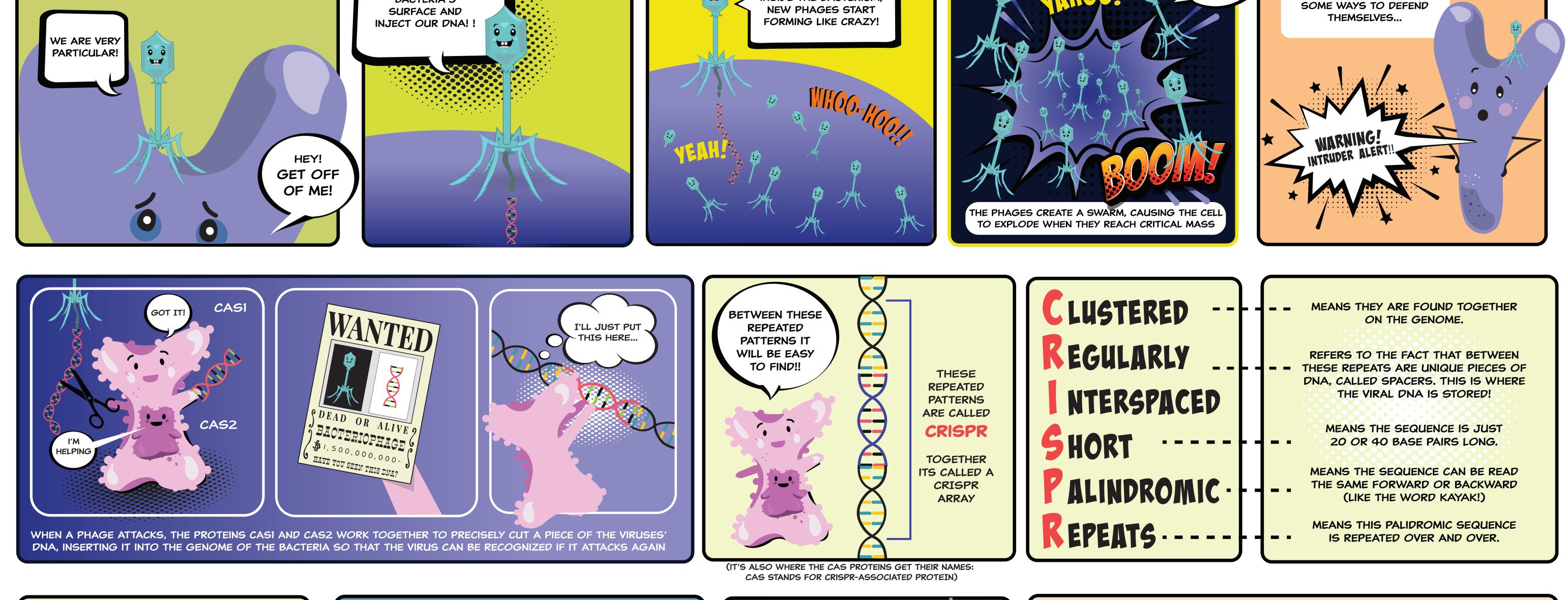
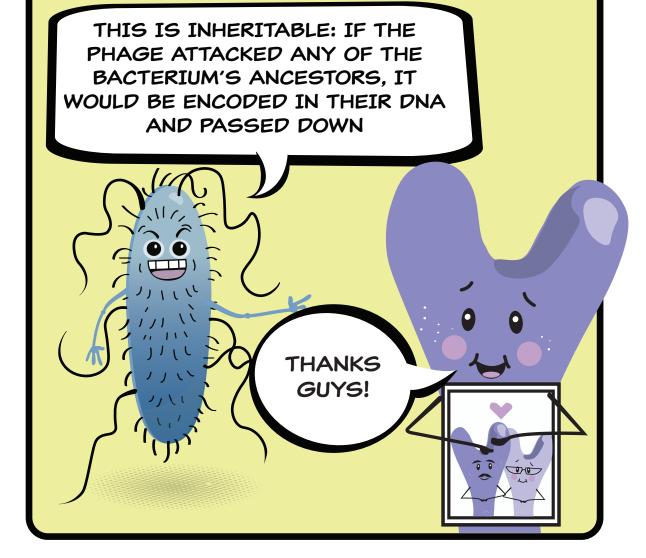


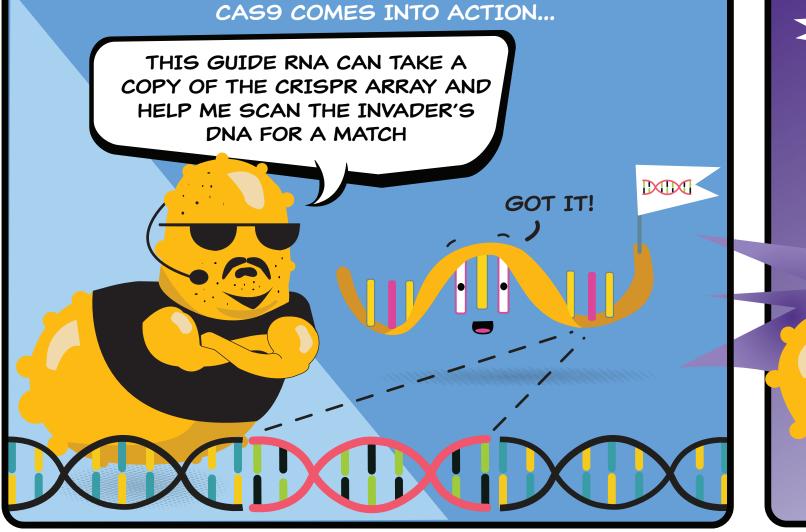
THE VIRUSES THAT ATTACK BACTERIA ARE SOME OF US BACTERIA ARE GOOD. LIKE CALLED BACTERIOPHAGES DID YOU KNOW HI! I DON'T FEEL THOSE THAT HELP YOU DIGEST YOUR SOME OF US ARE A BACTERIA CAN I'M A BACTERIUM SO GOOD! LITTLE BIT OF FOOD! AND OTHERS ARE NOT SO GOOD, **GET VIRUSES BACTERIA ARE TINY** LIKE THOSE THAT CAN MAKE YOU SICK! **BOTH!** TOO? YOU CAN SINGLE-CELLED 6 0 CALL US ORGANISMS AND PHAGES FOR CAN BE FOUND SHORT! ALMOST EVERYWHERE ON EARTH! 00 ESCHERICHIA COLI STREPTOCOCCUS BIFIDIO-BACTERIUM PYOGENES LET'S GO INFECT MOST PHAGES ATTACK ONLY A WE ATTACH ANOTHER LUCKY FOR THE BACTERIA ONCE OUR DNA IS SPECIFIC TYPE OF BACTERIA OURSELVES TO THE ONE! THEY HAVE DEVELOPED INSIDE THE BACTERIUM, BACTERIA'S



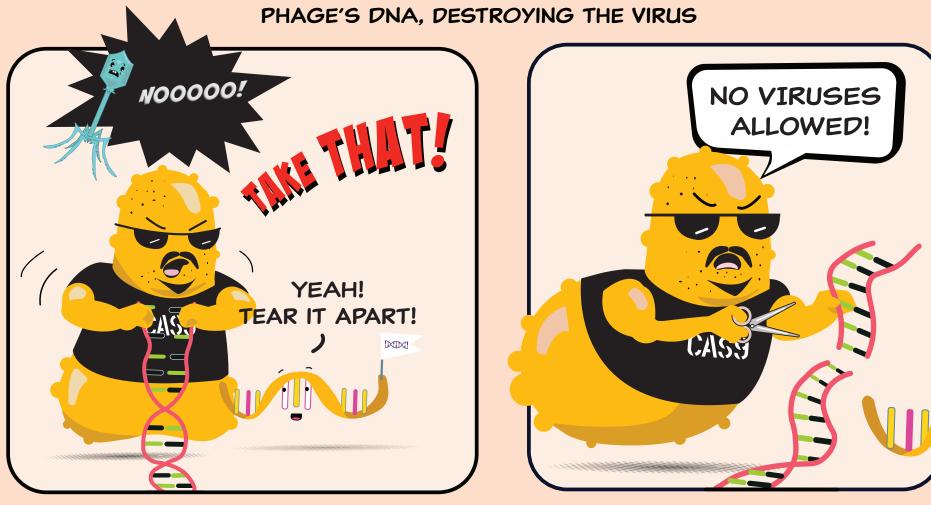
BUT WAIT! THIS IS WHERE THE PROTEIN

IF THERE IS A MATCH, CAS9 UNWINDS AND CUTS UP THE

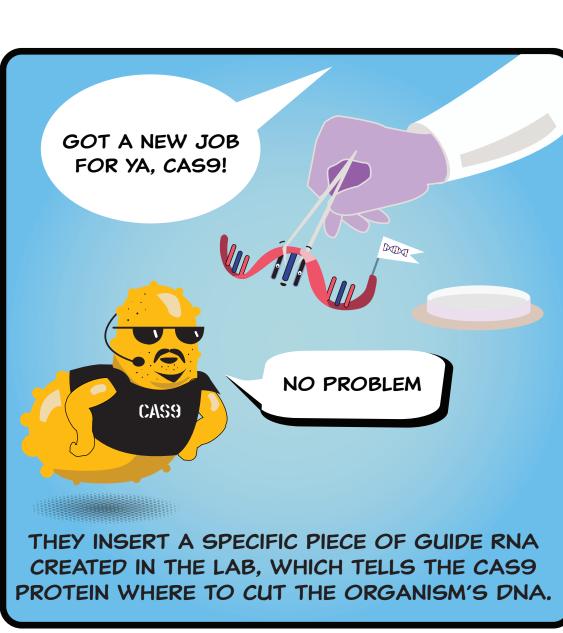


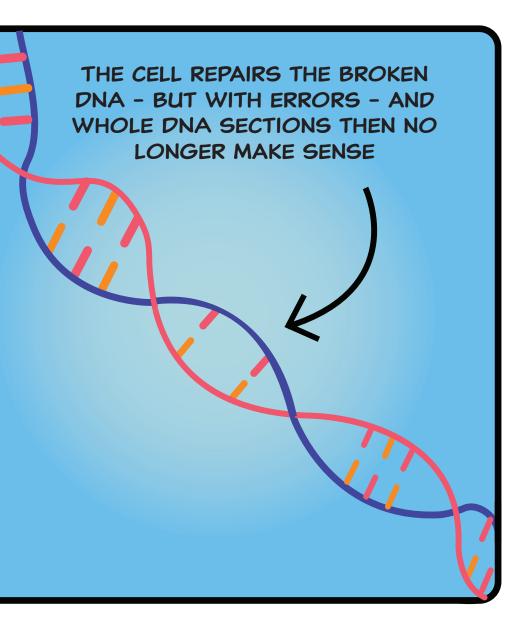


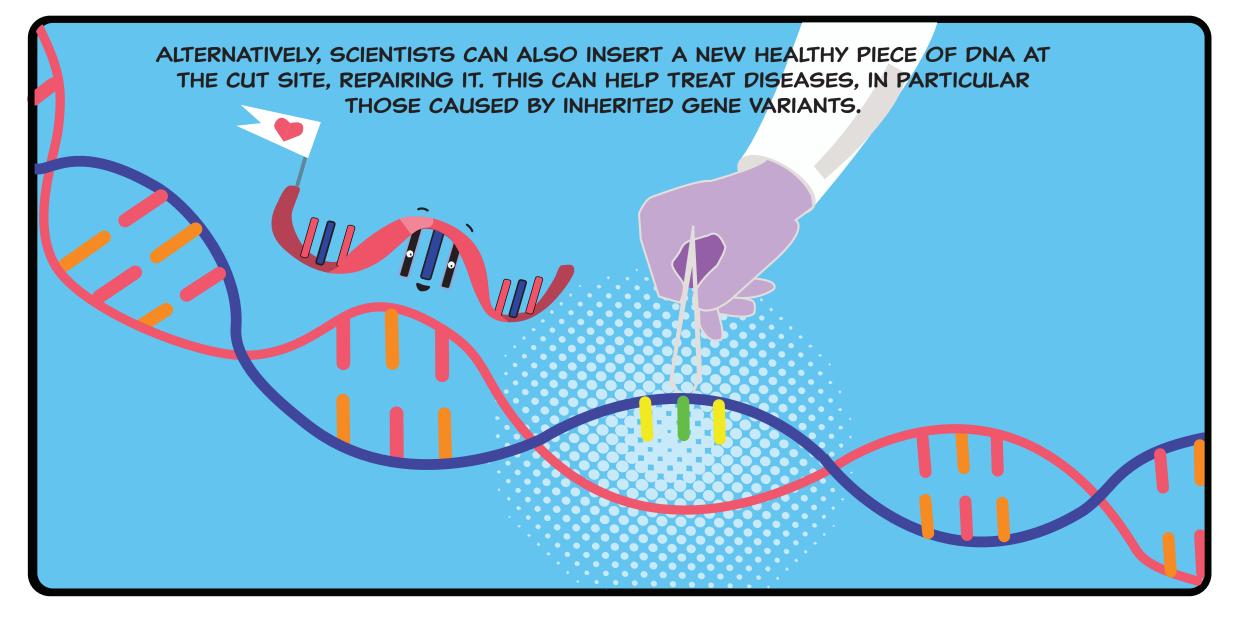






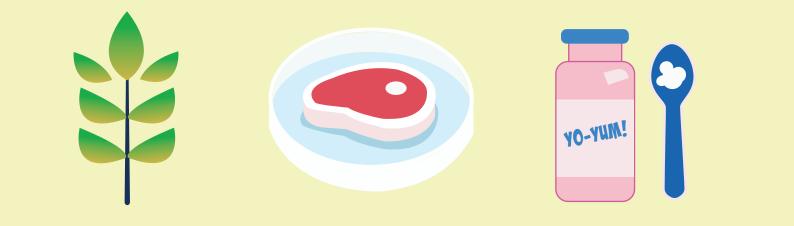




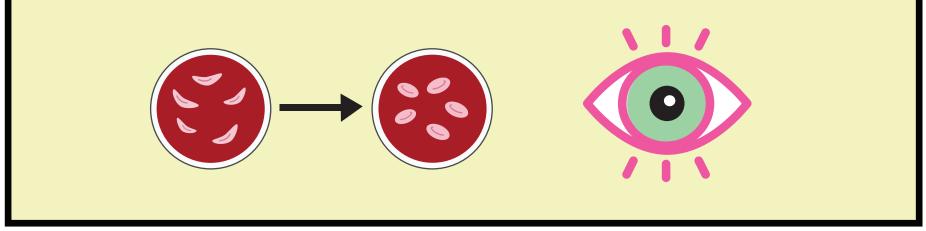


CURRENT USES:

CRISPR IS INVOLVED IN MANY DIFFERENT FOOD PRODUCTION STAGES. FROM SPECIALIZED CROPS, TO CELL-BASED MEATS, TO MODIFIED YOGHURT CULTURES.



IT HAS BEEN USED IN THE BIOMEDICAL FIELD TO COMBAT HEREDITABLE GENETIC DISEASES SUCH AS SICKLE-CELL ANEMIA AND BETA-THALASSEMIA, AND IN TREATING RETINAL DISEASES.



FUTURE USES:

THERE IS A GREAT POSSIBILITY IN THE FUTURE TO FIND CURES AND TREATMENTS FOR MANY DIFFERENT DISEASES, IMPROVED TRANSPLANT METHODS, AND SMARTER T-CELLS.

CRISPR COULD BE USED AS A DIAGNOSTIC TOOL TO PREVENT THE SPREAD OF INFECTIOUS OUTBREAKS OR TREAT CHRONIC INFECTIONS.

CRISPR CAN BE USED TO ENGINEER CROPS AND LIVESTOCK THAT CAN WITHSTAND EXTREME WEATHER CONDITIONS, AND TO ELIMINATE PESTS AND WEEDS WITHOUT HARMFUL CHEMICALS.

IT COULD BE USED TO ENGINEER SUPERFOODS SUCH AS NUTS WITHOUT ALLERGENS, OILS WITH LESS TRANS-FAT, VEGETABLES WITH EXTRA VITAMINS, AND WHEAT WITH GLUTEN THAT CAN BE EASILY TOLERATED.

CRISPR COULD BE USED IN ANIMAL AND ENVIRONMENTAL CONSERVATION. FOR EXAMPLE, IN DETERMINING WHICH GENES ARE VITAL TO CORAL REEF SURVIVAL, GETTING RID OF INVASIVE SPECIES FROM NATIVE HABITATS, AND THE MANUFACTURE OF ENHANCED BIOFUELS.



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ETHICAL CONCERNS:

THERE ARE A LOT OF ETHICAL CONCERNS WHEN DISCUSSING THE USE OF CRISPR:

-WHO HAS THE RIGHT TO DECIDE WHICH SPECIES CAN BE ELIMINATED AND WHERE DOES THAT END?

-EDITING THE HUMAN GERMLINE, I.E., CREATING "DESIGNER BABIES" IS HIGHLY UNETHICAL AS IT COULD CREATE A GREAT DISBALANCE IN HUMAN EQUALITY AND THE DEFINITION OF WHAT MAKES ONE HUMAN COULD BE PUT FORTH FOR DEBATE.



-SOME GENE EDITS COULD SOLVE ONE PROBLEM WHILE CREATING ANOTHER: COULD IT BACKFIRE AND CREATE SUPERBUGS, OVERPOPULATION, OR DISRUPT THE FOOD CHAIN?

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