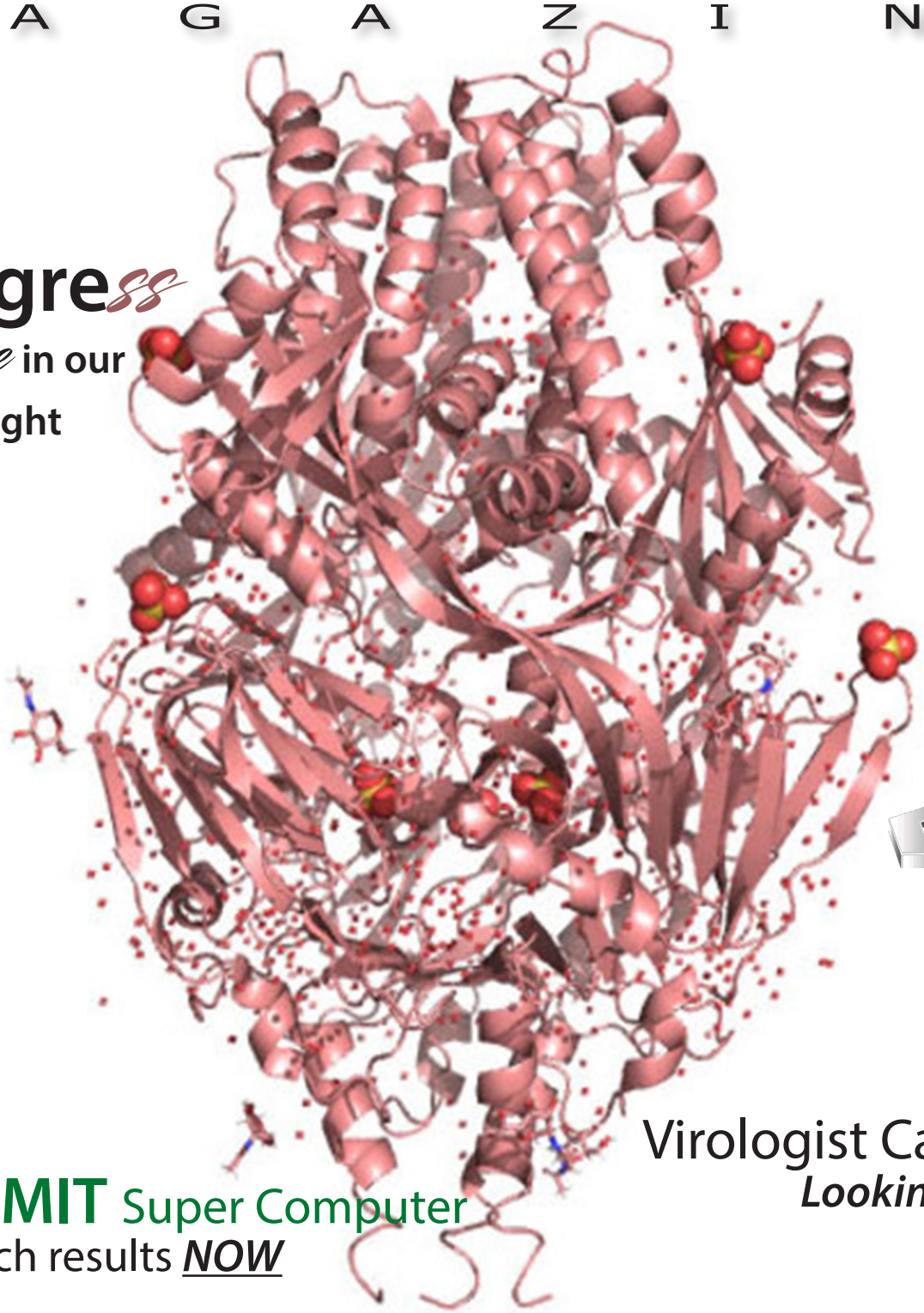
STEM

MAGAZINE



Atomic model gathered by X-ray crystallography of the portion of the respiratory syncytial virus that attacks human cells.

Progress
Hope in our viral fight

U.S. DEPT. OF DEFENSE

Virologist Careers
Looking deep

SUMMIT Super Computer
Research results ***NOW***

Home STEM Activities
To prevent boredom and engage families

March 2020
\\237v

We believe that the key to success in seeing higher graduation rates, improved testing results, student inspiration, creativity, excitement and career satisfaction rests in the hands of the teacher.

The example and inspiration of individual educators carries tremendous weight on a daily basis, greatly impacting the quality and effectiveness of the classroom environment.

Our mission: Encourage curiosity, investigation, inspiration, creativity, and innovation; the foundations of every career passion.

Wayne Carley
Publisher / CEO
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STEAM Magazine

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STEM Magazine is a monthly subscription non-profit education publication for educators, students, their parents and industry professionals.

Read monthly in 67 countries, STEM Magazines strive to encourage the educator to better understand the importance of STEM skills, their use in every school subject, the need and ease of integration into curriculum and the urgency for students to embrace STEM.

STEM

MAGAZINE

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OAK RIDGE National Laboratory

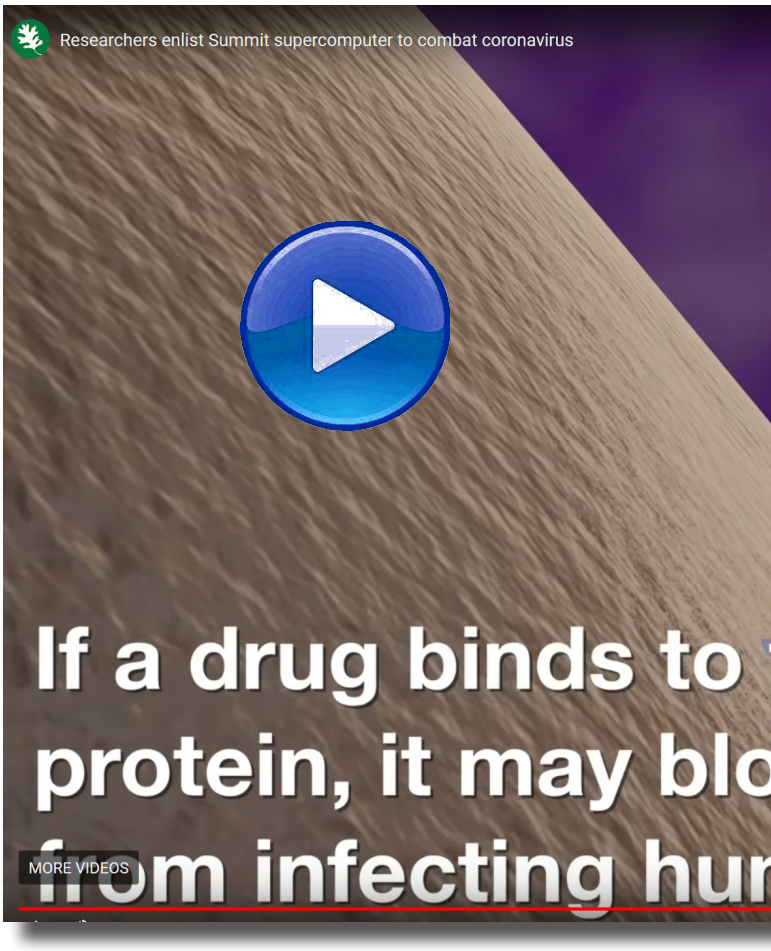
Summit Computer Power At Work

by Rachel HARKEN / ORNL

Researchers at the Department of Energy's Oak Ridge National Laboratory have used Summit, the world's most powerful and smartest supercomputer, to identify 77 small-molecule drug compounds that might warrant further study in the fight against the SARS-CoV-2 coronavirus, which is responsible for the COVID-19 disease outbreak.

The two researchers performed simulations on Summit of more than 8,000 compounds to screen for those that are most likely to bind to the main "spike" protein of the coronavirus, rendering it unable to infect host cells. They ranked compounds of interest that could have value in experimental studies of the virus. They published their results on ChemRxiv.

The idea was born out of an interest in the coronavirus' entry point into a host cell. When Chinese researchers sequenced the virus, they discovered that it infects the body by one of the same mechanisms as the Severe Acute Respiratory Syndrome, or SARS, virus that spread to 26 countries during the SARS epidemic in 2003.



The similarity between the two virus structures facilitated the study of the new virus.

Jeremy C. Smith, Governor's Chair at the University of Tennessee and director of the UT/ORNL Center for Molecular Biophysics, worked from the assumption that

the two viruses may even "dock" to the cell in the same way.

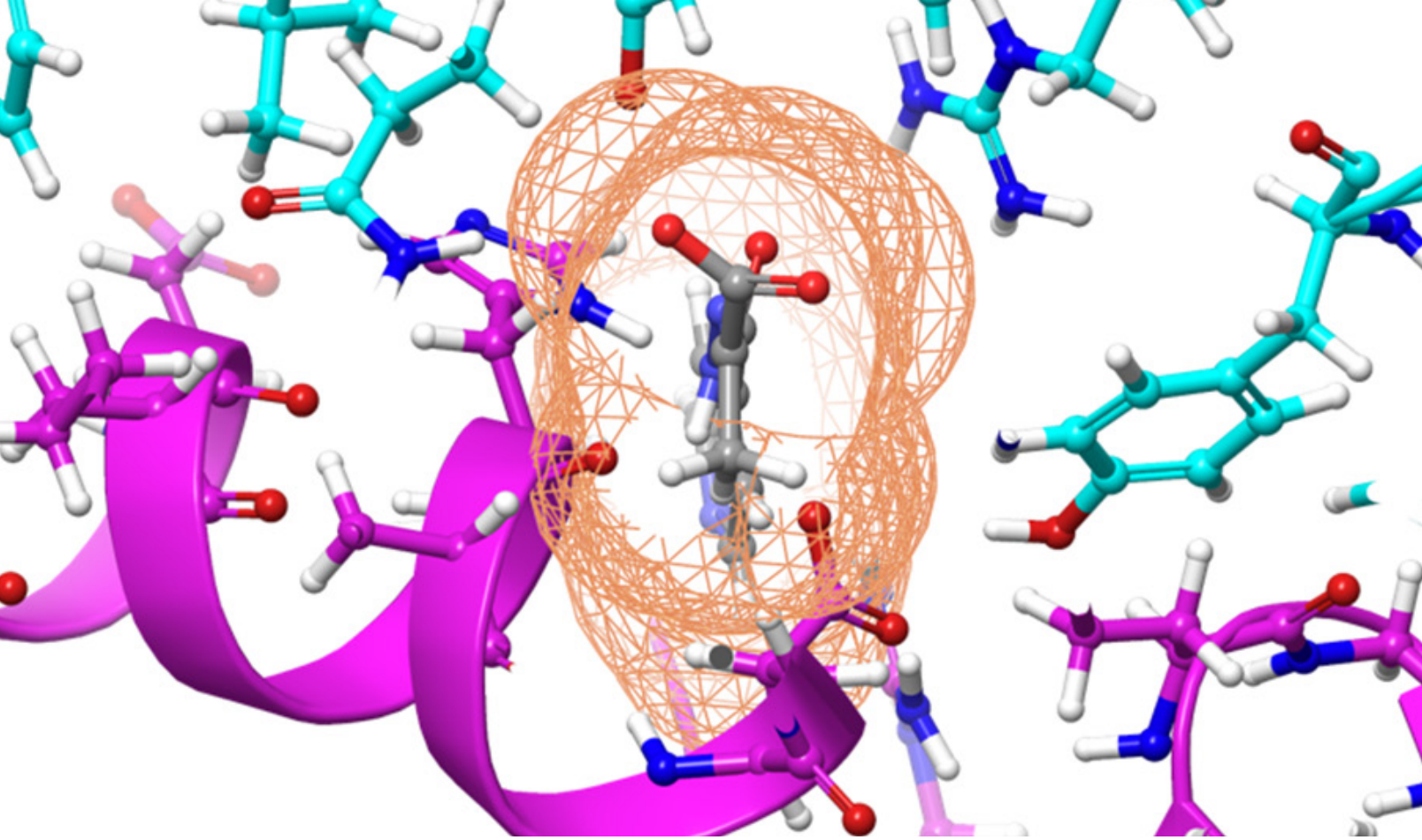
Team member and UT/ORNL CMB postdoctoral researcher Micholas Smith built a model of the coronavirus' spike protein, also called the S-protein, based on early studies of the structure.

Video produced by Jenny Woodbery

"We were able to design a thorough computational model based on information that has only recently been published in the literature on this virus," Micholas Smith said, referring to a study published in Science China Life Sciences.

After being granted computational time on Summit through a Director's Discretionary allocation, Micholas Smith used a chemical simulations code to perform molecular dynamics simulations, which analyze the movements of atoms and particles in the protein. He simulated different compounds docking to the S-protein spike of the coronavirus to determine if any of them might prevent the spike from sticking to human cells.

"Using Summit, we ranked these compounds based on a set of criteria related to how likely they were to bind to the S-protein spike," Micholas Smith said. The team found 77 small-molecule compounds, such as medications and natural compounds, that they suspect may be of value for experimental testing. In the simulations, the compounds bind to regions of the spike that are important for entry into the human cell, and therefore might interfere with the infection process.



The compound, shown in gray, was calculated to bind to the SARS-CoV-2 spike protein, shown in cyan (blue-green), to prevent it from docking to the Human Angiotensin-Converting Enzyme 2, or ACE2, receptor, shown in purple. Credit: Micholas Smith/Oak Ridge National Laboratory, U.S. Dept. of Energy

After a highly accurate S-protein model was released in Science, the team plans to rapidly run the computational study again with the new version of the S-protein. This may change the ranking of the chemicals likely to be of most use. The researchers emphasized the necessity of testing of the 77 compounds experimentally before any determinations can be made about their usability.

"Summit was needed to rapidly get the simulation results we needed. It took us a day or two whereas it would have taken months on a normal computer," said Jeremy Smith. "Our results don't mean that we have found a cure or treatment for the Wuhan coronavirus.

We are very hopeful, though, that our computational findings will both inform future studies and provide a framework that experimentalists will use to further investigate these compounds. Only then will we know whether any of them exhibit the characteristics needed to mitigate this virus."

Computation must be followed by experiment. Computational screening essentially "shines the light" on promising candidates for experimental studies, which are essential for verifying that certain chemicals will combat the virus, according to Jeremy Smith. The use of a supercomputer such as Summit was important to get the results quickly.

This research was funded by the Laboratory Directed Research and Development program and used resources of the OLCF, a DOE Office of Science User Facility located at ORNL.

UT-Battelle manages Oak Ridge National Laboratory for DOE's Office of Science, the single largest supporter of basic research in the physical sciences in the United States. DOE's Office of Science is working to address some of the most pressing challenges of our time.

For more information, visit:
https://energy.gov/science
Rachel Harken

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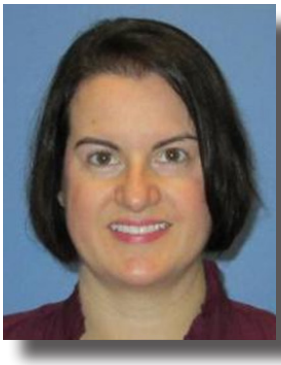


Sara S Shoemaker
shoemakerms@ornl.gov

Summit Computer Specifications

FLOP: In computing, floating point operations per second is a measure of computer performance, useful in fields of scientific computations that require floating-point calculations. For such cases it is a more accurate measure than measuring instructions per second.

Application Performance
200 PF (petaflops)
Petaflop: a unit of computing speed equal to ***one thousand million million*** (10^{15}) floating-point operations ***per second***.
A petabyte (PB) is 1,000,000 gigabytes (GB).

The typical home laptop has about 300 gigabyte of computing power.

Number of Nodes
4,608
Node: In computer science, nodes are devices or data points on a large network, devices such a PC, phone, or printer are considered nodes.

Node performance
42 TF (42 trillion floating-point operations per second)

Memory per Node
512 GB DDR4 + 96 GB HBM2

NV memory per Node
1600 GB

Total System Memory
>10 PB DDR4 + HBM2 + Non-volatile

Processors
2 IBM POWER9™ 9,216 CPUs
6 NVIDIA Volta™ 27,648 GPUs

File System
250 PB, 2.5 TB/s, GPFS™

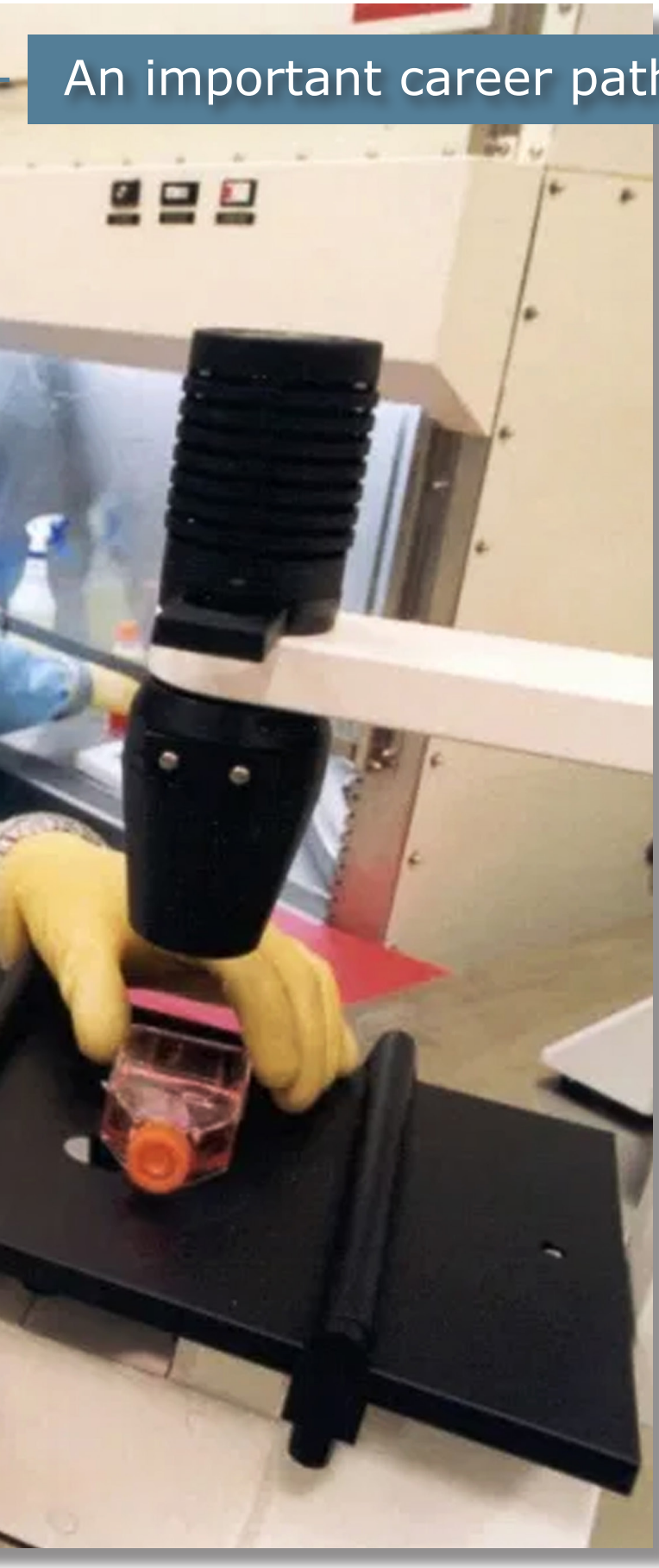
Power Consumption
13 MW (megawatts)

Interconnect
Mellanox EDR 100G InfiniBand

Operating System
Red Hat Enterprise Linux (RHEL) version 7.4


summit

Virologist



An important career path to a microscopic destination

by Wayne Carley

Virology is the study of the viral – sub-microscopic, parasitic particles of genetic material.

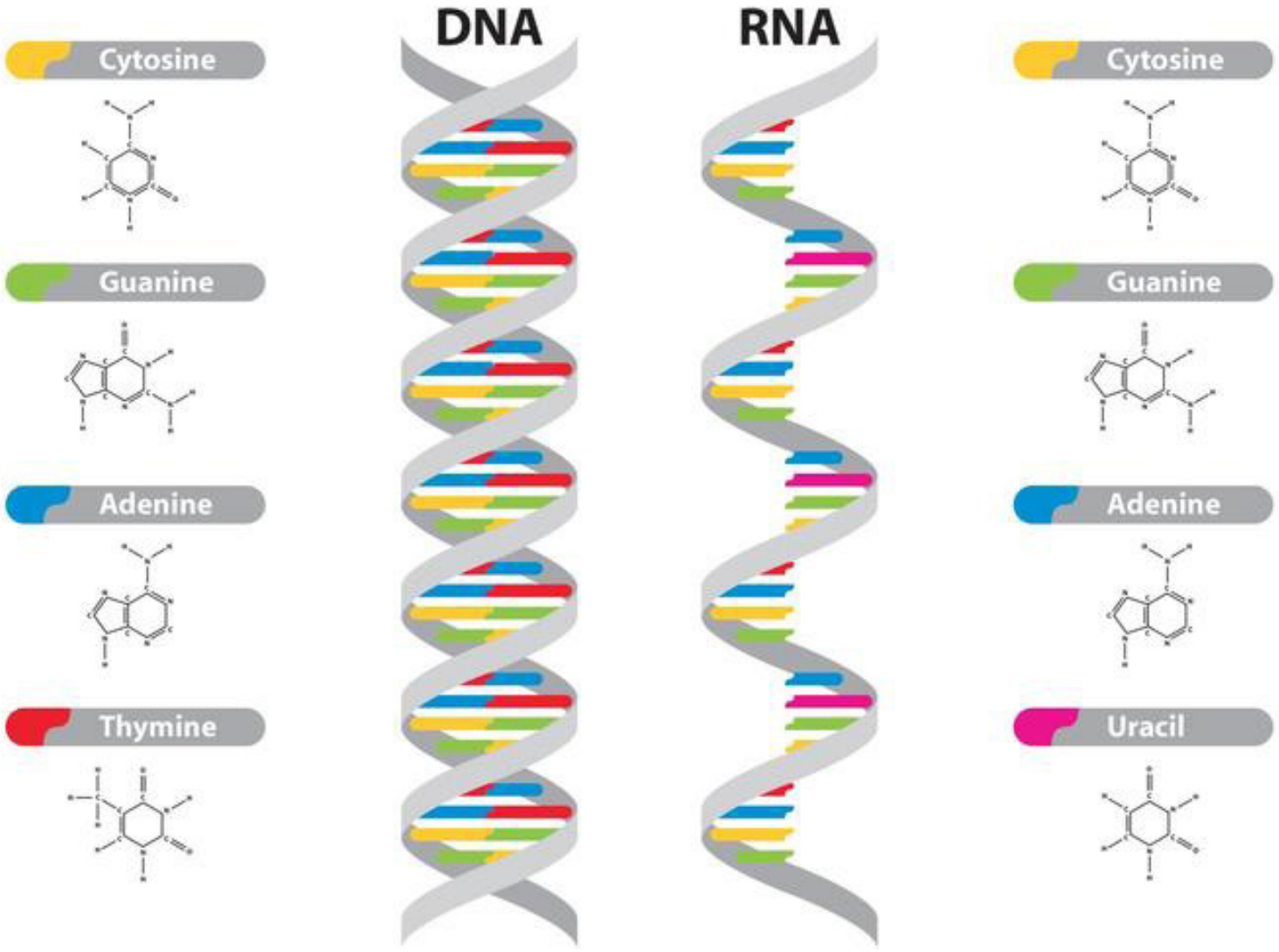
Virologists are microbiologists who study microorganisms that quickly duplicate, resulting in the rapid spreading of viruses. Their primary work is to figure out how viral diseases spread in order to prevent more rapid development and to help in the creation of vaccines (treatments) against viruses.

A virus is a small infectious agent (something that infiltrates another living thing) that replicates (multiplies) only inside the living cells of a host organism. For a virus to spread it must get into a healthy cell to form additional biological viruses and continue infecting new host cells through this process. The type of gene associated with a virus determines its replication process.

Most DNA viruses assemble in the nucleus of a cell, while most RNA viruses develop solely in cytoplasm. The cytoplasm is responsible for giving a cell its shape. It helps to fill out the cell and keeps organelles (a tiny cellular structure that performs specific functions within a cell) in their place.

DNA is the acronym for deoxyribonucleic acid; a molecule that contains the genetic code of organisms that determines every characteristic of a living thing.

RNA is the acronym for ribonucleic acid; a nucleic acid present in all living cells. Its primary function is to act as a messenger carrying instructions from DNA for controlling the production of chemical compounds of proteins, although in some viruses RNA rather than DNA carries the genetic information.



Viruses can infect all types of life forms, from animals and plants to microorganisms, including bacteria (a type of biological cell) and archaea (a category of single-celled organisms).

Virology focuses on –

 - Virus structure

 - Classification: Viruses can be classified according to the host cell they infect such as animal viruses, plant viruses, fungal viruses, and bacteriophages (viruses infecting bacterium, which include the most complex viruses).

Another classification uses the geometrical shape of the viral container or structure. Viruses range in size from about 30 nanometers (nm) to about 450 nm, which means that most of them cannot be seen with light microscopes that are often used in classrooms, but rather seen and studied using an electron microscopy or other ultra high magnification instrument.

A nanometer is a unit of measurement for length just as you have with meters and centimeters. A nanometer is one billionth of a meter, 0.000000001 or 10^{-9} meters. The word nano comes from the Greek word for "dwarf."

The most useful and most widely used classification system distinguishes viruses according to the type of nucleic acid (DNA and RNA) they use as genetic material and the viral replication method they use to manipulate the host cells into producing more viruses. Keep in mind that the host or healthy cells do not realize that the virus is harmful, and are very limited in any resistance to the attack.

 - Evolution:

> the ways they infect and influence host cells for reproduction

> how they interact with host or organism behaviors

> the diseases they cause

> the techniques to isolate and culture them

> and their use in research and therapy

A virologist is a research professional who is constantly exploring known viruses for a better understanding of their behavior in preparation for those new unknown viruses that occasionally and inevitably appear now and in the future.

Preparing, conducting and overseeing studies of microorganisms is a core duty and uses a variety of scientific lab equipment. Virologists observe bacteria that may have become a host to a virus by applying different levels of moisture, temperatures and air conditions to see how it reacts. This helps them understand what causes viral growth and spreading in the bacteria, so they can better predict the spreading of the virus in humans and develop vaccines.

A vaccine is a biological preparation that

provides a level of immunity to a particular infectious disease. A vaccine typically contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed forms of the microbe, its toxins, or one of its chemical compounds.

In 1717 Lady Mary Wortley Montagu observed the practice in Istanbul and introduced it in Britain, but met great resistance. In 1796 Edward Jenner developed a much safer method, using cowpox to successfully immunize a young boy against smallpox, and this practice was widely adopted.

A brief history of virology

The word virus first appeared in 1599 and originally meant "venom" (a poisonous substance). A very early form of vaccination or viral treatment was developed several thousand years ago in China involving the exposure of materials from smallpox patients to non-infected people to give them viral resistance or some level of immunity.

Vaccinations against other viral diseases followed, including the successful rabies vaccination by Louis Pasteur in 1886. These researchers did not understand viruses, but through the study of infected patients and experimentation, found ways of treating these mysterious and deadly plagues of their time.

The existence of viruses that infect bacteria was first recognized by Frederick Twort in 1911, and, independently, by Félix d'Herelle in 1917. As bacteria could be grown easily in culture, this led to an explosion of virology research. In 1977, Frederick Sanger achieved the first complete sequencing of the genome (genetic blueprint) of any organism, the bacteriophage Phi X 174.

In 1979, based on this discovery and research, a worldwide vaccination campaign led by the United Nations World Health Organization resulted in the eradication of smallpox.

lab assistants are among the common scientific roles held by people who are managed by virologists. In larger labs, the virologist spends more time planning, coordinating and supervising the research process of "the team" as opposed to personally participating in the research.

Coaching and training the research team on equipment use and proper procedures is vital to research project success. While a bachelor's degree usually gets you a job as a lab assistant, advanced research positions in virology normally require a master's or doctoral degree (PhD).

"In 1977, Frederick Sanger achieved the first complete sequencing of the genome (genetic blueprint) of any organism, the bacteriophage Phi X 174."

While viruses reproduce and evolve, they do not engage in metabolism, (the chemical processes that occur within a living organism in order to maintain life), do not move, and depend on a host cell for reproduction. Scientists still disagree as to whether viruses are "alive" or are life forms. They do carry genetic structure, but lack cell structure usually seen in life forms.

Virologist as a supervision / manager

Virologists usually supervise a team of researchers, especially in universities or in larger private corporation laboratories. Biological technologists, technicians and

If your interest is in a "hands on" virology career, the technologist, technician or lab assistant roles may be of greater interest.

Once research projects are completed, the virologist assumes primary responsibility for communicating the research results to his or her employer. Some virologists work in bigger labs where a variety of health research is conducted. These technical reports and presentations may go to other researchers, lab administrators or government health agencies who also have an interest in this research. At the highest levels, virology contributes to various plans developed by the federal Centers for Disease Control, or CDC, to control outbreaks of influenza and other viral infections.

Many virologists work in hospitals or in large medical clinics and often collaborate (work together) with other medical staff who deal with individual patient cases. Once a viral condition is identified by medical doctors, virologists collect samples for study.

The virologist often gives their professional opinion regarding treatment and controlling an viral outbreaks. In extreme cases, the virologist may recommend a patient be quarantined to prevent contamination of the hospital, staff and other patients and visitors.

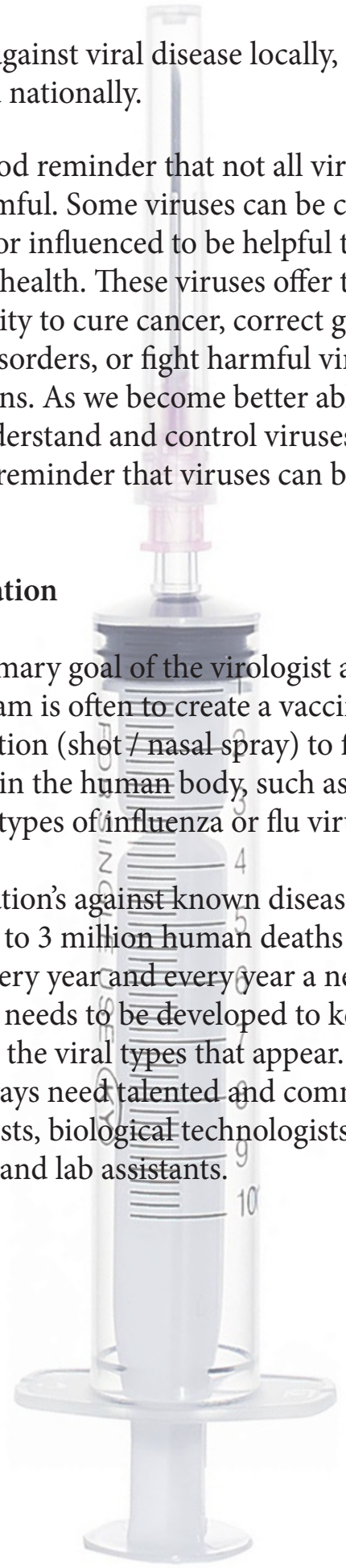
A virologist has tremendous responsibilities, both as a supervisor of life saving research, as well as an influential expert in guiding the decision making course of action against viral disease locally, regionally and nationally.

It's a good reminder that not all viruses are harmful. Some viruses can be controlled or influenced to be helpful to human health. These viruses offer the possibility to cure cancer, correct genetic disorders, or fight harmful viral infections. As we become better able to see, understand and control viruses, it's a good reminder that viruses can be our ally.

Vaccination

The primary goal of the virologist and their team is often to create a vaccine or vaccination (shot / nasal spray) to fight viruses in the human body, such as the known types of influenza or flu viruses.

Vaccination's against known diseases prevent up to 3 million human deaths worldwide every year and every year a new flu vaccine needs to be developed to keep up with the viral types that appear. We will always need talented and committed virologists, biological technologists, technicians and lab assistants.



4 Easy Tips to Having Fun Doing STEM Activities at Home

**The third one may shock you!*

by Thea Sahr

Keeping your kids occupied and happy is a standard parenting goal. But keeping your kids occupied and happy when they are out of school for the foreseeable future has moved well beyond the tricks and tips we normally use. So, what's a busy parent to do?

As a parent and someone who has worked in STEM education for a long time, I have a few ideas. My organization, DiscoverE, is a nonprofit focused on the E (for engineering) in STEM, and we have tons of FREE projects for kids ages 3 to 18. Better yet, most of the materials required are already in your house.

Got plastic cups? Challenge your child to build the tallest tower possible. Then ask them to knock it down and start all over. I've seen kids do this simple activity for two hours straight! Have some index cards? Encourage your daughter to design a structure that can hold up a soup can using only one index card and some tape. Believe me – it's possible and fun.

Here are some tips for heading off the "I'm bored, there is nothing to do" comment we all dread.

1. Create an Activity Notebook

I used an old three ring binder and printed out the instructions for a bunch of hands-on activities. (Hint: When selecting activities, look for ones that are open-ended. Meaning they don't have a 'recipe' to follow.

But instead offer a challenge, a list of materials, and they encourage your child to figure it out.) I then gave the book to my daughter and encouraged her to look through it and find things that inspired her or that she wanted to try. Here are some links to a few of our favorite activity resources:

- DiscoverE
- PBS Kids
- ScienceBuddies

2. Make a Supply Box

Having basic materials on hand gives your kids the chance to direct their own learning and is an easy answer to the I'm bored statement. Here's a list to get you started, but don't stop here. Keep brainstorming as you look around your house or apartment.

I stored my items in an extra drawer in my kitchen, but it can be as simple as a cardboard box in the corner.

- baking soda
- balloons
- markers
- newspapers

- notebook
- different kinds of paper
- paper clips
- paper cups
- pencils
- rubber bands
- ruler
- scissors
- straws
- string
- tape - all kinds!
- toothpicks
- vinegar
- old cd's
- empty toilet paper rolls

- cardboard
- empty bottles
- and another 20 item I forgot !

3. Be Prepared for a Mess

Active learning can be a bit messy and that's okay – at least that's what I keep telling myself. Big or little projects that engage your child's imagination and learning are worth it. And who says you have to clean it up? That's another project to keep them busy.

4 Encourage Them

Not all activities are going to work or turn out like your child thought. And that's okay. In fact, that might be the best outcome of all, as that gives you an opportunity to encourage them to explore what didn't work and what they might do differently next time.

One word of caution – don't over cheerlead, kids can see right through that. And don't fix it either. Ask them questions like:

"Can you describe what you were hoping would happen?"

"What actually happened?"

"How were they different and what might you try instead?"

Good luck! And if you have time, try out an activity yourself. They are a lot of fun!

Author Thea Sahr is the Director of Communications and Programs at DiscoverE. She lives in Massachusetts with her husband and daughter.

Activity Ideas and Projects

This is the easy part. Your kids already have a fascinating imagination and will quickly come up with their own ideas of what to make. These are of course ***toy imitations for play.*** Nothing electrical, sharp, heavy, too small (swallow hazard) or generally dangerous should be considered. ***The kids can run their ideas by you for approval.***

- A robot suit
- A box car
- A house for the dog / cat
- Something they saw on TV
- An item in the house or outside
- Making something they've seen in a book or magazine
- A creation no one has every seen - pure imagination
- Our solar system
- A rocket ship
- The space station
- A play house (boxes are perfect)
- A maze
- A tent house (my childhood favorite)
- A costume
- A laboratory
- Tools / tool box
- Kitchen appliances to play cook
- A toy radio to speak to someone
- A cell phone they can carry around
- A painting / drawing
- A gift for a family member or neighbor

Stem Cells Improve the Outcomes
of Patients with COVID-19 Pneumonia

By Dr.'s Liu Hongjian, Jin Ronghua, Jin Kunlin, Zhao Robert Chunhua

A coronavirus (HCoV-19) has caused the novel coronavirus disease (COVID-19) outbreak beginning in Wuhan, China.

Corona is Latin for "crown"

This study focused on preventing and reversing the cytokine storm, (a severe immune reaction in which the body releases too many normal immune defenses in the form of cytokines into the blood too quickly).

Cytokines play an important role in normal immune responses, but having a large amount of them released in the body all at once can be harmful. A cytokine storm can occur as a result of an infection, autoimmune condition, or other disease. It may also occur after treatment with some types of immunotherapy. Signs and symptoms include high fever, inflammation (redness and swelling), and severe fatigue and nausea. Sometimes, a cytokine storm may be severe or life threatening and lead to multiple organ failure also referred to as hypercytokinemia.

Preventing and reversing this storm may be the key to save the patients with severe COVID-19 pneumonia.

Mesenchymal stem cells (MSCs - cells that can function as a variety of cell types, including,

- ***osteoblasts (bone cells)***

- ***chondrocytes (cartilage cells)***

- ***myocytes (muscle cells) and***

- ***adipocytes (fat cells which give rise to marrow tissue),***

have been shown to possess a broad and powerful immunomodulatory function that modifies the immune response.

This study aimed to investigate whether these injected stem cells would improve the outcome of 7 enrolled patients with COVID-19 pneumonia in Beijing YouAn Hospital, China, from Jan 23, 2020 to Feb 16, 2020.

The clinical results, as well as changes of inflammatory and immune function levels and adverse effects of 7 enrolled patients were assessed for 14 days after MSC injection.

The pulmonary function (relating to the lungs) and symptoms of these seven patients were significantly improved in 2 days after MSC transplantation.

Among them, two common and one severe patient were recovered and discharged in 10 days after treatment.

After treatment, the **peripheral lymphocytes were increased** -

A lymphocyte is a form of small leukocyte (white blood cell) with a single round nucleus, occurring especially in the lymphatic system,

- **C-reactive protein decreased**

C-Reactive Protein is a plasma protein that rises in the blood with the inflammation from certain conditions,

and the **overactivated immune cells (CXCR3+CD4+ T cells, CXCR3+CD8+ T cells, and CXCR3+ NK) cells disappeared in 3-6 days**

Additionally a group of CD14+CD-11c+CD11bmid **regulatory DC cells population dramatically increased.**

(DC cells allow the immune system to recognize and respond to potential threats in a controlled but normally limited fashion thereby preventing a destructive overreaction against healthy tissues).

Meanwhile, the level of **TNF-α was significantly decreased**, while **IL-10 increased** in MSC treatment group compared to the placebo control group.

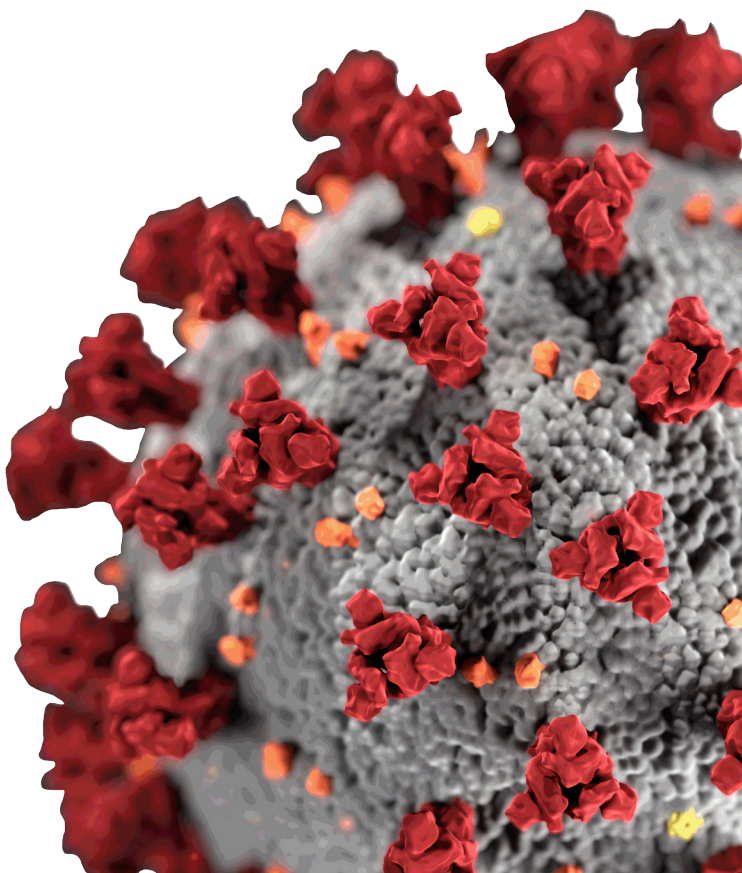
TNF-a is part of the inflammation process and IL-10 has potent anti-inflammatory properties.

Furthermore, the **gene expression profile** showed MSCs were ACE2- and TMPRSS2- which indicated **MSCs are free from COVID-19 infection.**

The **Gene Expression Profile** is a measurement of the activity of thousands of genes at once, to create a global picture of cellular function.

ACE2- and TMPRSS2 are the receptors or points where the virus attaches to the gene.

Thus, the intravenous transplantation of MSCs was safe and effective for treatment in patients with COVID-19 pneumonia, especially for the patients in critically severe condition.



The Simple Things I Do
To Promote Brain-Based Learning In My Classroom

by Judy Willis M.D., M.Ed.

If we want to empower students, we must show them how they can control their own cognitive and emotional health and their own learning. Teaching students how the brain operates is a huge step. Even young students can learn strategies for priming their brains to learn more efficiently; I know, because I've taught both 5th graders and 7th graders about how their brains learn.

I was a practicing neurologist before I became a teacher. Once I entered the classroom and observed how my students learned, the connections between my two professions became clear. I began to write about brain-based teaching strategies. It took a few years, though, before I realized that my students could also understand how their brains learn.

When I began incorporating basic instruction about the brain into my classes and teaching simple activities to improve brain processing, students not only became more engaged and confident, but they also began changing their study practices in ways that paid off in higher achievement.

Consider these typical comments from my 7th graders:

"I imagine neurons making connections in my brain when I study. I feel like I'm changing my brain when I learn something, understand it, and review it."

"If I use my prefrontal cortex to mentally manipulate what I learn, my dendrites and synapses grow, and I will own that learning for a long, long time. I won't have to learn fractions all over again each year."

Explaining how the brain works is especially important for students who believe that they are "not smart" and that nothing they do can change that. Many children, and even some parents and teachers, think that intelligence is determined at birth and that even intense effort will not budge their academic abilities. The realization that they can literally change their brains by improving how they approach learning and how they study is liberating.

Brain Filters: Let The Right Stuff In

I have taught both upper elementary and middle school students about filters in the brain that determine what information reaches their prefrontal cortex, which I call their thinking brains. We discuss three key elements of this filtering system: the reticular activating system, the limbic system, and dopamine. Students realize that their physical health, their emotions, and how well they focus their attention affects whether new information even reaches their thinking brains or gets filtered out because of negative emotions.

I guide students in activities that help them focus and achieve positive moods to prime themselves for learning. We practice techniques to increase mindfulness. For example, students learn to do visualizations, deliberately recalling in detail a place where they felt happy, calm, and safe. The more learners practice visualizing their particular calming place, the stronger the neural network holding that memory becomes; eventually, the students can easily return to that memory whenever they feel stressed. Returning to that safe place enables learners to let new information that someone is presenting flow into their thinking brain rather than being filtered out.

Students discover that when I guide them to visualize historic events, to picture vocabulary words with images that depict their meaning, or to see math procedures acted out in their mind's eye with "dancing numbers," they can better recall history, vocabulary, or math lessons.

I have students do relaxation breathing before we begin a test or challenging lesson. Students report that they feel calmer, more alert, and more focused—and they do understand and remember more.

To help students realize that brains and intelligence can change, I discuss neuroplasticity—the fact that the brain can grow new connections between neurons as we learn something by having new experiences. We can then strengthen these connections by remembering, practicing, visualizing, or using the new information. I show them brain scans, and we make diagrams and clay models of connections forming between neurons through cellular projections called dendrites. More dendrites grow when a person learns something new and then gets adequate sleep, I explain.

I send home photos of growing dendrites taken through an electron microscope and assign students to explain to family members the neuroanatomy behind these photos.

Students' Most Powerful Tool

The more students practice, the sharper their brain—already their most powerful tool—becomes.

Students know that the more they practice a basketball shot or rehearse a ballet performance, the more their skills improve. In my class, they learn that brains respond the same way. When a learner goes over multiplication facts or rereads confusing parts of a book, the brain gets better at processing this information because, with such repetition, more neurons grow and connect to other neurons, and neurons get more efficient at sending one another signals.

I talk directly with students about why strategies like taking scheduled short breaks or connecting learning to something pleasurable enhance brain function because of the role of dopamine and the emotion-monitoring amygdala. Students hypothesize about what strategies (such as taking too-frequent snack breaks and interrupting their focus with texting versus creating a homework schedule or turning off the television) will help—or hinder—their learning.

They experiment with studying under different conditions (with and without music, working in bed or at a desk, and so on), collect their own data about what works best, and compare data. Students also chart the relationship between their level of effort and the achievement of their goals.

When my students started telling other teachers about how they had learned to "make my brain work the way I want it to," colleagues began asking me for my brain lessons. I have shared with fellow teachers a brief overview of what I think students should know about their brains. In the interest of helping more teachers gain and share this information, I present that overview here as a downloadable pdf document. I invite readers to use this document ("What You Should Know About Your Brain") with students as they wish.

During the first four weeks of school, I present about three 15-minute sessions focused on this material each week. Each time, I explain a section of the material in my own words and demonstrate on models, with sketches, or with actual images of brain structures. Questions prompt discussion that deepens students' understanding of brain function. For example, asking, "Why don't neurons (nerve cells in the brain) replace themselves like skin and blood cells do?" reinforces the fact that neurons store memories; if brains continually replaced neurons, learned information would be lost.

As we learn about brain function, students write about how this new information influences their attitude toward school, their study habits, and their ability to change their own intelligence. Throughout the year, I incorporate reminders about brain function into my instructional strategies.

For example, I explain how growing more dendrites connects new information that a person learns into neural networks, solidifying the knowledge. Rehearsing newly learned material stimulates dendrites. After we discuss a new concept, I have students write summaries of the new information in their own words in their learning journals; we call these summaries dend-writes.

Students Take Charge

I have seen direct discussions of brain functioning yield wonderful results in terms of students taking charge of their own learning. One 10-year-old student told me, "Now I know about growing dendrites when I study and get a good night's sleep. Now when I'm deciding whether to watch TV or review my notes, I tell myself that I have the power to grow brain cells if I review. I'd still rather watch TV, but I do the review because I want my brain to grow smarter. It's already working and feels really good."

Having seen how interested my students are in learning about their brains and how they respond to that learning with increased motivation and better study habits, I've come to believe that instruction about how the brain processes information should be included in the curriculum. Whether as part of health class or class, or in a separate course, students should receive direct instruction in how best to use their most powerful tool.

Teaching students the mechanism behind how the brain operates and teaching them approaches they can use to work that mechanism more effectively helps students believe they can create a more intelligent, creative, and powerful brain. It also shows them that striving for emotional awareness and physical health is part of keeping an optimally functioning brain.

Thus, instruction in brain function will lead to healthier learners as well as wiser ones.

Looking for Your New Career Frontier? Try Thinking Small

Over the past year, the small satellite industry saw not only a massive year of growth, but one that demonstrated the many reasons why the small satellite industry is primed for long-term success.

Technological advancements, increased innovation and a growing demand from a variety of government agencies and other potential customers have resulted in a thriving small sat economy. The industry is reducing barriers of entry to space as well as enabling many of today's most promising next-generation scientific and commercial innovations, and subsequently, the careers of many promising innovators, making it a perfect field to start your career.

Finding your place in the aerospace universe can be a formidable task. Even if you've narrowed your search to the small satellite industry, like space itself, there are seemingly endless opportunities and companies to explore during the job-search process. Approximately 8,600 small sats will be launched in the next decade, so the field is rife with opportunity.

As you begin your search, start your evaluation of potential roles by asking a few basic questions, so that you can quickly screen opportunities to determine if they are right for you. For example:

- Is there 100% paid Health Insurance?

- Does the company offer a 401K with competitive match?

- Is there Short and Long-term Disability?

- Is the company public or private? If private, are they employee-owned?

With your narrowed-down list in-hand, a good next step is to consider one of the more overlooked aspects of potential roles: company size. Both large and small companies offer a unique range of benefits, and many professionals often end up working at both during some point in their career.

In the small sat industry, you really can't go wrong. However, here are four reasons to consider starting your career with a small company:

1. Learn many aspects of the industry

Being part of a small company peels away some administrative layers – as the size of the company shrinks, the impact of the individual employee grows. For example, working on smaller, more nimble teams ensures each member has an essential role to play. Additionally, at a smaller company there is higher probability of crossing paths with senior management, enabling you to learn from, and work alongside, the very best.

Smaller organizations also allow employees to gain experience across a greater range of aerospace disciplines. The realm of satellites and aerospace is rampant with opportunities to learn about and get hands-on in areas including: Mission

Services, Spacecraft Bus Design, Component Builds and others.

2. Provide novel solutions to new aerospace problems

Many small companies are staffed by thought-leaders equipped to "break the mold" by tackling age-old problems with bold new solutions. For example: NASA hand-picked Blue Canyon Technologies to develop and conduct an in-space demonstration of a new autonomous navigation solution, as part of the organization's "Tipping Point" mission. Older satellites rely on communication between the satellite itself and humans on Earth; Tipping Point demonstrated a new approach allowing the satellite to function self-sufficiently and, in turn, more efficiently.

Because small companies such as Blue Canyon Technologies aren't constrained by size and industry conformity, the "Tipping Point" isn't just an end goal; it's the starting line.

3. Partner with a broader range of industry players

Being a "smaller fish" in the aerospace and subset satellite industry isn't a hindrance – it's a benefit.

For example, many small aerospace companies in Colorado support missions for premier organizations including the U.S.

Air Force Research Laboratory, NASA Jet Propulsion Lab, MIT Lincoln Labs, DARPA, CU-Boulder and the Johns Hopkins Applied Physics Laboratory, just to name a few.

4. Work on high-impact missions
The size of a company is by no means correlated to its propensity to have a resounding impact on the industry. Colorado has been coined "Aerospace Alley" due to the proliferation of space-related industry in the region- a great deal of them being small businesses. In fact, the state ranks 2nd in the nation for both private aerospace employment as a percentage of total employment, and in total private-sector employment.

If 2019 was any indication, it's clear that 2020 will continue to see rapid progression in the small satellite industry, serving more versatile and critical functions than ever before including telecommunications, Earth observation, information and more. Whether it's for a large company or a small one, the small sat field offers endless opportunity to make an impact.

The small satellite industry is booming and should continue to do so for decades to come. A wide variety of careers within this industry are yours for the choosing.

MATH Refreshment!

You're stuck at home. How about some refreshers:

Solve for 4th Grade -

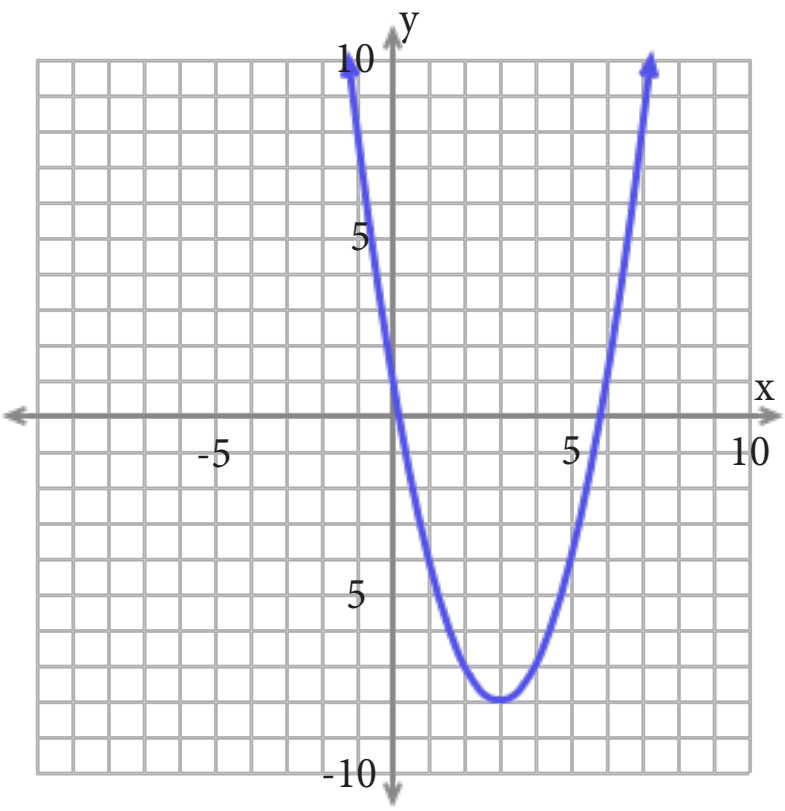
$$(62 \div 2 - 3) \times 3 + 6 \times 2 =$$

Solve for 6th Grade -

$$33 - (-100)2 =$$

Solve for 9th Grade -

What is the y-intercept?



Solve for 12th Grade -

Simplify.

$5i - 9i$ Write your answer in the form:

$$a + bi$$

Solve for **Teachers** -

Convert A to scientific notation base 2 (C++ has function "frexp" for this). Note: mantissa is ³ .5 and < 1.

Let

a = mantissa of A
exp = exponent of a
a = a * 2(exp mod 2)
exp = exp \ 2 (Note: integer divide)
xn+1 = (xn/2)(3 - axn2)

Reiterate about 5 or 6 times then do y with that result.

yi+1 = yi + (xn/2)(a - yi2)

Reiterate until required precision attained.

[sqrt]A = yi * 2exp

What do *Chemical Engineers* do?

Chemical engineers use math, physics, and economics to solve practical problems. The difference between chemical engineers and other types of engineers is that they apply a knowledge of chemistry in addition to other engineering disciplines. Chemical engineers may be called 'universal engineers' because their scientific and technical mastery is so extensive.

They design processes and equipment for large-scale safe and sustainable manufacturing, plan and test methods of manufacturing products and treating byproducts, and supervise production.

Manufacturing

Chemical engineers often work in manufacturing to help design and coordinate any chemical processes used in making goods. They help to manufacture goods such as pharmaceuticals, organic products, textiles, industrial chemicals such as paint and fertilizer, composite materials, food and electronics. They make sure that these goods have the best quality and the cheapest manufacturing costs possible.

Environment

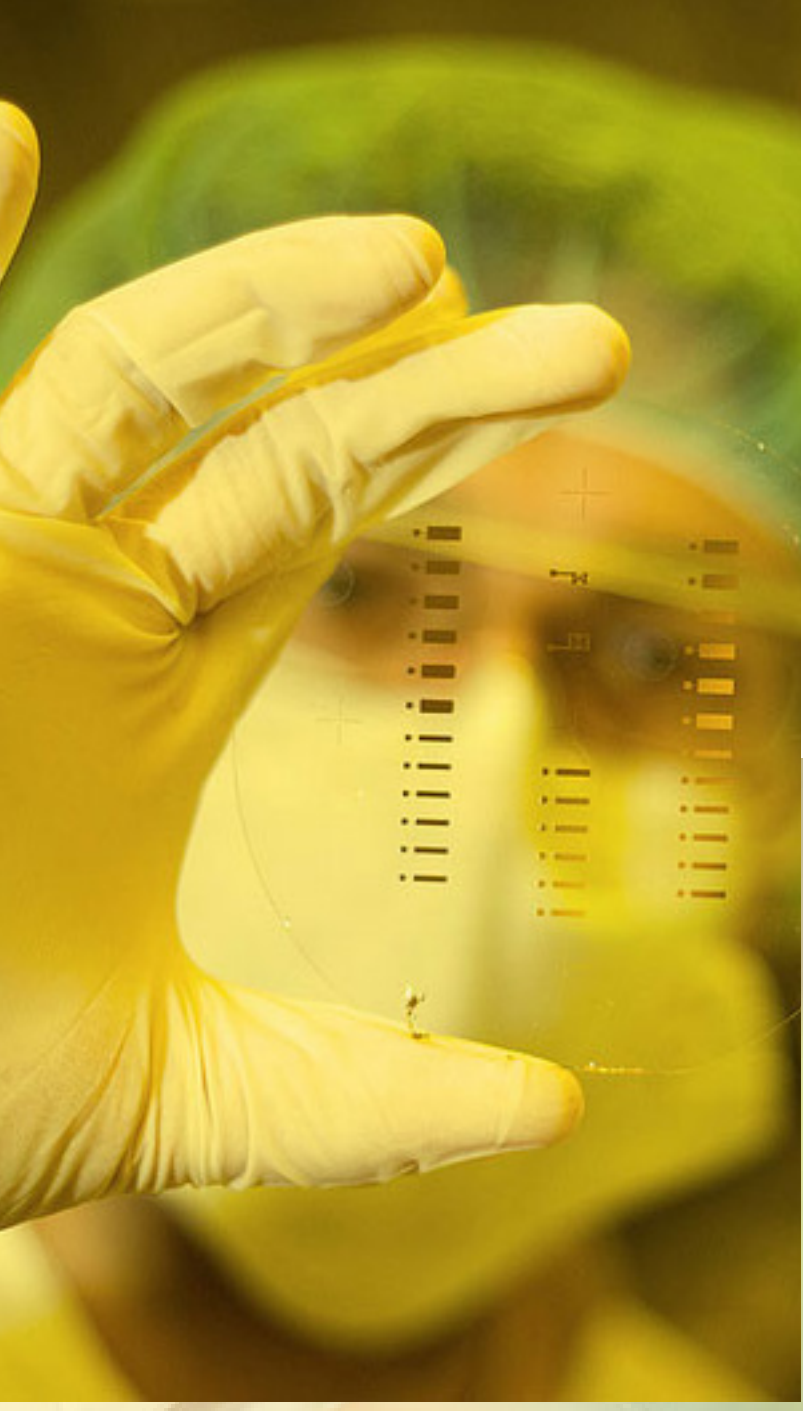
Chemical engineers also use their knowledge of chemical processes to help counteract the effects of chemicals on the environment. They help companies and organizations to reduce pollution in the air, soil and water as well as assist manufacturers in creating a manufacturing process that causes less pollution.

Chemical Production

Other chemical engineers work directly with chemicals to see how they work in mass quantities. In order to manufacture large quantities of chemicals or use a significant amount of chemicals in a manufacturing process, chemical engineers have to study the properties of each chemical, such as the polymerization or oxidation qualities for that specific type of chemical.

Salary

Recently, the U.S. Department of Labor estimated there were 30,000+ chemical engineers in the United States. At the time of the survey, the average hourly wage for a chemical engineer was $39.23 per hour, ranging from $24.07 to $57.05 per hour. The median annual salary for a chemical engineer was $78,860. The middle 80 percent of chemical engineers made $50,060 to 118,670 annually.



Employment of chemical engineers (as well other types of engineers and chemists) is expected to grow at the average growth rate for all occupations through 2025. The related field of environmental engineering is expected to grow at a much faster rate.

Entry level chemical engineers advance as they assume more independence and responsibility. As they gain experience, solve problems (the engineering method), and develop designs they may move into supervisory positions or may become technical specialists. Some engineers start their own companies. Some move into sales. Others become team leaders and managers.

Chemical engineers will save our lives as their contributions provide cures for our most deadly diseases, renewable energy solutions, crop and food production innovation and answers to questions we have not thought of yet.

This could be your job.

We see the Chemical Engineer in you

STEM Magazine is GLOBAL