SWOOOSHHH!

WOAH!

IT'S LIKE RUSH HOUR TRAFFIC IN HERE!

YOU'RE IN THE BLOOD STREAM. BLOOD CELLS TRAVEL RAPIDLY FROM ONE PART OF THE BODY TO THE OTHER TO PERFORM THEIR SPECIFIC FUNCTIONS.

WANT TO EXPLORE ONE OF THEM?
WHAT ABOUT THAT ONE? THAT ONE LOOKS COOL!

THAT'S A LYMPHOCYTE, A TYPE OF WHITE BLOOD CELL. GOOD CHOICE.

GUYS, ARE YOU SEEING THIS?

COOL! LET'S DO IT.

WOOAH!
LYSOSOME RECYCLING PLANT

GOLGI MAIL-CENTER

NUCLEUS

GUYS? HELLO?

Huh, I wonder what's wrong.
AT THE GOLGI MAIL CENTER...

25:47

25:46

ARE YOU KITSO?

I'VE GOT A LETTER FOR YOU.

FOR ME?

IT'S FROM THE SUPERHEROES!

DEAR KITSO,

WELCOME TO CELL-TOWN AS YOU CAN SEE, IT'S QUITE A BUSY PLACE. YOU ARE CURRENTLY IN THE ENTRANCE OF THE CELL, AND EACH BUILDING IS AN ORGANELLE. EVERY ORGANELLE HAS A UNIQUE FUNCTION TO KEEP THE CELL RUNNING SMOOTHLY.

UNFORTUNATELY, YOU'RE GOING TO HAVE TO EXPLORE THE REST ON YOUR OWN FOR NOW. THE CELL MUCRONAL IS INTERFERING WITH OUR TRANSMISSION SIGNAL, SO WE CAN'T REACH YOU ON THE WATCH. DON'T WORRY! WE'RE WORKING ON A STRONGER SIGNAL. FOR NOW, USE WHAT YOU'VE LEARNED TO FIND A WAY OUT OF THERE. WE'LL KEEP TRYING TO GET IN TOUCH.

GOOD LUCK,

YOUR GENOME ADVENTURE CREW
BAD NEWS?

I'VE GOT TO FIND A WAY OUT OF HERE. BUT I DON'T EVEN KNOW WHERE TO BEGIN!

DON'T WORRY, KID. ALL YOU HAVE TO DO IS GET A TICKET!

YOU SEE THOSE RIBOSOMES OVER THERE? YOU CAN FIND A TICKET THERE.

THANKS, MR. MAILMAN!

AHA! MY TICKET! NOW HOW AM I SUPPOSED TO GET IT OUT OF THERE?

YOU JUST HAVE TO PUNCH IN THE RIGHT CODE.

DO YOU KNOW THE CODE FOR THE EXIT TICKET?

N O P E. BUT YOU CAN FIND OUT WHAT IT IS.

WHERE DO I DO THAT?

AT THE LIBRARY, OF COURSE!

THE LIBRARY?

YEP, THE HOUSE OF KNOWLEDGE, THE BIG BRAIN, COMMAND CENTRAL, OTHERWISE KNOWN AS THE NUCLEUS.

IT'S FULL OF IMPORTANT INFORMATION AND WONDERFUL STORIES. IN FACT, IT'S PROBABLY THE MOST IMPORTANT BUILDING IN ALL OF CELL-TOWN!

GOOD LUCK! I'VE GOT TO GET BACK TO WORK!

WOW, I SHOULD GO TO THE LIBRARY MORE OFTEN. THANKS!
MAY I HELP YOU?

I'M LOOKING FOR THE CODE TO GET AN EXIT TICKET.

THAT'S IN THE MAIN STACKS UPSTAIRS. CHECK GENE 2.67. JUST FOLLOW THE NUMBERS.

OH, SORRY. HEY, HAVE YOU EVER NOTICED THAT ALL THESE BOOK SHELVES LOOK LIKE DNA?

WOW!

SHHH! I'M TRYING TO READ.

OF COURSE THEY DO, SILLY. THE NUCLEUS HOUSES YOUR DNA. ALL THAT DNA IS COLLECTIVELY CALLED YOUR GENOME. YOU'RE NEW HERE, HUH?

YEAH.
OH MAN, HOW AM I EVER GOING TO FIND THE CODE FOR GENE 2.67?

IT'S EASIER THAN YOU THINK! THERE ARE THOUSANDS OF GENES IN THE NUCLEUS, TRUE, BUT EACH STRAND IS ORGANIZED INTO 46 STAIR CASES.

23 FROM EACH PARENT, CALLED CHROMOSOMES. SEE IF YOU CAN FIND STAIRCASE 2 AND FOLLOW THE NUMBERS TO GENE 2.67.

THERE IT IS!

GOOD, NOW FIND THE BOOK FOR GENE 2.67.

WAIT! THIS CODE IS MADE UP OF THE SAME LETTERS THAT WATSON AND CRICK HAD BACK WHEN THEY DISCOVERED DNA--A,T,C,G!

GOOD OBSERVATION! AS YOU CAN SEE, THE CODE REALLY DOES COME DOWN TO 4 SIMPLE LETTERS.

SO ... ALL I HAVE TO DO IS BRING THIS BOOK BACK TO THE RIBOSOMES, ENTER THE CODE, AND CLAIM MY TICKET HOME.

THANKS SO MUCH, KE A LEBOGA!

EXCUSE ME, NGWANAKA, YOU CAN'T TAKE BOOKS OUT OF THE LIBRARY.

BUT I NEED THIS CODE TO GET HOME!

YOU MAY MAKE PHOTOCOPIES OVER THERE.
WAIT! Why are there all these Us and no Ts? Is the machine broken? Just my luck!

When you make copies here, all of the Ts are replaced with Us. U stands for uracil - and it's a much better messenger than thiamine.

Eish! Thank you, MMA. You're a life saver!

Take care now!

Kitos, I repeat, if you can hear us, please indicate that you are okay!

05:51

Relax, guys. I'm fine. You wouldn't believe the adventure I've had! Check this out.

You've discovered the process of transcription. Well done!

It was easy! I just made copies of the DNA code.

And those copies are called RNA.

Now all I have to do is take this code to the ribosomes.

Exactly! By entering the RNA code you transcribed, the ribosome will complete the process of translation...

And produce the protein, the ticket you will need to leave the cell!

Way to go, Kitos!
I'll actually be kind of sad to leave this place.

It's really cool, especially the library, err... nucleus.

You should check out your local library when you get back home.

Wait, this isn't my ticket home! What happened?

Oh no, you may have created a mutated RNA code when you were photocopying.

A mutation is a change in the code: an addition, a deletion, or a re-arrangement, resulting in a totally different protein product.

You probably have a page missing! You'll need to go back to the library to find it.

Is this yours?

Thank you, MMA.

You're a...

Life-saver? I know.

Congratulations, Kitso.

You've done it! Head over to the transport vesicle station.

The folks over there will help you get home.

Kitso! You got your ticket! Here's your ride.

02:22s

03:20s

Ee, rra.
YOU MADE IT, KITSO! YOU SHOULD BE PROUD OF YOURSELF. ARE YOU READY TO LEAVE THE HUMAN BODY AND COME HOME?

I’VE HAD A BLAST, BUT I THINK I’M DONE WITH ADVENTURES FOR NOW...

THAT’S A WEIRD LOOKING CELL! LOOKS LIKE A BANANA!

Sssshooooo...

WHOA!

UH-OH! WATCH OUT!

WHAT ARE THE WEIRD BANANA-SHAPED CELLS? WILL KITSO MAKE IT OUT ALIVE? WILL HE EVER RETURN TO NORMAL SIZE? STAY TUNED FOR PART THREE OF THE GENOME ADVENTURES COMIC BOOK SERIES TO FIND OUT!
GLOSSARY

SCIENTIFIC TERMS

BASE – A BUILDING BLOCK OF DNA. THE FOUR BASES ARE ADENINE, GUANINE, THYMINE, CYTOSINE.

CELL MEMBRANE – A THIN, BIOLOGICAL MEMBRANE THAT SEPARATES THE CONTENTS OF CELLS FROM THE EXTERNAL ENVIRONMENT.

CHROMOSOMES – LINEAR STRANDS OF DNA FOUND IN THE NUCLEUS OF MOST LIVING CELLS, CARRYING GENETIC INFORMATION IN THE FORM OF GENES.

CYTOPLASM – THE JELLY-LIKE FLUID THAT FILLS EACH CELL AND IS ENCLOSED BY THE CELL MEMBRANE.

DNA – DEOXYRIBONUCLEIC ACID, THE MOLECULE THAT CARRIES MOST OF THE INSTRUCTIONS THAT ARE REQUIRED FOR THE DEVELOPMENT AND FUNCTIONING OF LIVING ORGANISMS.

NUCLEOTIDES – THE BUILDING BLOCKS OF THE NUCLEIC ACIDS, DNA AND RNA.

GENOME – ALL THE DNA CONTAINED IN THE CHROMOSOMES OF AN ORGANISM COLLECTIVELY IS CALLED THE GENOME.

GOLGI – AN ORGANELLE, CONSISTING OF A STACK OF FLATTENED SACCS, THAT IS INVOLVED IN THE MODIFICATION AND SORTING OF PROTEINS.

HELIX – A COILED STRUCTURE OF DNA CONSISTING OF COMPLEMENTARY STRANDS OF DNA LINKED TOGETHER BY HYDROGEN BONDS.

LYMPHOCYTES – A TYPE OF WHITE BLOOD CELLS WHICH PLAY AN IMPORTANT ROLE IN OUR IMMUNE SYSTEMS.

MUTATION – A CHANGE IN THE DNA CODE, AN ADDITION, A DELETION, OR A SUBSTITUTION RESULTING IN A DIFFERENT PROTEIN BEING PRODUCED.

NUCLEUS – AN ORGANELLE SURROUNDED BY A DOUBLE MEMBRANE, FOUND IN MOST LIVING CELLS, THAT CONTAINS GENETIC MATERIAL IN THE FORM OF DNA MOLECULES.

ORGANELLE – ONE OF SEVERAL MEMBRANE-BOUND COMPARTMENTS WITH SPECIALIZED FUNCTIONS, THAT ARE PRESENT IN THE CELL CYTOPLASM.

PROTEINS – MOLECULES COMPOSED OF ONE OR MORE CHAINS OF AMINO ACIDS. THE ORDER OF AMINO ACIDS IS DETERMINED BY THE SEQUENCE OF THE NUCLEOTIDES IN THE DNA CODING FOR THE PROTEIN.

RIBOSOMES – COMPLEX MACHINERY FOUND WITHIN ALL LIVING CELLS THAT ARE THE SITES OF PROTEIN MANUFACTURE.

RNA – RIBONUCLEIC ACID; A NUCLEIC ACID PRESENT IN ALL LIVING CELLS AND MANY VIRUSES, THAT IS INVOLVED IN PROTEIN SYNTHESIS.

TRANSCRIPTION – A PROCESS INVOLVED IN THE SYNTHESIS OF PROTEINS WHERE A DNA TEMPLATE IS USED TO MAKE RNA.

TRANSLATION – THE PROCESS IN WHICH PROTEINS ARE CREATED AT RIBOSOMES.

VESICLE – A MEMBRANE-BOUND SAC IN PLANT OR ANIMAL CELLS THAT IS INVOLVED IN STORAGE OR TRANSPORT OF THE PRODUCTS OF METABOLISM.

X-RAY CRYSTALLOGRAPHY – A TECHNIQUE USED TO IDENTIFY THE STRUCTURE OF CRYSTALS OR BIOLOGICAL MOLECULES SUCH AS DNA.

SETSWANA TERMS

NGWANAKA- MY CHILD
MELAII- SLANG WORD FOUND AMONG YOUTHS IN BOTSWANA MEANING “MY MAN”.
MMA- MADAM
KE A LEBOGA- THANK YOU
EE RRA- YES, SIR
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