# CARMA

## THE CAREER MAGAZINE

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# INDEX

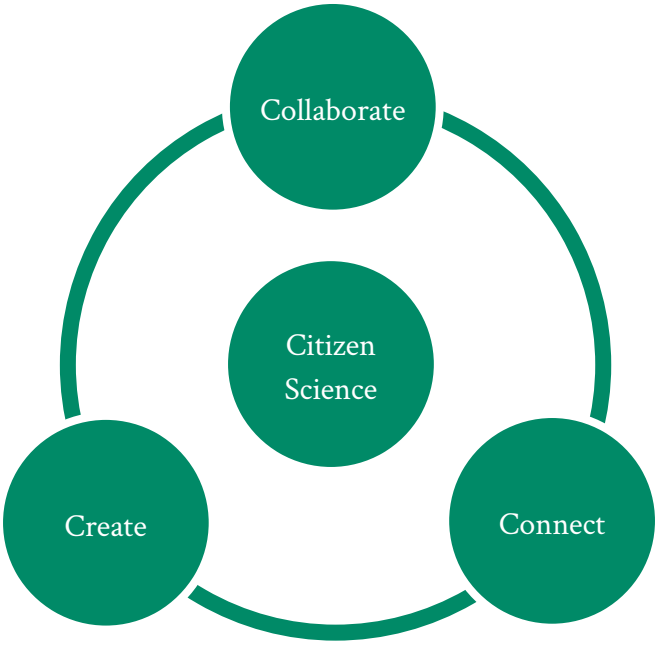
# CITIZEN SCIENCE

*"Tell me and I forget*
*Teach me and I remember*
*Involve me and I learn,"*
*- Benjamin Franklin*

## *What is Citizen Science?*

Being Students of Science, we are expected to have an edge in its matters. But surprisingly, even then some things hide in plain sight. The concept of Citizen Science can be considered in that category.

So, what actually is 'Citizen Science'? If the name itself hasn't given away all of the meaning then, Citizen Science is something where anyone and from anywhere can participate in the Scientific Process, addressing and solving real-world problems in ways that may include:




- Formulating Research Questions
- Conducting various Scientific Experiments
- Collecting and Analyzing Data, Interpreting Result
- Developing Technologies and Applications

The concept of Citizen Science is not a new one (can be traced as back as the 1890s), but its efficacy has been monitored majorly in recent times. Citizen Science is in itself a breakthrough in conventional scientific research methodology, but the current COVID-19 situation makes it more important, especially for those who feel missing out on scientific work.

## *The Awesome Power of Citizen Science*

Citizen science has provided researchers with access to a vast resource of information while connecting enthusiasts to the authentic process of science. This citizen-researcher relationship creates an incredible alliance, allowing for the creation and analysis of research projects that would otherwise prove impossible in traditional research environments, namely due to the lack of needed human or financial resources.

The Goal of Citizen Science is to produce new and Legitimate Knowledge and develop new approaches and methods to tackle our problems. And so far, it has succeeded in this work as according to the Nature post "Data brief: Citizen science papers have more impact" articles published by citizen science projects are cited four times more on average than those that do not involve the public, albeit for a brief stint.

There are many success stories in almost all the fields of Science which involved the general public.

In 2007, the approach of involving Citizen during the epidemic of Influenza in Indonesia, prevented the loss of lives and fewer people got infected.

North American Breeding Bird Survey helped scientist to gather information about the population, migration pattern, effect of Climate change on them etc.

Amateur Astronomers of Exoplanet Explorer Project helped in finding K2-288Bb – a type of exoplanet considered rare so far, in the habitable zone from its star.

FoldIt players outperformed advanced computer algorithms for predicting protein structure and contributed to solving the crystal structure of the Mason-Pfizer monkey virus (M-PMV) retroviral protease.

## *What's in it for Citizens?*

Citizen Science helps in knowledge co-creation which ultimately benefits all of mankind. It has led to the Democratization of Science. But there are personal gains for citizens as well.

It is a fun way of doing Science which has space for amateurs as well as graduate Science students. It can be as easy as playing a computer game, or involve complex analytical and pattern solving skills. Citizens become holders of specific useful knowledge. It provides them the

opportunity to do real-time research, use experimental tools both virtually and physically, and do collaborations which sometimes awards them with a Scientific Publication as well! Citizens are benefitted with improved scientific literacy, honed observational and analytical skills, project-specific skills, etc. They can carry out multiple projects at the comfort of their homes, even do Interdisciplinary work, and gain important insights.

While you are encouraged to go on and find these exciting projects for yourself, here are some of the interesting ones which can act as a starting point.

**EteRNA** empowers Citizen Scientists to invent Medicine through molecular design in a fun and interactive way. You play by solving puzzles using RNAs, tiny molecules at the heart of every cell.

**SETI@home** is a scientific experiment, based at UCB that uses Internet-connected computers in the Search for Extraterrestrial Intelligence (SETI)

**Planet Patrol** is a new NASA citizen science project to find exoplanets.

**INaturalist** is built on the concept of mapping and sharing observations of biodiversity across the globe

### *The way forward...*

Even after finding new arenas for scientific research process, Citizen Science does have some drawbacks as well. Some of the challenges faced by large-scale Citizen Science Projects point towards the importance of consistent training, data consistency, and data reproducibility for efficacious use of the acquired data. Managing a large number of people, actively involving them at all possible stages, effectively conveying the general public about the actual goals of the project remain some of the troubling issues as well.

Regardless of their limitations, citizen-science projects have transformed the practice of science by making it available to the masses and giving them access to scientific methods, encouraging scientific literacy, and engaging the next generation of scientists early in their life.

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# PERSPECTIVES

*Ms. Lipi Jain, Research Scientist at Asian Paints*
*An IISER Pune Chemistry alumna who did her MS Thesis in Shell talks about being a research scientist in the industry*

Having pursued an industrial internship in SHELL, Lipi was much more accustomed to the industrial science as a field and had already established a useful industrial network to boost her career in the field. She learnt that the most important skill to exist in industry is networking and collaboration.

Being a team player is necessary and also the network established in one company mostly extends to other companies helping one to get jobs and move upwards through the ladder. Secondly, she learnt to be efficient after her initial year in her research projects. Companies expect one to stick to deadlines without extra hours in the labs or at work. Overtime as a researcher is highly unusual and questionable, so efficiency is the key to survival and maintaining a good reputation.

Working as research scientist in industry comes with its own risky as seen by Lipi. While her internship at SHELL, she came to know that security in a company for scientists is rare, as budgets are driven by company profits. To adapt to the volatile market, one has to go beyond pure intensive research and work on application of research in common market rather than the research itself. These are the areas where networking and communication skills come in handy. "Perhaps doing a management course can inch your career to administration which certainly is a good place to be".

Lipi works with many engineers in her research team and feels that as an IISER student she has much more relevant lab and technical skills along with in-depth knowledge, but that is what is required from her as a part of the team. Whereas the engineers look at the applications part of the project. Thus, there is very little direct competition as a research team requires specialists from different fields. Hence having multiple potentials and utility to

your employer is certainly an advantage. This can be achieved by looking up at relevant courses provided by some of the IITs that are applicable in industry and then pursuing such courses online. This practice is used by many industrial scientists nowadays irrespective of their field. Some of the popular skills are applicable knowledge of machine learning and programming as many companies are inching towards automation in their research departments.

Speaking of her transition, Lipi thinks that industrial MS thesis certainly is the best step to move to industry from an academic background. Apart from that, keeping an eye out for the intended job market is essential from the 3rd year onwards; wisely choosing electives and pursuing online courses. As she did, by focusing her academic internships and courseware around polymers and petrochemicals which are more industry relevant

*Dr. Omkar Jani*
*Director, Kanoda Energy Solutions (involved in solar energy projects and consultancy for companies)*
*B.Tech. (EE), Ph.D. (Photovoltaics), Georgia University*
*Worked as a scientist in GERMI*

Omkar, talking about his PhD experience in interdisciplinary sciences, reflects that learning the importance of keeping a wide perspective and gaining knowledge by communication from different backgrounds is something which has helped him a long way, especially in industry.

Now as an entrepreneur, he finds that he needs a greater knowledge of financial handling and applicable information regarding intellectual law. Apart from this, professional writing and his communications skill have proved to be much more of an asset than he had expected them to be, even prior to his becoming an entrepreneur, during his work as research scientist. Above all, Omkar believes that the correct ATTITUDE is utmost important to establishing a career in industry rather than academia and is often sought after by modern recruiters. He likes to go by the following acronym when judging a colleague.

*"ASK - Attitude › Skill › Knowledge"*

"The foremost thing to do while pursuing academics is to be in constant touch with the intended market and industrial needs and norms. Given the current trend of market, ability to program fluently in AI is a major advantage regardless of the field and degree of the candidate. Also, being able to handle large chunks of data and to make meaningful reports out of them, is something very useful in industry in today's age of search engines. For this, one need not have a certificate in data analysis but should have a sound logical background, however this can change from field to field.

*"Industrial applications require a specific set of thinking and logic which is intricately similar to that of pure academic sciences, but has nuances that are specifically appealing to many people I believe, including me. It depends much more on innovation and handling knowledge, than the knowledge itself."*

Speaking about the approach in industrial sciences, Omkar thinks scientists should have a wider adaptability and use to the company, like possessing additional humane skills like marketing and client communication, can prove to be some of the key factors in the forthcoming decade.

Many of his colleagues that are employed in academia pursue projects that might not be considered as main stream research opportunities. Much of their work caters directly to industrial applications or general citizens. For example- the research papers in waste management and energy solutions are not pure scientific and don't require intensive scientific knowledge, but creativity and innovation and also skills in application-based systems. There are many academics who are involved in such research projects, which draw industrial and government's attention.

"To a student planning his transition into applied sciences, such projects are the best starting point to relate his critical thinking to application-based ideas. Such types of projects have been undertaken by researchers and few of the professors in IITs and NITs."

# CAREER TREATS: DRUG RESEARCH

*A brief insight on the career opportunities in the field of pharmaceutical sciences*

Career opportunities for biochemistry majors are not just limited to academia. There is a lot of scope in the industry for application of chemistry and life sciences in practical scenarios. One such field is drug research and development. The field of drug discovery, R&D, and commercialization offers a plethora of job and career opportunities for graduates with a background of life sciences and/or basic sciences.

**Discovery and Development**

New insights about the disease and thereby new ideas on countering the effects
Detailed study of the properties of the promising compound for development

**Preclinical Research**

Checking for toxicity and safety
Detailed information on controlling dosage

**Clinical Research**

Studies of the ways the drug will interact with human systems
Clinical Trials (testing on selected people) and drug optimization based on observations.

**Review**

Review and examination of all submitted data from the previous trials by an authority before sanctioning approval for marketing of the drug in question

**Sales**

Drug manufacture and commercial marketing

The Drug Development Process

(Sources of information: "Stages of Drug Development" https://pacificbiolabs.com/stages-of-drug-development, "The Drug Life Cycle" https://www.intechopen.com/books/special-topics-in-drug-discovery/job-and-career-opportunities-in-the-pharmaceutical-sector, "The Drug Development Process" https://www.fda.gov/patients/learn-about-drug-and-device-approvals/drug-development-process)

### *Pharmacist vs. Pharmaceutical Scientist*

Pharmacists are directly involved in patient care and work with drugs that already exist. Pharmaceutical Scientists, on the other hand, are the ones who create new drugs and therapies and evaluate their effectiveness and safety.

### *Career opportunities along the way…*

Developing new drugs is a risky, expensive and time-consuming process. There are several career opportunities for pure science graduates throughout this cycle:

- **Discovery Research:** Includes collaboration of scientists from several disciplines
  - Biologists such as molecular biologists, biochemists, biotechnologists, bioinformaticians and biomedical scientists) who contribute to indentificaiton and manipulation of a viable target.
  - Chemists like medicinal chemists, analytical chemists and protein chemists to analyze and provide novel compounds as pharmacological probes, and chemical synthesis.
  - Pharmacologists, toxicologists, and other specialities from pharmacy. They deal with areas such as dosage, mode of action, metabolism, toxicity, etc.
- **Non-clinical Development:** All experiments not involving human subjects. It is an umbrella term for a collection of areas such as chemical and pharmaceutical development, non-clinical toxicology, safety experiments, etc.
  - Chemical and pharmaceutical development offers opportunities

for analytical chemists, chemical engineers etc. for drug manufacturing and analysis.

- Non-clinical efficacy, safety pharmacology and toxicology are more pharmacy based, but still offer scope for toxicologists, biomedical scientists.

- **Clinical Development:** It consists of all studies involving human subjects. Despite being a stage which requires more medical expertise, there are opportunities for individuals who are from the following fields.

  - Molecular biologists and chemists to assist in drug modification

  - Biostatisticians, data analysts and computer programmers for clinical data management and statistics.

## *The Suitable Candidate*

The field of pharmaceutical sciences typically focuses on a specific phase of the drug development cycle: discovery, optimization, pre-clinical testing, manufacture and evaluation.

Theoretically speaking, the pharmaceutical sciences are a promising avenue for biology and chemistry majors; however, the competition is cut-throat. There is a good chance for individuals whose research or area of expertise deals closely with topics relevant to pharmaceutical sciences.

That being said, while corporate R&D is mainly dominated by graduates/post-graduates of pharmacy, graduates with majors in disciplines like biology, chemistry, biochemistry, medicine, pharmacy, epidemiology, immunology etc. are suitable candidates for a career in pharmaceutical sciences and drug research.

## *What's new?*

Targeted drug delivery, sometimes also called smart drug delivery, is a way of administering the medication to a patient such that its concentration in some parts of the body is increased relative to others. Targeted drug delivery research is among the frontrunners in cutting-edge scientific research. The goal of targeted drug delivery is to prolong, localize, target, and have a protected interaction of the drug with the diseased tissue.

The foundation of this method rests largely in the field of nanomedicine, which uses

drug-loaded nanoparticles to target specific parts of the body which solely have diseased tissue, thereby avoiding any detrimental interaction with healthy tissue.

The advantage, therefore, is reduced frequency of dosage, uniform effect of the drug, reduction of side-effects and a more efficient regulation of drug levels in the system.

### *Contrast with Academic Research*

Drug discovery is unique in offering multiple career options that let one stay connected with science without necessarily going through the daily grind of laboratory life. A majority of drug discovery scientists are motivated by the change to discover a new medicine.

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# INTERSECTION

*This tiny blue speck of dust that we live on has come a long way since its inception. Some processes so ridiculously random happened to this slowly accumulating speck of dust that one's mere existence seems preposterous. But still, you're here now and the most logical thing to do is to cherish and salvage what we have. Enter: Environmental science.*

Environmental science is an interdisciplinary science that draws from ecology, geology, meteorology, biology, chemistry, engineering, and physics to study environmental problems and human impacts on the environment.

Environmental science came alive as a substantive, active field of scientific investigation in the '60s and '70s driven by the need for an approach to analyze complex environmental problems. The arrival of substantive environmental laws required specific environmental protocols of investigation and growing public awareness of a need for action in addressing environmental problems.

With tech behemoths such as big data and data sciences, you have the keys to a whole new kingdom! Data is central to environmental science with significant investments in techniques for managing a wide range of environmental data.

The data challenge is quite distinct from many fields of science with the most striking factor being the heterogeneity of the underlying data sources and types of data, hence the inappropriateness of the term "big data" in this field.

More specifically, data science is often annotated using the four "V"s of data: volume, velocity, variety, and veracity. While in many areas of data science, consideration of volume and velocity dominate, in the environment, variety and veracity (accuracy/precision) are the most important characteristics.

This is not to diminish the first two properties. There are areas with very large data sets, the processing of which can be challenging, e.g., in climate science; but this

only helps to exacerbate the issue of variety when considered alongside other data sources.

### *Data Science in Environmental Science*

The processes of environment are diverse and depend on various small, complex and interconnected phenomena. The data produced is heterogeneous. Each of these needs to be accounted for by some parameters and hence a unique model needs to be empirically developed for each. Earth System Modeling Framework (ESMF) or the OGC standard OpenMI (Open Modeling Interface), amongst many others, are attempts at integrating the study of rich variety of data sources, models, data with models, and most profoundly of disciplines to work together in interpreting the associated data and models to achieve new scientific insights through a new integrative science.

### *What are some of the opportunities in environmental science in the industry?*

What exactly is happening out in the world and what's there for someone aspiring to enter this field of work? With respect to the first question, there is an obvious urgent need for renewable and sustainable sources of energy. For what minor advancements that have come already, they are either not enough or what they yield is lesser than what they consume in terms of energy, capital, environmental health and natural resources.

As a result of this, there is whole new industry that has risen, based on the principles of optimization - because a dime for prevention is better than a pound of cure.

Mining and energy companies, both government and private (such as Energex and Sibelco) alike develop ingenious methods for reduction of energy consumption and monitoring world environmental health. They hire environmental science and earth science majors both with bachelors and post graduates, the latter having more specialized and better salaries. In such a day and age where there exists a pressing need for a pursuit of sustainability along with profitability, large multinationals such as Amazon, Google, Microsoft, IBM and a lot of Silicon Valley based companies are looking for environmental scientists and environmental consultancies to make their products eco-friendly and maximize their yields through different algorithms.

Such people need to be equipped with the different tools of data science such as programming across various languages, knowing and developing different modelling software and, of course, machine learning algorithms to optimize energy consumption

Then there are R&D departments for different nature related organizations such as EarthCheck, Schlumberger and National Geographic to name a few.

All in all, everything is linked to environment science because after all, nothing is alone in nature.

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# INTERNSHIP ACCOUNTS: INDIAN RESEARCH PROGRAMMES

*In conversation with Yash Palan and Sreepadmanabh M; their experiences of interning in India and opinions on importance of internships, along with other Indian programmes aiding research students.*

Summer or short term research training programmes organized by various Indian institutes and academic societies offer extremely valuable opportunities for students to gain internship experiences as well as financial and infrastructural aid for budding researchers to support their forays into science. In this article, we will be covering a few such promising avenues.

Internship portals are established platforms where students can apply to work under professional researchers by mentioning their area of interest. The IAS portal which is handled by the Indian Academy of Sciences, Bangalore, is one such portal for paid summer internships. As per the eligibility criteria, students from first three years of integrated M.S. or M.Sc. and second and third years of B.E. programs can apply. Applications are generally accepted in the month of November. Academic record and the statement of purpose (SOP) as submitted by the student are the criteria for selection.

"Your SOP is indeed important and talking to faculties helps a lot in refining it. As a matter of fact, the applications given through the IAS portal are screened by folks primarily handling administration and not by professors. Hence it is important to make it a point to strike a balance by using simple language while being descriptive about your specific area of interest which is as essential," adds Yash.

Many students get in direct touch over mail with professors across institutes on reading through their work, applying to work under them.

Sree, who had applied for an internship to a professor in IISc elucidates, "In my mail, I

had distinctly mentioned my interest in his lab's vision as first year is still far too early to get into specifics. I had also clarified that I wouldn't be requiring any financial support since I had a KVPY stipend."

It is important to keep an eye out for any announcements regarding research/ summer internship programmes formally introduced by individual institutes or organizations. This includes summer programmes in IISc, the VSRP (Visiting Students Research Programme) sponsored by TIFR, the summer internship programme of TIFR at the Mumbai campus and also in the National Centre for Radio Astrophysics NCRA, Pune and so on. RESPOND initiated by ISRO is aimed at encouraging academia to innovate and participate in the space research activities.

One of the most sought after paths for availing benefits offered by the government is by clearing the JRF (Junior Research Fellow) and SRF (Senior Research fellow) examination which is conducted twice every year. Clearing the exam benefits PhD aspirants with a monthly scholarship for four years, two as a JRF and two as an SRF.

Amidst the opportunities and the challenging competition, identifying your area of interest or the purpose of your work and being able to convey the extent of interest effectively is important at every stage, be it writing applications that demand an SOP, through the course of the project and lab work or taking subsequent follow ups regarding the project you got to be involved in.

*"Around the time of my internship, Dr. Bhushan Toley (the professor he was working under), was beginning an investigation on cancer biology and since I had indicated that I had an interest in learning about cancer, he advised me to go through the literature on it. We ended up writing a review paper, which was in the works for the better part of the year, even after the next semester resumed," says Sree.*

"I was considering microfluids as an area of interest for my second internship. Dr. Toley, who is a chemical engineer with interests in developing diagnostic devices was considering a collaborative project with Dr. Ramray Bhat who works mainly in areas of ovarian cancer and developmental biology. The project started off without much of a

clear definition and it was only in the last three weeks of my intern period that we saw some interesting results, which gave us confidence to pursue the project. I was convinced to continue the project the next year and get something concrete out of it."

What is crucial for good projects to build up is the coming together of likeminded people- in terms of purpose and passion! This in turn will lead to meaningful additions of good recommendations in your CV, making your future journey smoother. "It is always the healthiest approach to think from interest, work experience (internship) to CV," says Yash in response to, "What criteria must one keep in mind while choosing where to intern?"

*"The word student is etymologically derived from a Latin verb 'studere', meaning 'to direct one's zeal at'."*

It is important that we understand that the purpose of the internship exercise is exploring the subject and meeting people having similar interests.

"By the end of my third year, I had become of the opinion that experimental physics is just rotating knobs, waiting for the machine to do its work and finally noting down observations, which, to me, seemed very boring. However, watching the PhD students in our lab, work rigorously and passionately, improvising and developing newer ideas for achieving the best level of accuracy totally changed the earlier belief.

"A lot of informal conversations with my professor gave me insights regarding my own interests. This, I think, is the whole point of internships- you might not develop a very strong new knowledge base in the limited span of two months, but surely, you start to think differently," says Yash as he signs off.

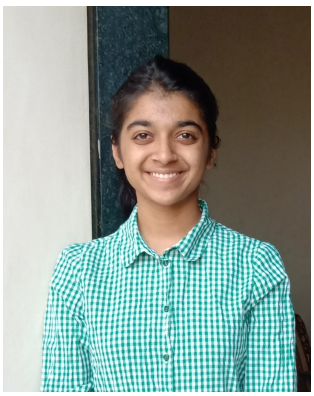
# THE CARMA MAY 2020 TEAM

*Anuprita Kulkarni*

Just a simple hooman vibin' with the universe. (also, Han shot first.)

*Bela Lodh*

Obsessed with to-do lists and planners. For me, the satisfaction of drawing perfectly round circles is unparalleled.

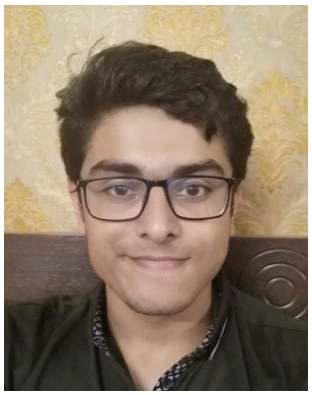


*Dhawal Patil*

Obsessed about details.

*Khush Dave*

Is a fan of critical analysis crafted from a neutral and broad minded perspective.

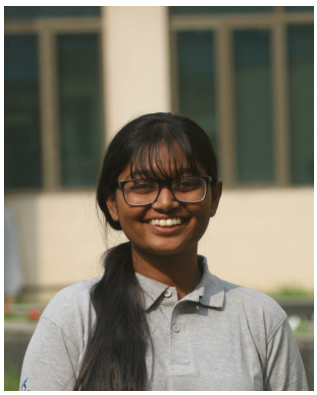


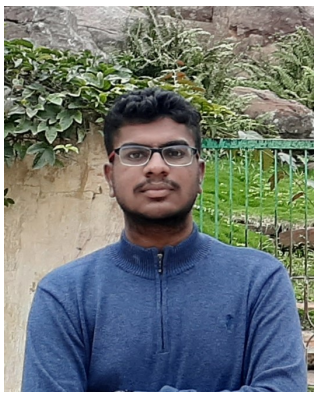
*Manas Dubey*

A nihilist, a hypocrite and a solemn exponent of 'wubba lubba dub dub'

*Sampurna Roychoudhury*

Whaddup I'm sami, I'm 19 and— /holds up v sign/





*Shubham Mulay*

Likes theories, storylines and anything that's well structured so as to experience different lives in one.

*Vatsalya Sharan*

Physics and Sports Enthusiast.
Fascinated by Nature and Human Mind.