SPECTRUM

THE MANY HUES OF SCIENCE

ISSUE NO : 3

In the News

Smart Servants that Reside in Bugs

Dr. Manasi Nachiket Khasnis

Long long ago, there was a mighty king. He ruled his empire wisely. His servants strictly followed his witty instructions and protected the kingdom from foreign invaders. Once, a gatecrasher attacked the walls of the empire. The king was quiet and calm. “My dear brave servants! We have an intruder and we want to shoo him away. He pretends to be like one of us but has a special tag on him! You have all the necessary lenses to find the tag. Find him and cut him in pieces! ”, said the King. The servants undertook the task, found the enemy and chopped him off in pieces. The empire was then free and happy!

Friends, whom are we talking about? The story here was told by Nobel laureate Werner Arber to his daughter Silvia. The little girl wanted to know what her father won the Nobel Prize for. Arber discovered the secrets of the king and his servants. The empire here is a tiny cell of a bacterium. The cell functions by following the instructions of the master molecule Deoxyribo Nucleic Acid or DNA. The DNA is the KING! (As you know, each one of us have our very own molecular KING (DNA) in all our cells.) The smart servants that protect the empire of the bacterial cell are called “restriction enzymes”.

Just as you and me get infected with a virus, so do the bacteria. The virus sits on the wall of the bacterial cell and injects its DNA inside. The viral DNA then hijacks the bacterial machinery and goes on to produce its own kind: many more viruses! But the bacteria have got a strategy to fight back. The restriction enzymes identify a small molecular signature on the foreign DNA. This signature is an indication of alert! The enzymes then attack the viral DNA and cut it to pieces.

The restriction enzymes are also called as molecular scissors because they cut the DNA just like a pair of scissors snipping a thread. Today, these molecular scissors have found their use in engineering DNA. Scientists use these scissors and their colleagues (other enzymes like ligases) as a tool to cut and paste DNA for a variety of purposes. We now have genetic engineering expanding its wings from transgenic plants to cloning animals: all by virtue of wonder molecular scissors. Interestingly, year 2016 witnessed a series of blooming research on another molecular scissors called CRISPR-CAS. These clippers are smarter and are also able to memorize the enemy!

Clever huh?

The story of the King and his servants is just the beginning! Scientists all over the world are still fishing out more secrets of King to overcome foreign attack.

Insight

Death by Fall? Not for a squirrel!

Mr. Cyrus Khan,
Freelance Science Communicator

You’ve probably come across a squirrel at some point in your life. Those furry little hyper-energetic creatures that dart hither and tither like a cat chasing a laser pointer. You know what I’m talking about. Infamous for scurrying about in search of nuts to nibble on, most squirrels are tree dwelling species, and reside at significant heights. With the advent of urban architecture, squirrels have also taken to bunking in urban homes, settling on roofs and terraces, much to the annoyance of some of its occupants. But constantly living and scurrying about at heights has its dangers - specifically…falling. Now most mammals dread falls, but squirrels seem to risk them all the time? Why? Surely falling is bad for them too, right?

Wrong. Let’s see why.

First, we have to understand a bit about falling objects, and the physics behind them. In school class, you’ve had to calculate the velocity of an object falling from a certain height. But out in the real world, we have to take into account something we consistently ignore in problems - Air resistance.

Any falling object has two forces acting on it while

it falls.

- Gravity
- Aerodynamic resistance or Drag

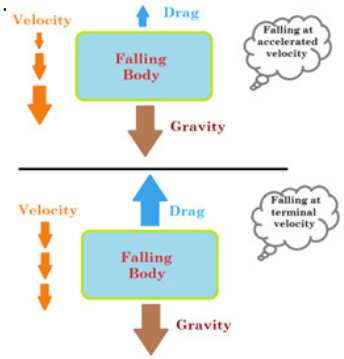
But while the gravitational force is constant throughout it's fall, this drag increases with increase in (the square of) the velocity. So as the velocity increases, there comes a point when the force of drag is equal to the pull of gravity. Since the net force on the body is zero, the body will move at a constant velocity. (Newton's first law!) This constant velocity is special for any falling body, and is known as its terminal velocity.

No object will fall faster than it's terminal velocity, no matter what height it is dropped from.

Now, back to cute furry little things.

Squirrels, since they are small and light, means they have comparatively little pull from gravity, and since they have stretchy bodies and puffy tails, they experience a lot of drag. This means that their terminal velocity is actually quite low, and squirrels can survive impacts of that velocity.

Which means no matter what height you drop a squirrel from, it will probably survive. Though don't try flinging squirrels out of buildings



- I believe I can fly.… (© Peter Trimming (CC BY-SA 2.0))
- "On Being the Right Size." J.B.S. Haldane
- 5.2 Drag Forces, College Physics (Paul Peter Urone,Roger Hinrichs) OpenStax ISBN-10: 1-947172-01-8

Science In Daily Life

Memory and the Brain

Ms. Akshi Babel,
T.Y.B.Sc. Life science, St. Xaviers College , Mumbai.

Our brain is by far the most complicated structure in our entire body. Understanding the way it functions and controls the entire body has always made scientists study it more and more. One major process which has fascinated all the neuroscientists in the world is "Memory". Our brain behaves as a massive USB storage device which allows us to store and recover information which we come across throughout our life!

In true sense, it is the memory process handled by the brain which makes us who we are. From fondly recollecting childhood events to remembering where we left our keys, memories play a vital role in every aspect of our lives. It provides us with a sense of self and makes up our experiences. We can think of memory as a filing cabinet, storing away bits and pieces of information, until we need them. In reality, it is much complex, as the entire process of memory involves different parts of the brain.

Here are a few facts about Memory and Brain.

1# The storage capacity of the human brain is virtually limitless. It has the capacity to store information worth 2.5 Petabytes!! (1 Petabyte= 10^6 Gigabytes)

2# All individuals start creating memories in their mother's womb, approximately after 20 weeks of conception. Yet the mystery still remains why we don't remember any of it.

3# Every time you make a new memory, you end up forming a new connection between neurons to store it. Hence there is a physical change in the structure of the brain every time you build a memory!

4 # You are less likely to remember information which is easily available. If the information can easily be accessed, the brain does not bother storing it. (Also called The Google Effect.) Hence…put away the internet, go books!!

5# Memories are not always accurate. We can remember things which didn't even happen.!!

6# Memory is enhanced by being tested, rather than rereading over and over again. (That means, exams and tests are not bad, right?)

7# Walking into a new room can make you forget what you went in the room for!! (Ever left after locking the room and forgot whether you locked the door or not?) This phenomenon is called "Event Horizon Model of short term memory"

8# Closing your eyes enhances your memory. (Does this remind you of meditation?)

9# Being sleep-deprived decreases your memory power. (Sleep well to remember well!)

10# A recent study by scientists shows that teaching something to others helps you remember better than just reading it.

11# Scientists believe procrastination helps in building memory, as longer the time you take to finish

something off, more the ideas you integrate to perform the task better.! (Who said procrastination has no benefits?)

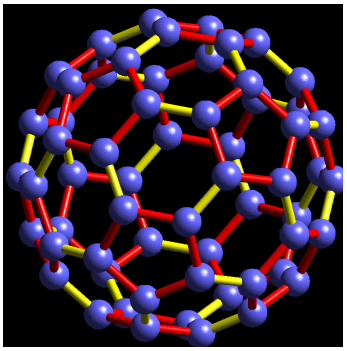
12# Memories are recalled more easily if narrated in a form of a story or even with pictures and videos!

13# Aging has nothing to do with memory. It's the use of the brain which decreases with increase in age that you tend to forget stuff easily.

https://www.google.co.in/amp/s/amp.livescience.com/44940-strange-facts-about-memory.html

https://www.google.co.in/amp/s/www.buzzfeed.com/amphtml/kellyoakes/things-you-probably-didnt-know-about-memory

Through the Lens



Buckminsterfullerene

http://www.godunov.com/bucky/fullerene.html

Spaceship Earth – geodesic dome at Epcot

http://education.mrsec.wisc.edu/nanoquest/carbon/

Buckminsterfullerene or buckyball (because it resembles a soccer ball) is an interesting allotrope of carbon. An allotrope is one of two or more different physical forms in which an element can exist. For example, graphite, charcoal and diamond are other allotropes of carbon. The first fullerene to be discovered had the formula C_{60} with a spherical structure made of 20 hexagons and 12 pentagons as in a soccer ball. It was named after Buckminster Fuller, an architect who created geodesic domes (which appear similar to the structure of C_{60}) like the one pictured above in Disney's Epcot Centre theme park, Florida.

The 1996 Nobel prize in chemistry was awarded to Smalley, Curl and Kroto 'for their discovery of fullerenes'. The fullerenes are being studied for a wide range of potential applications from superconductors and lubricants to drug delivery systems and cosmetics and even as precursors for diamond production.

Stimulate your Grey

Select the correct option!

Mr. Cyrus Khan,
Freelance Science Communicator

1) A woman stands spinning a stone at the end of a string around her head. There are 4 men standing at her North, South, East and West, all equally far away. The string breaks when the stone is nearest to the man at her South. Whom does the stone hit?
A) South B) North C) East D) West

2) A man and a woman stand together on a flat field. The woman fires a gun, and at the same, the man drops a bullet from the same height as the gun.
Which bullet hits the ground first?
A) Gun B) Both together C) Dropped

3) A plane travelling in a straight line to Mumbai from North Pole must point
A) North of Mumbai B) South of Mumbai
B) East of Mumbai C) West of Mumbai

4) If you take a packet of chips under water it will look
A) Inflated B) Deflated C) Neither inflated nor deflated D) Depends on the brand

5) The only planet in the solar system that rotates in the direction opposite to the earth is
A) Mercury B) Venus C) Mars D) Uranus

6) Sound can travel fastest through
A) Water B) Air C) Stone D) Space

7) Telephone remotes trasmit using
A) Sound waves B) Ultraviolet rays
B) Visible rays D) Infrared waves

8) If you had to quintuple the area of a balloon, you would increase it's volume by
A) Two times B) Four times
B) Eight times C) Sixteen times

Long, Long ago

Of bugs and bath

Ms. Suparna Dugal,
Department of Microbiology, Sophia College, Mumbai

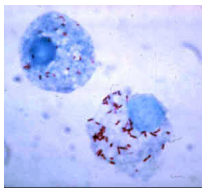
Today, not many people know about epidemic typhus, but for thousands of years, it was one of the most dreaded of diseases. It caused death of millions of people. Individuals infected with epidemic typhus would suffer from very high fever and rash. Later patients would enter into a state of delirium. It was due to this state of 'confused mind', that the disease acquired the name 'typhus'- from the Greek word, 'typhos' meaning 'cloudy' or 'hazy'.

Despite the disease being so rampant, especially in Europe and Russia, people did not know what caused it. It was usually prevalent in extremely cold countries, during wars, in barracks and in prisons. So what was common among all these individuals? -In all these situations people did not bathe for months. Due to extremely poor hygiene people developed body lice which spread from one person to another. One would be surprised to know that throughout the ages, the aristocracy in Europe and Russia had a great aversion to bathe and bathed only twice or thrice in a life-time. It was a common belief, that bathing would cause a person to fall sick. Many kings often banned bathing!

Today it is known that body lice contain very tiny microbes inside their gut which cause epidemic typhus. These microbes are given out by the lice in their faeces. When people scratch, they create very fine cuts on their skin, through which the germs enter and cause the disease. This discovery, came at a price. Since these microbes were extremely deadly, anyone who handled them, exposed themselves to great danger. During the early part of the last century, two scientists named Ricketts and Prowazek while studying typhus fever separately, got infected and died. It is in their honour that the microbes causing epidemic typhus were later named *Rickettsia prowazekii.*

Can you guess what was one of the first uses of the pesticide, DDT? It was used to kill body lice on people. Today of course this type of extreme control measure is unthinkable. We have now developed vaccines as well as antibiotics.

DDT being sprayed on people.



Body louse (left) and *Rickettsia* inside human cells *(*above).

Though outbreaks of this disease are still reported from time to time in different parts of the world, we now know how to control this deadly disease- through regular bathing and by maintaining good body hygiene.

Further reading: Ananthanarayan and Panikar's Textbook of Microbiology 9th edition, University Press, 2017.

Students' Speak

We like the newsletter- Spectrum because there is more information for science club. I like that I got to learn a lot of new things like five moons of Pluto, A planet beyond Pluto and the reason behind why Pluto got it's name. We liked that in the poem there were two colour, Blue and Green to describe the whole Earth

- 7th class science club, Worli Seaface BMC school

We request you for information about Black holes and Evolution tree, we also want to know about cyclones.

Answers to CHEM-GRID: 1.Vinegar 2. Precipitate 3. Base 4.Particle 5. Brass 6. Sodium 7.Sublime 8. Steel 9. Bromine 10.ppm11.Isotope 12.Octet 13. Indicator 14.Gas 15.Law 16.Polar 17.Solid 18.Cation 19.Alkane 20. Alloy 21.Phosphorus 22.Metal 23.Spin 24. Molecule 25. One. Scientist's name: MARIE CURIE

We look forward to your feedback and suggestions. Write to us at spectrum.sciencehues@gmail.com

Layout and design by Ishaan Patil, SYBSc,St. Xavier's College Autonomous, Mumbai