



M. Alex Brown, Ph.D., Chemist

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Radiochemist

Who are they?

Think of Marie Curie and her husband, Pierre—the chemists who discovered radioactivity and used it to fight cancer. Think of Lisa Meitner who discovered that atoms could be split in half. Radiochemists study the power of nuclear energy on the small scale which leads to the nuclear technologies that we use today. They explore the chemical properties of radioactive elements and test their applications for things like medical use to fight cancer. They work in international laboratories, medical research facilities, and government agencies. Radiochemists are curious about the link between nuclear energy and human biology. They work to discover the ways nuclear energy impacts our bodies and help develop protocols for how to best work with the powerful force of nuclear radiation.

What do they do?

Radiochemists study the behavior of atoms and molecules in order to understand important characteristics of nuclear energy and how it behaves. Radiochemists often work with radioactive isotopes, which are variations on the atomic structures of elements. Different isotopes have different properties and uses. Radiochemists study these isotopes in order to build new applications.

How do I become one?

Radiochemists earn college degrees in chemistry, chemical engineering, or similar fields and then go on to work in research labs. Radiochemists should be interested in chemistry and math along with physics and engineering. Students can also join the American Nuclear Society in order to network with other students and professionals in the nuclear field.

Spotlight on a real Radiochemist!

M. Alex Brown, Ph.D. is a chemist working with Argonne National Laboratory. His research specialties are nuclear medicine and nuclear waste. His work leads to real-world innovations in fields like cancer care.

Brown's career in nuclear chemistry has led to exciting applications in healthcare. He has partnered with medical professionals and hospitals to merge the fields of medicine and nuclear science. Brown received his bachelor's degree in Chemical Engineering, his Master's in Radiation Physics and his Ph.D. in Radiochemistry.

His background in chemistry and physics has led him to work on many important research projects, including the production of nuclear isotopes that can destroy cancer and other infectious diseases.

With great power...comes great responsibility! Brown notes that nuclear chemists have a moral duty to promote peaceful uses of nuclear technology and dispel negative and harmful myths about nuclear energy.

Let's Chat with Dr. Brown!

Tell us about some of the exciting projects and innovations you have worked on:

The most exciting project of mine to date has been the focus on producing nuclear medicines used in the treatment of cancer and various diseases. Collaborating with cancer centers and hospitals has been particularly challenging and exciting throughout my career.

What skills are required in your position on a day-to-day basis?

A basic understanding of math, nuclear science, chemistry, and physics is required to enhance my research focus areas. But more importantly, being enthusiastic about nuclear science as well as conducting outreach to the communities and next generations of scientists are critical components.

What do you do in your spare time?

In my spare time, I enjoy nuclear science outreach for high schools and universities. I also enjoy snowboarding, travelling, and exploring every corner of Chicago.

What educational preparation would you recommend for someone who wants to enter this field?

Excelling in math and science is important for a student interested in the nuclear sciences. Read, ask questions, and engage in as many activities as possible related to your field of interest. But most of all, be curious!

What qualifications do you seek in a new hire or colleague?

Curiosity and enthusiasm come first. Perfect grades and test scores, though important, don't always reflect the best scientists.

From your experience, how do most people enter this profession?

Nuclear scientists and engineers generally have a background in (any!) type of science or engineering. This can include math, physics, chemistry, mechanical or chemical engineering, as well as many other technical disciplines.

Are there professional organizations or events that teens and college students can join/participate in?

The American Nuclear Society is an important organization that promotes nuclear science and technology. They engage in outreach within the communities and universities. They are diverse, understanding, and efficient in meeting their goals of spreading the peaceful uses of nuclear energy.



**Natalie Zaczek McIntosh,
Fuels Reliability Engineer**

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Mechanical Engineer

Who are they?

Mechanical engineers are women and men who design and oversee the manufacturing of many products ranging from medical devices to components that power a ship or spacecraft. They provide day-to-day technical and practical engineering advice, problem solving, and support to operations and maintenance departments.

What do they do?

Mechanical engineers can work in nearly every area of science and technology. In nuclear science, they research the benefits of nuclear energy and radiation to develop systems and processes. They provide input for safe operations of nuclear facilities and make improvements for nuclear plant operation. They are on the forefront of developing exciting innovations in medicine, agriculture, space travel, flight, and robotics.

In nuclear sciences, they use their experience and background with mechanical and thermal sensors to develop nuclear equipment and systems. This may include reactor cores, radiation shielding, and designing safe shutdown scenarios. Mechanical engineers apply thermodynamics (the relationship between heat, work, temperature, and energy) to transform thermal energy into electrical energy. Mechanical engineers work at nuclear power plants, energy companies, and some even work in the military!

How do I become one?

Mechanical engineers typically need a bachelor's degree in mechanical engineering. Courses include math, science, engineering, and design. Fields of study, like engineering, encourage strong skills in math, problem-solving, and communication. Mechanical engineers in nuclear focus on thermodynamics, heat transfer, and materials.

Spotlight on a real Mechanical Engineer!

Natalie Zaczek McIntosh is a Fuels Reliability Engineer at Exelon. She has more than 10 years of experience in different aspects of nuclear energy.

McIntosh has been responsible for maintaining the safe, reliable operation of many nuclear power plants. This includes making changes to the design of power plants over time to improve operations and incorporate new technologies. McIntosh's background in environmental engineering led her to a career in nuclear science.

She was interested in maximizing the benefits of nuclear as a safe, carbon-free energy source.

A word of advice: The Society of Women Engineers can help connect high school students to college visits and professionals in the field. She also recommends getting involved with the American Nuclear Society Young Members group in college.

Let's Chat with Mrs. McIntosh!

Tell us about the most exciting project that you worked on.

Being part of a high-functioning team for a project from start to finish was the most rewarding. We installed new efficient turbines as part of a power uprate for one nuclear plant. A power uprate is where we improved the design to get more electrical power out of the same site. This was exciting because I followed the design, the installation, and ultimately witnessed the startup testing. This plant was in another state, so I got to travel and meet new people.

What skills are required in your position on a day-to-day basis? Do you use skills that you learned before college?

Having a strong technical basis is required including critical thinking skills, but another essential skill is communication. An operating power plant requires working with many other people in different departments and thus different perspectives. This is a skill that can be developed over time and maybe isn't the easiest for an engineer. But being able to communicate issues is valuable. I use many of the social skills learned from being on sports teams and working in groups at school at my job every day!

What do you do in your spare time?

I have a young toddler, so I enjoy spending time with my family and watching my son learn about the world. I am the Chair of the American Nuclear Society (ANS) Chicago Local Section and am a member of the local Women in Nuclear (WIN) chapter and the NAYGN (North American Young Generation in Nuclear). As a lifetime Girl Scout, I enjoy giving back to that organization. I lead a 'Get to Know Nuclear' patch session for Girl Scouts every year and I volunteer at the Girl Scouts' STEMAPALOOZA. STEMAPALOOZA is a STEM

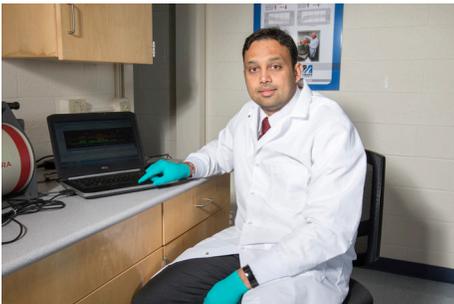
expo that provides hands-on activities to inspire girls to pursue STEM subjects and careers. I also enjoy board game nights with my friends, coworkers, and family.

What educational preparation would you recommend for someone who wants to enter this field?

A bachelor's degree in engineering opens the door to a wide variety of career options anywhere, including at the nuclear power plant and is a minimum requirement for engineering fields. Note that this does not need to be specifically a nuclear engineering degree to be part of the industry. I have a mechanical engineering degree, so don't worry too much if you're uncertain about which type of engineering degree to pursue.

Is there anything else we should know about this career path? Anything unexpected?

A career in nuclear engineering can go in many different directions, based on your interests. You can be a technical nuclear engineer or move into operations or another department or develop into management. What I enjoy about my career is that every 3–4 years I move into a new role which improves my overall understanding and keeps things interesting because I get to learn new things.



Sukesh Aghara, Ph.D., Associate Professor of Chemical Engineering

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Nuclear Researcher

Who are they?

Nuclear researchers are professors, scientists, and researchers. They work for universities, corporations, and the government. Some nuclear researchers study the basic principles of nuclear energy, such as how it interacts with matter. Others study how humans use nuclear energy for power generation as well as health and medicine, and how it plays a deterrent role in foreign policy. Nuclear researchers are important to the aerospace industry, where they work with other scientists and engineers to study how nuclear energy can power spacecraft and other important methods of propulsion.

What do they do?

Nuclear researchers use computers, data, and other tools to investigate nuclear energy and its place in our world and society. They are often called to serve as experts and advisors for governments and agencies, helping to establish laws, policies, and best practices for the use of nuclear energy. If a nuclear emergency happens, nuclear researchers will be called in to help determine what happened and develop protocols on how to prevent another emergency in the future. Nuclear researchers may also teach students and future nuclear engineers who will be joining the nuclear workforce.

How do I become one?

Nuclear researchers must have a bachelor's degree in engineering or chemistry. From there, they go on to earn a doctorate in nuclear engineering. Once they have a Ph.D., nuclear researchers may work as faculty members for universities or for a variety of private and public companies and organizations. Having a strong background in math, science, and computers is essential to becoming a nuclear researcher. Internships are also an important part of gaining hands-on experience and training in nuclear science. Organizations like NASA and the Department of Energy (DOE) are great places to look for internship opportunities.

Spotlight on a real Nuclear Researcher!

Sukesh Aghara, Ph.D., is an Associate Professor of Chemical Engineering and the Director of the Nuclear Engineering Program and the Integrated Nuclear Security and Safeguards Laboratory at the University of Massachusetts, Lowell (UMass Lowell).

Prof. Aghara's research expertise is the interaction of nuclear energy and matter. He started out as an environmental engineer, but his passion to make lives and communities better quickly led him to study nuclear waste sites and how they

impact the ecosystems around them. He went on to earn a doctorate in nuclear engineering and now serves as a faculty member of the Department of Chemical Engineering at UMass Lowell. In addition to his academic responsibilities, Prof. Aghara serves as an advisor and expert on nuclear energy to many important agencies, including NASA, the Department of State, and the International Atomic Energy Agency (IAEA).

A word of advice: Prof. Aghara says that aspiring nuclear researchers should be analytical thinkers who are naturally curious and have a predisposition to saying “yes.”

Let’s chat with Dr. Aghara!

Tell us about some of the exciting projects and innovations you have worked on.

What I like most about my job as a university professor is that I get to choose projects that excite me. It also allows me to work with the brightest and most motivated young minds. Two projects stand out for me in all the different research that I have had the opportunity to be a part of. First, my work at NASA’s Langley Research Center in Virginia where, as a NASA Administrator’s Fellow, I had the opportunity to work alongside the space agency’s top scientists, solving the radiation transport problems for the International Space Station as well as lunar and deep-space missions. More recently, I have been involved in research that is at the cutting edge of technology and policy, with a focus on security and safeguards of nuclear materials and facilities. This project has led to tremendous professional and personal growth for me as I apply my technical knowledge and develop my communications skills to engage experts from around the world working on national and global nuclear security and safeguards challenges. The effort has stoked the fire in me to continue to be part of an international community that seeks technology solutions for the safe and secure use of nuclear energy.

What skills are required in your position on a day-to-day basis?

The use of advanced computational and analysis tools is fundamental to the work we do in our research group. This includes using several radiation transport codes running on multiple OS and hardware platforms. We use MatLab, Python, and Excel for most of our analysis tools. To be able

to communicate scientific data in a meaningful way to a broad range of audiences is a skill that I continue to develop and expand.

What do you do in your spare time?

I grew up playing tennis, and it continues to be something that I really enjoy, particularly on clay courts. I also enjoy hiking with friends and family. My wife and I share a passion for food from around the country and the world. We seek new cuisines and learn new cultures whenever and wherever we can.

What educational preparation would you recommend for someone who wants to enter this field?

Science and mathematics are the fundamental building blocks to any engineering field. Nuclear engineering is by definition a multidisciplinary field, with nuclear energy being an engineering system that integrates many core areas of engineering—chemical, mechanical, civil, electrical, and computer.

From your experience, how do most people enter this profession?

Although the typical career pathway is through science and engineering fields, I have come across some exceptionally talented nuclear energy professionals who had their formal education in policy, communication, and history! Internships at national laboratories and fellowships through DOE and NASA can offer pathways for a successful career in nuclear energy.

Are there professional organizations or events that teens and college students can join/participate in?

At UMass Lowell, we host Boy and Girl Scouts for their merit badges. This is also an excellent way to learn or visit nuclear facilities in the area. Several high schools also have radiation science kits, which are a great way to learn about the fundamentals of nuclear science. The American Nuclear Society has local chapters that organize public events and are very receptive to aspiring young members.