

## PROFILE SPOTLIGHT – Careers in Microbiology

# Spotlight on... Emmanuelle Charpentier

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### Biographical summary



Emmanuelle Charpentier is a French microbiologist, geneticist and biochemist. She is a director at the Max Planck Institute for Infection Biology in Berlin, Honorary Professor at Humboldt University, visiting professor at Umeå University and recipient of an Alexander von Humboldt Professorship. Prior to her current appointments, she worked at several other institutions in Germany, Sweden, Austria, the USA and France. Emmanuelle Charpentier's research on a bacterial immune system laid the foundation for the groundbreaking CRISPR-Cas9 genome engineering technology. She has received numerous prestigious awards and distinctions, and is an elected member of several renowned academies of sciences. She is a co-founder of CRISPR Therapeutics and ERS Genomics.

### Q: What is your current research addressing and what impact may this research have on the wider field?

Our laboratory investigates fundamental mechanisms of regulation in processes of infection and immunity with a focus on Gram-positive bacterial human pathogens. We are interested in understanding how RNAs and proteins control cellular processes on the transcriptional, post-transcriptional and post-translational level. We study regulatory RNAs and proteins in various biological pathways such as horizontal gene transfer, adaptation to stress, physiology, persistence, virulence, infection and immunity. In particular, we do research on interference systems in the defence against genetic elements

(CRISPR-Cas), on small regulatory RNAs that interfere with pathogenic processes, on protein quality control that regulates bacterial adaptation, physiology and virulence, on basic principles of DNA replication and its role for life and on bacterial and vesicular interactions with host innate immunity.

It is critical to support research in this area. Only a greater understanding of the fundamental regulatory mechanisms in pathogens will allow us to effectively develop novel biotechnological tools and strategies to combat infectious diseases. A prominent example of the successful application of our research is the development of the CRISPR-Cas9 gene editing technology, which arose from our study of the CRISPR-Cas immune system in the human pathogen *Streptococcus pyogenes*.

### Q: What made you decide on a career in microbiology? Who or what had the most positive influence on your career?

The early phases of my undergraduate studies were quite general—basic biology at first, and then biochemistry and chemistry. I became interested in microbiology at a later stage of my undergraduate studies, and therefore decided to perform my Master's thesis at the Pasteur Institute in Paris. When I told my mother that I had chosen the Pasteur Institute as the host lab for my master, she actually told me that, at the age of about 12 years, I came back from school and said that I would work at the Pasteur Institute one day. So perhaps my interest in microbiology started earlier than I thought. My projects during my master's and PhD thesis combined medical microbiology and the genetics of traits such as of antibiotic resistance. I felt a strong attraction to this field, not only because of its importance given the rapid emergence of antibiotic resistance at the time but also because I simply enjoyed the process of experimentation, from planning to execution and analysis. I felt at home in the lab. Already during my master's thesis, I was

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given a lot of independence and responsibility for my projects. Looking back, I think this had a very positive influence on my career because I identified myself very early on as a scientist rather than a student—as someone creating knowledge rather than simply absorbing it. It seems small, but this change of mind set made me more curious and perceptive of the qualities and career paths of the established scientists at the Pasteur Institute. I was inspired by their enthusiasm and advocacy of basic research in microbiology. I also realised that many of them had done research abroad, and I thought I might also benefit from a change in perspective. Mobility has since become a defining feature of my career, and I have been fortunate to have many inspiring mentors and colleagues along the way. I have learned something special from every one of them.

**Q: What do you consider to be the most important skills for a microbiologist?**

Evolution and a strong pressure to adapt to dynamic and often hostile environments have given rise to enormous and largely uncharted diversity in species and mechanisms in the microbial world. What you expect from one species, strain or condition might not hold true in another. Therefore, I think it is especially important for microbiologists to be observant and open minded. As Pasteur said, 'chance favours the prepared mind'. Microbiologists need to be prepared for the unexpected. The diversity in the microbial world is a huge opportunity for our field, especially given the methods that are now available to explore it. There are certainly many interesting mechanisms and phenomena that remain undiscovered and could be harnessed for novel antimicrobial strategies and biotechnological tools. More generally, I think independence, resilience and curiosity are important qualities for all scientists.

**Q: What advice would you offer to early-career researchers in microbiology to help further their career? What is the best advice you can give for maintaining the work-life balance?**

I think it is important to surround yourself with people who share your level of ambition and your enthusiasm for science. This is something I really came to appreciate during my time as a post-doctoral researcher in the USA. During that time, I met so many researchers there who loved what they were doing and wanted to achieve something major for themselves and for science. These were people who saw science as their vocation. Research was a fundamental part of their life. Sometimes I have the impression that this degree of passion for science has fallen out of mode. I do not know why, but it did coincide with the popularisation of the unfortunate misnomer 'work-life balance'. This term seems to suggest that 'work' is not a part of 'life' and that the two rather oppose one another and compete for time

and attention. But work or a vocation is a part of life, and if you find the right occupation, it can bring a lot of happiness and satisfaction. Likewise, maintaining your personal life, family and health is fulfilling but can also be an immense amount of work. This being said, no matter how much you may love what you are doing for a living, one should not let work completely eclipse all other aspects of life. Every scientist needs to find their own way to achieve a sustainable equilibrium between the personal and professional aspects of their life. I think it is important for all scientists, and especially for those who are very passionate about their research, to have other activities and outlets. In a lot of cases, the best ideas come when you are out of the office or away from the bench, and the most valuable results are often produced at odd hours spent in the lab.

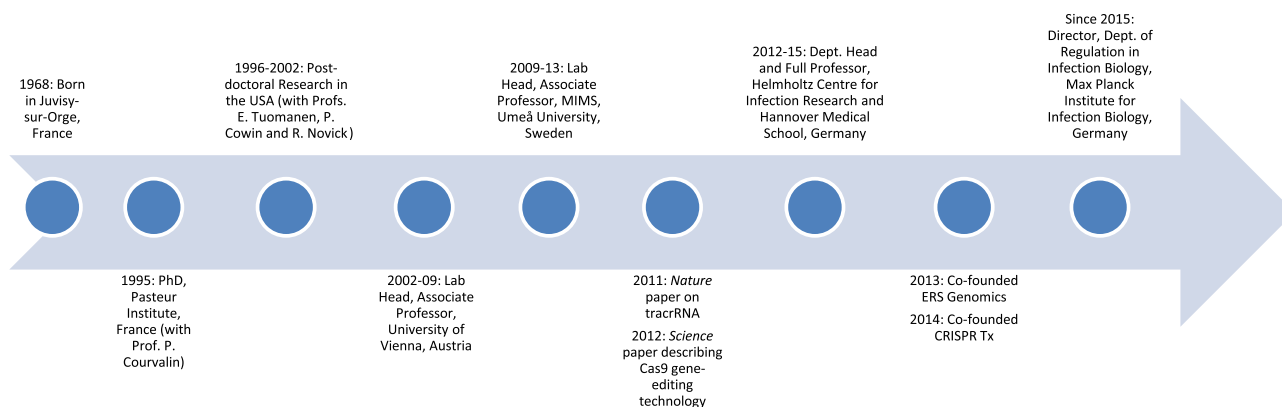
**Q: What would you say is the greatest challenge facing microbiologists today?**

In my opinion, there are several. In order to ensure that research in microbiology receives the funding it needs, microbiologists need to advocate for and to be aware of the achievements and enormous potential of this field. Tools and methods that have revolutionised the life sciences, including PCR, restriction enzymes and programmable nucleases like Cas9 would not have been possible without fundamental research in microbiology. Metagenomics has revealed that a large percentage of sequences in microbial communities are completely unknown to scientists, so there is a treasure trove of mechanisms and new tools yet to be discovered in the microbial world. Research on the basic biology of microbes has also led to many effective treatments against infectious diseases that pose a great risk to human health and the economy, as recently highlighted by a high-level meeting of the United Nations. It is our responsibility as microbiologists to lead the way in developing novel and durable strategies to combat infectious diseases.

### Overall experience as a microbiologist

Recently, I have had to take on a lot of responsibilities related to the CRISPR-Cas9 discovery, and this sometimes keeps me from spending as much time on my research as I would like. But overall, I feel very fortunate to be a microbiologist. It has been a very rewarding career path. When I was a post-doctoral fellow in the USA in the late 1990s, I felt privileged to work in the field at the time when the first complete sequences of bacterial genomes were released. In fact, I think that starting a career in microbiology today is even more exciting. There is so much of the microbial world that remains uncharted.

**Conflict of interest.** None declared.



## Important Publications

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