Moscrop Science Journal

Contents

Welcome to Moscrop's science Journal!

Here, you can read scientific articles based on newly published scientific documents, news, and interviews. As you read the articles, you may find that you can connect their ideas and topics to what you have learned, or are currently learning at school. Reading this journal can hopefully give you a better understanding of their applications, and a deeper understanding of the subjects. In this edition, you can read our interview with Mr. Sidney, introduce yourself to space, learn about fossils, noble prizes, and enjoy our funny science jokes!

So, let's start the journey through science!

Do you want to write an article?

Students can research and write about new and interesting scientific topics with the help of teachers, and publish them in the science journal! If you are interested in writing articles, or have any ideas for topics to write about, email us or ask our sponsor teacher, Ms. Lange, for more information.

For this edition:

We would like to thank ***Ms. Lange, Mr. Sidney*** and ***Mr. Fulop*** for reading and reviewing the articles; and also the science department, ***Mr. Fester,*** and ***Mr. Allen*** for supporting the journal.

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Tricking DNA

By: Goldin Joghataie

The octopus and its other cephalopod friends have always amazed everyone with their funny appearance and stunning problem-solving abilities. Still, to this day, they continue to surprize scientists and prove to be quite unique even at the molecular level!

Figures 1 & 2: Cephalopods

Extraordinarily, the way these creatures evolve and adapt to their environment is different from other multicellular organisms on Earth. New reports state that cephalopods edit their RNA to adapt to new situations.

Now what is RNA and what's so special about editing it?

RNA's main job in a way, is to deliver genetic information from DNA to ribosomes to carry on protein synthesis. These proteins are responsible for the different traits an organism has, for example eye color in humans.

DNA is basically the important original version of the genetic information, and RNA the copy used mostly by the cell. If DNA itself was to be used frequently in the cell, then the potential errors from different processes would accumulate. Since DNA is the original copy of the genetic information, these accumulated errors would then be passed on to future generations. With too

many errors, DNA would not function appropriately to support the organism. Think of it as storing the original version of valuable documents, and using a **copy** of the original for regular everyday purposes. RNA serves this purpose and is used by ribosomes for common processes.

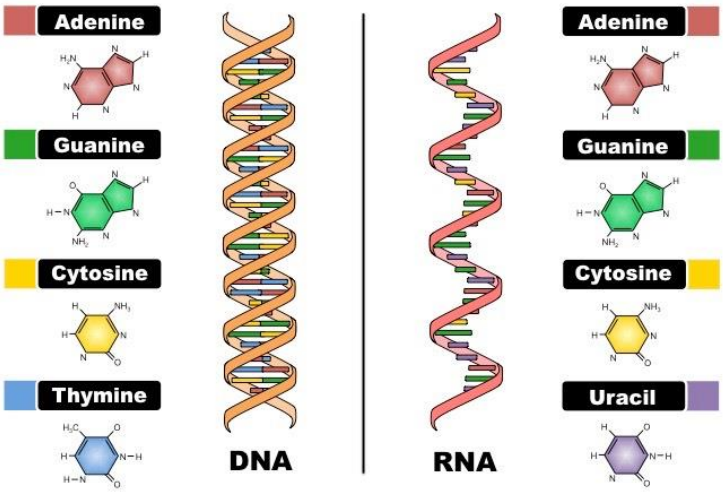


Figure 3: DNA vs. RNA

Now what do cephalopods do differently?

Most animals change because of **DNA mutations**. But cephalopods take a copy of DNA (being RNA), and change that instead of changing the original! This means that those changes do not show up in the original DNA sequences, and are **not stored genetically** to be passed on to later generations. In squid for example, there is an extremely high rate of RNA editing, particularly in nervous system cells. It is said that in the squid brain, more than 60% of RNA transcripts are recorded by editing while in humans this is only 1%.

How has this RNA editing been useful to cephalopods?

Cephalopods could use RNA editing to **change how proteins** work in relation to **changes in the environment**. Squid for example, use RNA editing to rapidly adapt to changes in temperature. It is thought that RNA editing is used to make a more complex and mature brain, allowing cephalopods to communicate, camouflage, and use tools to escape or solve problems.

Therefore, scientists think all this RNA editing is the reason behind why cephalopods have not changed physically over millions of years, but are so smart. RNA editing gives cephalopods the genetic advantage of adapting to changing environments.

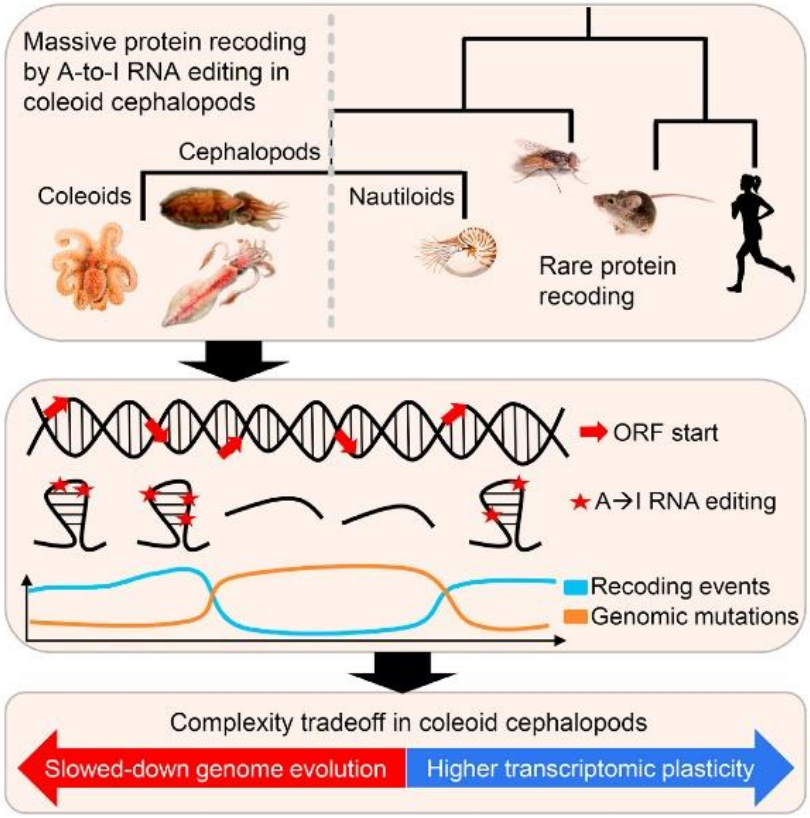


Figure 4: RNA editing decreasing from left to right while speed of genome evolution increases. Cephalopods are on the far left of this spectrum

Our Natural Sunscreen

By: Apple Fang

Did you know that there may be a chance of you getting skin cancer? No matter what you do outside, may it be biking or just relaxing on the beach, you are absorbing the invisible ultraviolet (UV) radiation which can damage DNA in the nucleus. The longer you are exposed to the sun, the more skin cells may die, leading to the possibility of mutations and getting skin cancer. Fortunately, a kind of "natural sunscreen" named melanin, which we all have, can help us protect our skin from being damaged.

First, let's look at our "enemy"---UV radiation! The UV rays are energetic and powerful enough to cause damage to the DNA in our skin cells. Meaning, when our skin is overexposed to sunlight, our skin cells will have the chance to mutate.

Most of the mutated skin cells will be killed by our immune system, although, there still may be some left that could lead to skin cancer. However, don't panic, we all have melanin to protect us.

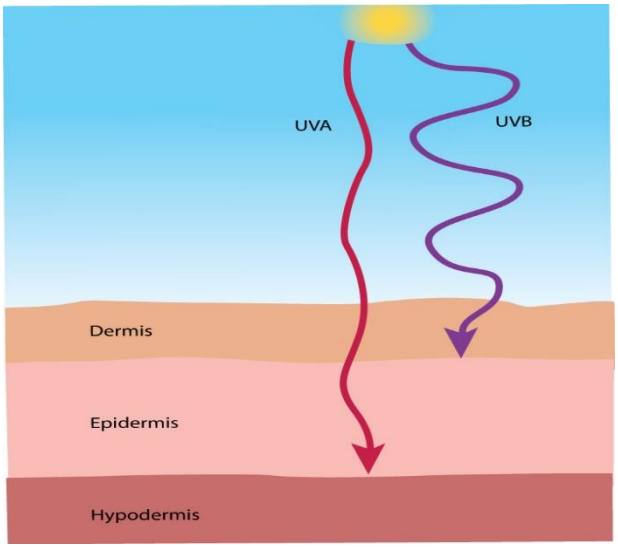


Figure 1:

Two types of UV Rays damaging skin. They are energetic and can go through the top layer of skin.

Melanin is a pigment (the natural coloring matter of animal or plant tissue), usually black or brown, which gives us our skin, hair, and eye colors. People with lighter skin colors have less melanin than those who have darker skin. Melanin is produced by melanocytes, a group of cells found mostly on the animal skin, specifically in the epidermis where they block the UV radiation.

Melanin works by absorbing UV light, and instead of letting the energy damage DNA in skin cells, melanin will transfer the energy into heat with almost 99.9% efficiency. This chemical reaction happens incredibly fast, taking less than a thousandth of a billionth of a second!

When our body detects the UV rays, melanocytes then start to produce black or brown colored melanin around where skin is exposed to radiation. That's how people get tanned in the sunlight. The tanned part of our skin indicates that damage has occurred there, and in fact, people who often use tanning beds increase their risk of getting melanoma (a type of tumor) by 75 percent.

As we all know, a better way to protect our skin other than only relying on melanin is to put sunscreen on before going to places like beaches or mountains. Also, avoiding direct exposure to strong sunlight, for example wearing hats or staying in the shadow, will be helpful. Fortunately, our body usually can function to adjust harm itself. With a little caution, the risk of getting skin cancer can be greatly reduced.

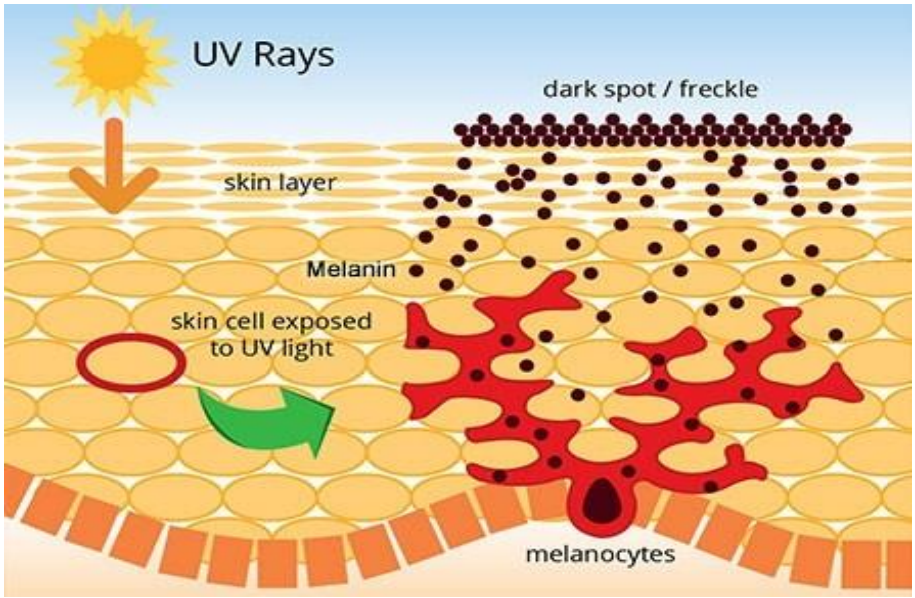


Figure 2: Melanocytes creating melanin to absorb UV Rays, forming dark spots.

Bee Hive Interview with Mr. Sidney

By: Goldin Joghataie, Apple Fang, Selina Huo

On the sunny Sunday afternoon, we visited Mr. Sidney's bee hive. Bees are extremely interesting and we wanted to learn more about them. We each had the chance to hold the heavy honey-filled frames, which were full of bees (see picture below), while many many other bees flew around us. With seeing the hive, all our past fear of bees disappeared! Well, mostly at least. So, read the following question-answer style interview we had with Mr. Sidney to learn more about Bees!

Figure 1: Holding bee honey frame!

What happens if bees have too much honey?

Bees save honey for the winter, as the workers and the queen stay inside during the season and their need for food is satisfied by the honey they store.
After taking honey from the hive, beekeepers must make sure they leave enough in the hive for the bees to survive upon during the winter. If bees run out of stored honey, giving them sugar water or an alternative, would be a possible solution. If the hive is managed well, however, bees produce more honey than they need for the winter.

How long does a queen live?

The queen is her strongest as a one year old. After that, the amount of eggs she lays will decrease, and she will be replaced in her second year. If the queen is not functioning properly (not laying eggs), the new reared queen will fight with her and kill her by stinging her to death. The workers do not interfere with the fight, as they only care for having one queen for the hive.

Then where do the males live?

All the workers are female bees, and the males are called Drones. The Drone's only purpose is for reproduction and is born a haploid (has half the chromosomes the diploid female worker has). The Drone's only responsibility is to fly around during the summer, waiting to mate with a queen, after which the drone dies.

That is sad. So the drones know where the hive is approximately?

The drone is born in the hive and will come back to feed on the honey. In a sense, drones are parasites and sometimes like now in autumn, as you can see, the workers will not let the drone in to use the honey saved for the winter. The drones therefore, are unable to feed on the honey and are left to die in the cold.

Why do the drones have larger eye?

Because they need to see queens to mate with as they fly in the air.

How do bees see?

Honey bees see in UV and do not very much like the color black. Beekeepers, as you have noticed, try to wear lighter colored clothing. Bees are less inclined to follow, or become aggressive around lighter colors noticing that their main predator, the bear, is dark black or brown.

Can different bees go into different hives?

Bees are supposedly loyal to their hive. If two hives are put together, bees sometimes drift from one hive to the other. If a worker comes into a new hive with pollen and nectar, she will usually be led in although she does not have the correct smell (each hive has its own special smell). If a foreign bee does not have nectar, the indication is that she may steal honey, so the workers of the hive may attack her. You can get a situation where one hive will actually start robbing another weaker hive.

Suddenly we hear loud buzzing and a group of bees gather in one spot:

This female is being swarmed. Interesting, maybe she is from another hive. From smell, the workers know she is not from this hive. As mentioned, since she has no pollen with her, they are defending the hive and closing her way in.

How do bees attack intruders?

Bees will all buzz onto the intruder and gather around it. That is their way of killing it actually: to heat it by vibrating and finally cooking the intruder inside their group. Wasps also eat bees, so when a wasp comes into the hive, the bees attack in this way. Yellow Jackets tend to search for weaker, dying bees. The hornets can even grab live, flying bees, to feed their young.

Figure 2: Yellow jacket

Figure 3: Hornet

What are the stages in a bee's life?

There are many stages in a worker's life. To start, when hatched, they stay in the hive and are responsible for maintenance, feeding, and cleaning. Then, they will fly out of the hive to learn their surroundings. Then, they take longer flights and start to gather.

Are bees good at math?

They have basic math and good navigation. Researchers have found that bees recognize geometric doubling patterns through an experiment done with changing the location of a source of sugar water. Also, the waggle dance, involves the bees recognizing angles from the sun, meant to show the approximate location of sources of nectar and pollen.

Why do bees die after they sting?

Figure 4: Bee Stinger

Bees that die after stinging are honey bees and only female. The honeybee stinger is a modified ovipositor, and is rough and hook-like. Once it is side an animal with rough skin, the bee is unable to remove it without removing all its own glands, muscles and venom sack. Although the bee dies, it leaves its stinger in the animal, sacrificing itself as its digestive tract separates with the stinger. By leaving the stinger in, the venom sack pumps poison into the animal and gradually kills it. This is for the overall benefit of the bee population. Interestingly, the queen has a smooth stinger and can remove her stinger, therefore stinging multiple times without dying.

Is temperature and air important in the hive?

Figure 5: Air flow in hive

Yes. Looking at the hive, air will travel up through the hive and leave from the top. The bees' biggest problem is not cold, but humidity building up (growth of bacteria and fungi) and that is why air flow is crucial. Interestingly, bees will turn upside down and start fanning their wings and this is because of two reasons: 1. in the summer they try to dry their honey, and will create more air flow this way; 2. As you can see them now, they are creating a warning chemical to signal all the bees to return to the hive because it is under threat.

We then put suits on, and used branches to create smoke around the hive so we could open it: With the following pictures, there are some interesting points about the bee hive and honey frames.

Figures 6 & 7: Bees drinking honey to protect it because of the smoke

The above frame is fairly empty; and there is wax combing but barley any honey. As you can see, the open cells mean that the bees have been drinking the honey to protect it (in an emergency situation like now because of the smoke). There was not enough honey to take from this hive and as we created the fake fire with the smoke, the bees have been drinking all the honey (picture on left).

Figure 8: This is a queen cell, clearly different from other cells as it droops from the side. When bees make a new queen, they create a cell like this and feed it royal jelly. Also, notice that cells from which the drones drink honey are larger.

Bees can make honey combs and know the shape; however, the frame lets them plan an organized way of making the cells. In wild bees or when without frames, the honeycomb cells have no certain order, as can be seen in the photo below.

Figure 9: without frames, honey comb cells made by honeybees

2017 Nobel prize in chemistry

By: Goldin Joghataie

Biomolecules are critically important molecules as all forms of life, from bacteria to whales, are composed of them. Since these molecules are so important to life, it is important to know how they function and what they look like. The shape of large biomolecules helps us explain how they work, and being able to see the shape of these extremely important molecules has been a challenge for decades.

Why is seeing biomolecules so important?

The 2017 Nobel Prize for chemistry was awarded for the development of cryo-electron microscopy; which allows researchers to view proteins and other large biomolecules with atomic precision. This is taking biochemistry and medicine into a new era, since new imagining techniques let scientists see crevices and gaps in the critically important building blocks of living things. With proper images, chemists can design drugs that fill into these empty spaces, making imaging techniques crucial to understanding and treating disorders and diseases.

"We are facing a revolution in biochemistry," says the Nobel Committee Chairman. "Now we can see the intricate details of the biomolecules in every corner of our cells. We can understand how they are built and how they act and how they work together in large communities."

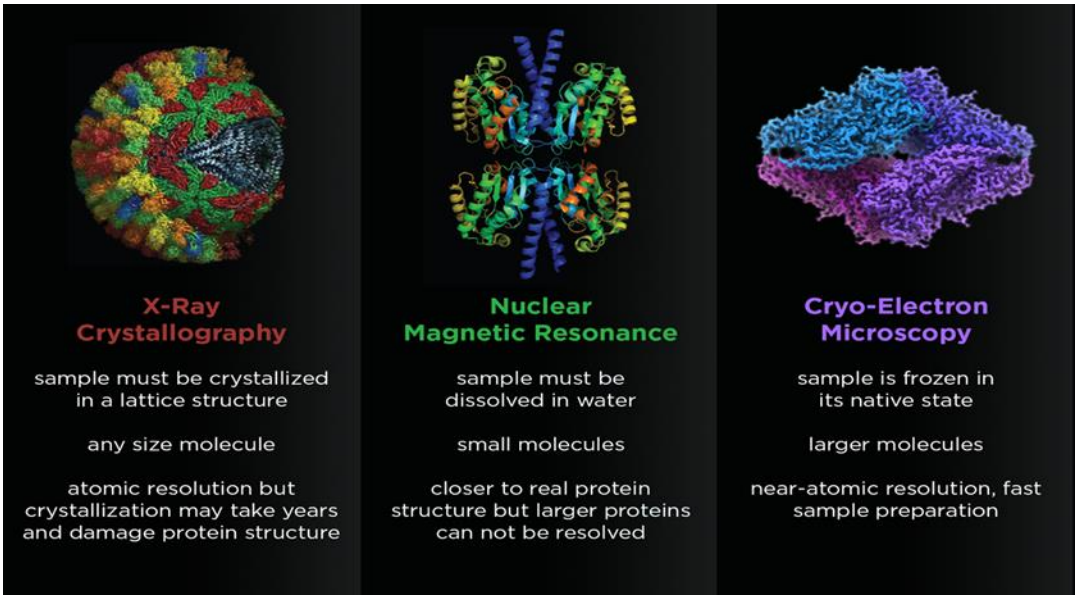
Figure 1: Cryo-electron microscope

Imaging techniques and their development:

Although there is great excitement for seeing biomolecules, strong tools for imaging have been around for quite a while. X-ray crystallography and nuclear magnetic resonance spectroscopy (NMR) are two examples. Surprisingly, many Nobel prizes have even been awarded to researches who have used these methods of imaging for examining biomolecules. So, why another prize related to imaging?

To answer this question, it is important to note that even these advanced methods of imaging have their weaknesses. NMR spectroscopy for example, works best for small biomolecules, but when it comes to larger ones like viruses, it is difficult to properly image them. Using X-ray crystallography has its own limitations as well, since it only works when the biomolecules crystalize, something not all of them are capable of.

Figure 2: comparing imaging techniques



Now let's look at what each of the three Nobel prize winners did to advance cryo-em:

1. Henderson who started as an X-ray crystallographer, turned to cryo-em because of the limitations of the other techniques for imaging. Studying a protein with this technique, he used liquid nitrogen to freeze samples, protecting them from the damages of electron

microscopy. Freezing protected samples inside the microscope, but ice crystals interfered with imaging.

2. To solve this problem, Debochet and his team used vitrified water, which did not interfere with imaging as much as the ice crystals did. Liquid water evaporates in the vacuum of the microscope and biomolecules breakdown. Dubochet cooled water so rapidly that it solidified in its liquid form around a biological sample. So, biomolecules were now able to keep their natural shape even in a vacuum environment.

3. Another problem was presenting the final results, since images were blurry and difficult to analyze. Jochium Frank developed an algorithm in which computers averaged electron positions from a blurry image, then estimated their positions to produce one clear image. The once blurry 2-dimentional images could now be analyzed and viewed as a sharp 3-dimentioal structure!

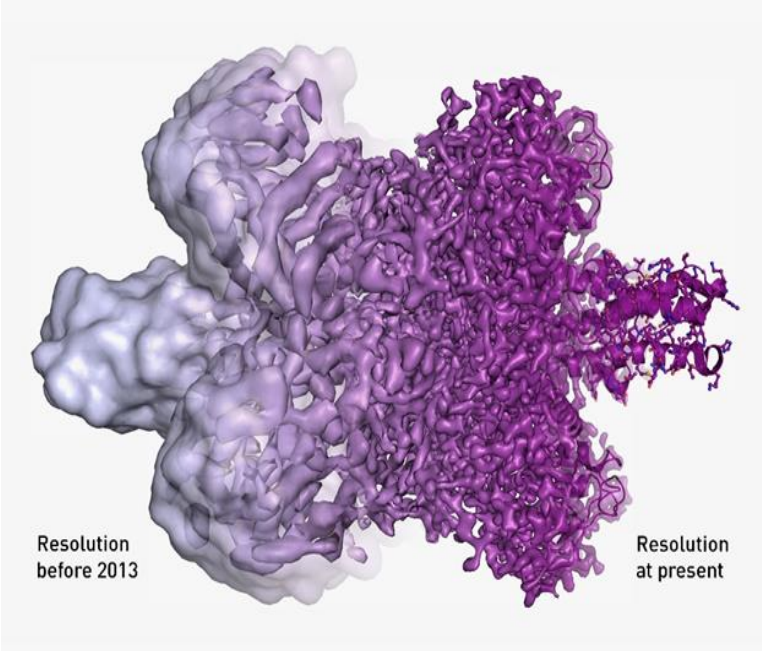
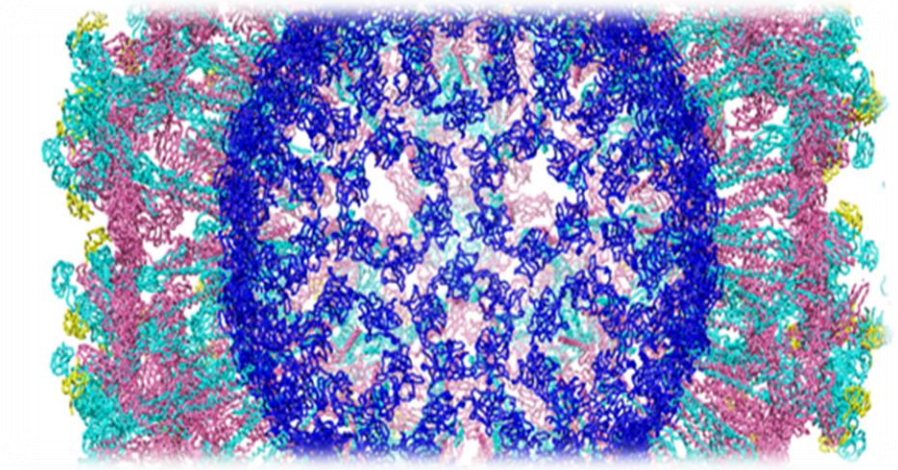


Figure 3: comparing image resolution over time

In conclusion: Cryo-em microscopy is an incredible step for science, since being able it to make precise 3-d images of biomolecules lets scientists advance cancer drug development and destroy viruses. Before having imaging Technique's to show the exact shape of biomolecules, it was hard for scientist to understand some of their functions. Cryo-em lets chemist see molecules, atoms, and their arrangements to from a structure or substance. Polymer samples, enzymes used in industries and human biological

samples can all be examined with this imaging technique. How molecules interact and operate can lead to our better understanding of their functions. “We can now see the molecules we work on, that in itself is very rewarding.” Says a member of the Nobel Prize committee. “In the future, we can analyze them in their different states. [We can] analyze their interactions with their surroundings and inside the cell. With new microscopes, there is a lot to be seen.”

Figure 4: Cryo-em- Current image resolution



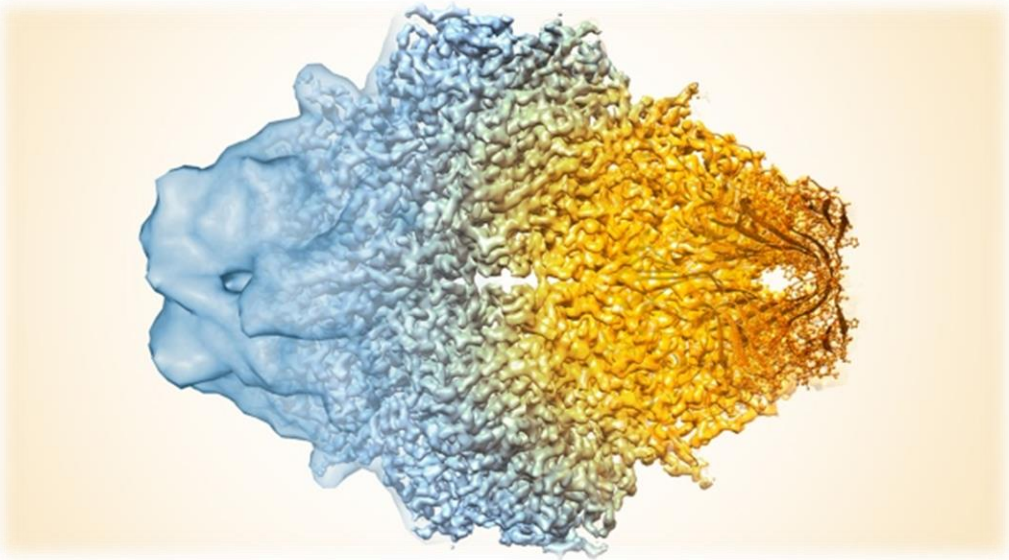


Figure 5: The evolution of image quality and precision: Older images left, most recent right

Scientists Believe Something with No Feet Moved Millions of Years Ago

By: Mable Wang

When speaking of the Ediacaran period, most people have no idea when that time frame was located regarding the whole of Earth's history. However, the word Cambrian period, or as it is more commonly referred to as, the Cambrian Explosion, triggers much more of a response. This is when animals that somewhat resemble what we see nowadays started to appear. Prior to this time, there lived animals on Earth which were nowhere close to looking like the animals that exist today. When faced with a fossil from that time, it is hard to tell if it were a plant or an animal, as a lot of the living creatures back then looked like giant leaves glued to the ocean floor.

Figure 1

Take the Ediacara biota, a peculiar soft-bodied kind of fossils from the Ediacaran period, which existed just before the Cambrian geological period. They possessed distinct features that just don't connect with present-day creatures. Curious questions such as how they fed, moved, and reproduced are raised, but since they have become long extinct, left unsolved. It was almost impossible to tell their place in the evolutionary history.

However, with a recent new technique, it became possible to simulate the ocean environment, thus enabling us to put the organisms back into their marine habitat, and to study their ways of life in moving fluids. By seeing how the organisms interact with the virtual surroundings, we may be able to figure out how they lived and died.

The method is called computational fluid dynamics, CFD for short. By obtaining a 3D model of the fossil and placing it in a virtual flume tank filled with simulated water, we would test hypotheses about how the organisms lived. Animals used to live in water, so they have developed adaptations to interact with water currents for finding food.

Figure 2: Simulation of the ocean environment at the time period

Take the example of Parvancorina, a shield-shaped organism about the size of a button, with a ridge at the front. Because of the lack of visible arms and legs, most scientists assumed it to be sessile, which means fixed to the floor. This conclusion was later on proved by the CFD to be false.

Based on the graphs from CFD, if the Parvancorina were in fact sessile, the way it arranges itself would've deeply changed its chance for survival. Should it prop itself up in a slightly different direction, the current would rip it apart! Another thing would be that assuming the Parvancorina were sessile, it would've only been good at capturing some food when its body was oriented in a specific direction. Both these conclusions suggest that animals would not evolve to eliminate their

chance of survival! This means the Parvancorina must've had a mobile lifestyle! The information is very important since Parvancorina left no trace of movement, then other Ediacaran fossils that were assumed sessile may also be mobile!

Figure 2: A sample of the Parvancorina fossil

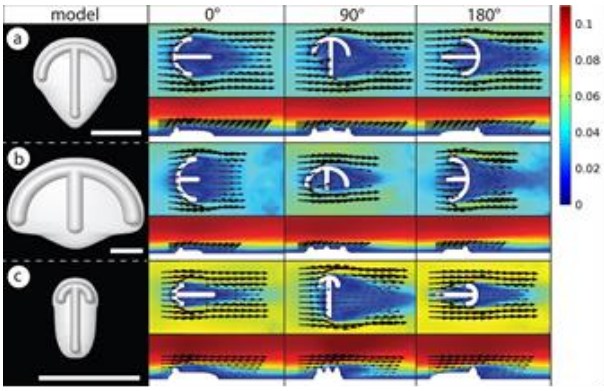


Figure 3: The diagram that depicts the movement of the fossil in current.

To conclude, by using newly developed technology, we may be able to view the world we live in with more care, and hopefully with science progressing every day, we may one day be able to reveal some more secrets of the universe. Who knows, maybe with new discoveries being made, we might realize something important about the human nature as well.

The Concept of Space

By: Goldin Joghataie

We are very familiar with space. It is the container of everything and anything. Everything moves inside space and empty space contains nothing.

But to physicists, space is more complicated than just a container full of things.

Everywhere you look, there is something. Now, imagine talking all this stuff away. Your laptop, your lunch, the cars, the streets, even the Earth, the planets, the galaxies, and sorry, your phone. Imagine taking all the particles of gas and dust and all the electrons away. What would be left? Nothing?

Based on modern physics, what you would have left, is empty space. In fact, the volume of an atom is also mostly empty space. But, interestingly, empty space also exists! It can be as real as your laptop, your lunch, and as real as the quiz papers on your desk. “Space can bend, space can twist, and it can ripple. Space is so real that you can call it the fabric of the universe.” Says Brian Greene author and physics professor at Columbia University.

Consider yourself driving in a car. You constantly describe your motion and all its attributes by referring to the objects that surround you: 2 kilometers from Moscrop secondary, near a shopping mall, close to the park… but now assume all the objects are gone. What is the meaning of motion and what is your speed relative to? Simply, where are you in the universe? How would you describe your motion? There is no reference for your motion when everything around you is taken away. Also, what is the universe now?

In Newtonian classical mechanics (older version of mechanics), space is separate from time and mass. In modern physics however, space, time, and mass are all connected together.

In classical mechanics, space is considered a container keeping everything inside and time is separate from that. So, all matter can be eliminated from space without damaging the shape of the container (being space), and time continues to tick independently.

In modern physics however, if you change mass, space changes too! Also, time and the dimensions of space are interconnected. To have a basic picture of this complicated subject, consider space as a floating table cloth. Now imagine that a mass such as a basketball or an orange is placed on it. Under the weight of the basketball or orange, the table cloth deforms and stretches at the points where the masses are placed. So, the masses have changed the shape of space! In other words, space and mass are attached to one another.

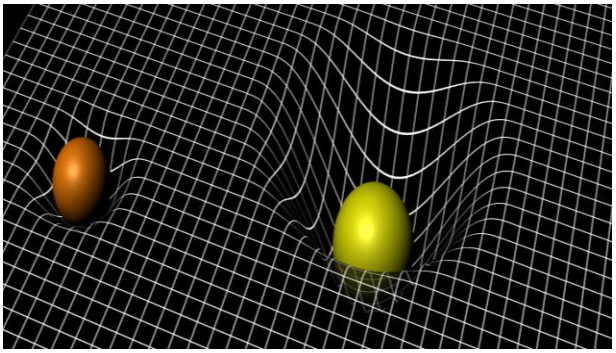



Figure 1 & 2: The concept of empty space, fabric of spacetime

While this simple picture is useful to explain how mass and space are connected, it is not easy to find an example to explain how time is also attached to space. But, the theory of relativity proves, based on precise experiments, that the mass and dimensions of an object change when the speed of the object changes.

If space and time being stretched or contracted do not sound familiar, it's only because we do not move fast enough in everyday life to see it in action. However, according to the theory of relativity, if you were in a car, moving at a speed close to the speed of light, the effects would no longer be hidden. If someone was watching from outside, the car would only appear a few cm long and the person would hear their watch ticking slowly. But from inside the car, everything would be normal for you and your watch would be ticking normally. So, length and time both depend on the relative speed of the person who observes the objects and measures the time! That is why it is called the theory of relativity.

Figure 3 & 4: Connecting time and space

However, don't worry, the above points about connectivity of mass, space and time only become significant when the speed of an object is thousands of Kilometers per second. In our daily lives, being at low speeds (low being up to thousands of Km/hr), we do not see lengths of objects decreasing when speeds increase. Notice that an airplane moves at only about 300 meters per second which is far below the speed for which this concept of relativity can be taken into account. With these topics of space, mass, and time we can explore many new and interesting concepts, which will be covered in the next editions of the journal.

SCIENCE JOKES:

1. We used to have a team bond, but that broke, so now we're all in an activated complex!
2. Would you rather learn about OH^- or H_3O^+?

   OH^- because its more *basic*!

3. - You know the store that sells pies, I can't find it anywhere!
   - Why? Doesn't it have a sine?
   - No, it doesn't have a sign.
   - Yes it does! sine of π is 0!
   - Maybe that's why I can't see it!

4. So for the last joke: (it requires some thought)
   What do you call bees that travel up this metal bar when you call them?

Bar-be-cue, BAR-BEE-cue! They travel up the metal bar when you give them their cue!

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5.Our natural Sunscreen

Kristen Fischer on February 19, 2015

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Written by Matthew Sedacca

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Bret Stetka is a writer who graduated from the University of Virginia School of Medicine in 2005.
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Reviewed by April Cashin-Garbutt, BA Hons (Cantab)

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All Images other images were our own

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