

Editorial

# Women in Bioorganic Chemistry

Francesca Cardona <sup>1,\*</sup> , Camilla Parmeggiani <sup>1,2</sup> and Camilla Matassini <sup>1</sup> 

<sup>1</sup> Dipartimento di Chimica "Ugo Schiff" (DICUS), Università di Firenze, via della Lastruccia 3-13, 50019 Sesto Fiorentino, Italy; camilla.parmeggiani@unifi.it (C.P.); camilla.matassini@unifi.it (C.M.)

<sup>2</sup> European Laboratory for Non Linear Spectroscopy (LENS), via Nello Carrara 1, 50019 Sesto Fiorentino, Italy

\* Correspondence: francesca.cardona@unifi.it

We are very happy to present this Special Issue, for which we acted as guest editors, and which includes scientific contributions from laboratories headed by women active in the field of bioorganic chemistry.

We made the decision to undertake this project since we deem that there are still gender biases that put women at a slight disadvantage when disseminating their research, preventing the science community from benefiting from a wider diversity of voices. The issues related to the gender scissor and the leaky pipeline that can be observed with career advancement in the academy, especially in the field of STEM disciplines, deserve our attention and the efforts of all of the scientific community to mitigate the gender gap. In order to embrace gender equality, recognize the career progression of women, and to celebrate the achievements of women in the field of bioorganic chemistry, we present in this Special Issue contributions both from highly renewed woman scientists and young woman researchers who are undertaking their early-stage careers.

This Special Issue includes fifteen manuscripts, among which eleven high-quality research articles and four comprehensive review articles in the area of bioorganic chemistry, published from mid-2020 to early 2022.

The scope of the Special Issue covers a wide range of topics at the organic chemistry-biology interface, including the synthesis and derivatization of natural compounds and their analogues, and the investigation of their biological activities in the human health field (for instance as antitumoral, antioxidants and antimicrobial agents) as well as their possible application in the crop protection field as agrochemicals. An example of nanoparticle-based biomaterial is also included. The techniques employed, besides organic synthesis, are in silico studies (docking procedures and molecular modeling), FT-IR spectroscopy, laser diffraction, PET, fluorescence, STD-NMR studies, enzymatic evaluation, experiments on cell lines, and in vivo studies on mice.

Cardona, Matassini and co-workers, from Sesto Fiorentino, Italy, reviewed the properties of carbohydrate-based natural compounds and other sugar mimics as trehalase inhibitors, in view of their potential use as non-toxic and therefore greener and safer pesticides [1].

Within the same field of agrochemicals, Dell'Oste, Spyrakis, Prandi and co-workers from Torino, Italy, described that strigolactones (SG), a class of sesquiterpenoid plant hormones, play a key role in the plants' response to biotic and abiotic stress. In addition, the authors highlighted the possibility that in the next future these compounds might have an application also in human health, and in particular in the control pathways related to apoptosis and inflammation (and therefore as anticancer and/or antimicrobial agents) [2]. Terpenes have a number of other different biological applications, as reported by the authors of this Special Issue. Zhan and co-workers, from Guangzhou, China, showed that the natural compound betulinic acid (BA), a pentacyclic triterpene widely distributed in nature, behave as a non-competitive inhibitor of  $\alpha$ -glucosidase, showing a synergistic effect with acarbose, which is known for its use for alleviation of post-prandial hyperglycemia. The authors also performed molecular docking and molecular dynamics simulation and



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some preliminary *in vivo* experiments on mice [3]. Mazzon and co-workers, from Messina, Italy, reported on the numerous studies supporting the great properties of cannabidiol (CBD), a terpenophenol natural compound, for the management of neurological disorders (such as epilepsy, Alzheimer, multiple sclerosis and Parkinson), due to its antioxidant, anti-inflammatory, antidepressant, anxiolytic, anticonvulsant and antipsychotic properties. The biochemical and molecular mechanisms underlying the effects of CBD show that a multi-target mechanism of action takes place [4]. Nesterkina and co-workers from Odessa, Ukraine studied, with the aid of different techniques (FT-IR, laser diffraction, fluorescent measurements), the impact of terpenoids-based hydrazones on the molecular organization of lipid matrices using model liposomes based on lecithin or cardiolipin phospholipids, as well as lipids isolated from rat strata cornea [5].

Triterpenes are biosynthetic precursors of steroids, which are an important class of both natural and synthetic products. Volkova and co-workers from Moscow, Russia, described the synthesis of D-annulated pentacyclic steroids based on a regioselective interrupted Nazarov cyclization with trapping chloride ion, and evaluated the antiproliferative activity of the synthesized compounds against two breast cancer cell lines [6].

The interest in the design and synthesis of novel anticancer therapeutics is also present in the manuscript by Beloglazina and co-workers from Moscow, Russia, who reported the synthesis of a series of S-, O- and Se- containing dispirooxindoles through 1,3-dipolar cycloaddition of azomethine ylides, assayed their cytotoxicity against different tumor cell lines and performed an *in silico* study to rationalize the results [7]. The group of Simone and co-workers from Callaghan, Australia, reported the synthesis, glycosidase inhibition and anticancer properties of highly chlorinated benzamide analogues bearing a boron-pinacolate ester group, with the perspective to use them in boron neutron capture therapy (BNCT) [8].

Sattin and co-workers from Milano, Italy, described, through virtual screening accompanied by STD-NMR studies, a structure-based approach to find new chemotypes able to target (p)ppGpp (guanosine tetra- or penta-phosphate) signaling, in view of overcoming antimicrobial resistance [9]. The issue of antimicrobial resistance was also addressed by the group of Grosdemange-Billiard and co-workers from Strasbourg, France, who synthesized fluorinated analogues of the natural compound fosmidomycin and tested them as *E. coli* 1-deoxy-D-xylulose 5-phosphate reductoisomerase (DXR) inhibitors as well as antimicrobial agents against *E. coli* on Petri dishes [10]. Pathogenic *E. coli* infection and food/water contamination by this pathogen was also the object of the article by Wu and co-workers from Nanchang, China, who designed and synthesized a  $\beta$ -galactosidase-activatable fluorescent probe (BOD-Gal) for the detection of this pathogen [11].

The process of microbial attack on dental enamel and the potential approaches for dental remineralization were described by Brimble and co-workers from Auckland, New Zealand, who highlighted the importance of the amelogenin protein and the efforts made by the researchers in the identification of the key structural motifs of this protein that enable dental remineralization, as well as the rational design of synthetic polypeptides for this aim [12].

Integrin  $\alpha_4\beta_1$  belongs to the leukocyte integrin family and represents a target of relevant therapeutic interest due to its role in mediating inflammation, autoimmune pathologies and cancer-related diseases. With the aim of discovering new compounds potentially able to recognize integrin  $\alpha_4\beta_1$ , Battistini and co-workers from Parma, Italy synthesized, through solid phase procedures followed by *in-solution* cyclization steps, seven new cyclic peptidomimetics bearing a 4-aminoproline core scaffold, and evaluated them in cell adhesion assays on Jurkat cells [13].

In the field of bionanomaterials, the Special Issue shows an example by Bodlenner from Strasbourg, France, and Matassini from Sesto Fiorentino, Italy, who reported the synthesis and biological evaluation as Jack Bean  $\alpha$ -mannosidase inhibitors of hybrid multivalent glyco gold nanoparticles decorated with deoxynojirimycin inhibitors, among the best known glycomimetics in the field of glycosidase inhibition. The authors found a strong

enhancement of the inhibitory activity consequent to the multivalent presentation of the inhitope [14].

Lastly, chirality is one of the most crucial aspects of nature and is of paramount importance in the area of bioorganic chemistry, and axial chirality represents an intriguing aspect of chirality itself. Viglianisi and co-workers from Sesto Fiorentino, Italy, developed an efficient chemical resolution of racemic aza[4]helicenes, interesting building blocks for the production of materials with chiroptical properties, using enantiopure camphanic acids as resolving agents [15].

We want to finish this Editorial by thanking again all of the authors who come from three different continents, namely Europe, Asia and Oceania, for having illustrated so well the importance of bioorganic chemistry in their contributions to this Special Issue.

A list of short biographical sketches of the authors, together with the description of the obstacles/challenges encountered during their career, or suggestions to a young woman keen to become a successful scientist in the field of bioorganic chemistry, follows in the Reference section.

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**Acknowledgments:** We thank the women researchers who kindly provided us their profiles and photos for the preparation of this manuscripts.

**Conflicts of Interest:** The authors declare no conflict of interest.

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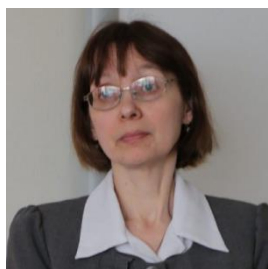
### Short Biography of Authors Who Contributed to the Special Issue



**Lucia Battistini** (Department of Food and Drug, University of Parma, Parco Area delle Scienze 27/A, 43124 Parma, Italy). Research interests: The main focus is on the development of new classes of peptidomimetic ligands for molecular recognition and their use for biomedical applications. *Molecules* **2021**, *26*, 6066; doi.org/10.3390/molecules26196066.

#### **What is the most important challenge for a woman working in the field of bioorganic chemistry?**

*One of the most challenging issues for a bioorganic chemist (not just for a female scientist) working in a field that lies at the interface between different disciplines (chemistry, biology, medicine, etc.) is to create the best empathic and collaborative atmosphere in the working group, and fully recognize and value the originality and creativity within each contribution. I believe that women leading research groups owing to their empathy and sensitivity have a step ahead to contrast stereotypes, unconscious biases, and prejudices that sometimes spoil the teamwork.*



**Elena Beloglazkina** (Department of Chemistry, Lomonosov Moscow State University, Leninskie gory 1-3, 119991 Moscow, Russia). Research interests: organic synthesis, biologically active organic compounds, organo-chalcogen compounds, metal complexes with organic ligands. *Molecules* **2021**, *26*, 7645; doi.org/10.3390/molecules26247645.

#### **What are your suggestions for a young woman keen to become a successful scientist (in the field of bioorganic chemistry)?**

*Do not be afraid to take on something completely new for your and do not give up in case of possible failures. Patience and interest in what you are doing sooner or later will yield results. It will not always be the same as you expected when starting your research, but that's the charm of our work.*



**Anne Bodlener** (Laboratoire d'Innovation Moléculaire et Applications UMR CNRS 7042-LIMA | ECPM), University of Strasbourg, 25 Rue Becquerel, 67087 Strasbourg, France). Research interests: bioorganic chemistry, interactions between small molecules and enzymes, multivalency, carbohydrates and glycomimetics. *Molecules* **2021**, *26*, 5864; doi.org/10.3390/molecules26195864.

#### **What is the most important challenge for a woman working in the field of bioorganic chemistry?**

*As a woman researcher in chemistry, an important challenge was to find my own balance between research, teachings and personal life, as I wish to spend as much quality time with my son as possible.*

#### **What is the secret of being a successful female bioorganic chemist?**

*I found that being well-organized, defining clear objectives at work, and being in harmony with my priorities works well for me. My tasks being essentially intellectual, sport and nature also help me to find my physical and intellectual balance, which is necessary to raise enough energy to tackle all challenges. I am also very lucky to have a supportive partner who is actively involved in the daily running of things.*



**Margaret Brimble** (School of Chemical Sciences, The University of Auckland, New Zealand). Research interests: Synthesis of bioactive natural products, antimicrobial peptides, antiviral peptides, lipopeptides and glycopeptides. Peptide based vaccines and adjuvants. *Molecules* **2020**, *25*, 4214; doi.org/10.3390/molecules25184214.

**What are your suggestions for a young woman keen to become a successful scientist (in the field of bioorganic chemistry)?**

*I didn't realize that to be a scientist you have to be able to multi-task exceptionally well. There are so many things that need to be written—grants, reports, papers, patents, marketing material, references, reviews, outreach material, teaching material etc. These tasks are endless and I wish I could write quicker. I did organic chemistry since I liked doing things in the lab and not writing! The best thing to succeed is to remember you can't do it alone and you are only as successful as the people who work alongside you in your team. Take each day in your stride and seek out like-minded people as your team members and collaborators. Remember you only learn from setbacks and making mistakes and rise above the intimidating bravado that many of your colleagues are good at displaying. A lot of it is hype! Doing good science always takes time and a lot of hard work.*



**Francesca Cardona** (Dipartimento di Chimica "Ugo Schiff" (DICUS), Università degli Studi di Firenze, Via della Lastruccia 3-13, 50019 Sesto Fiorentino, Italy). Research interests: Stereoselective syntheses of iminosugars as glycosidase inhibitors and/or pharmacological chaperones for lysosomal enzymes, green chemistry. *Molecules* **2020**, *25*, 3013; doi.org/10.3390/molecules25133013.

**What are your suggestions for a young woman keen to become a successful scientist (in the field of bioorganic chemistry)?**

*The greatest challenge I had to face up during my career has been how to conciliate my passion in bioorganic chemistry with my private life. I love being a scientist and I also love being a mother. The secret? Not being too individualist! In my personal experience, the secret for being a quite good scientist and a quite good mother (as I hope to be) has been to create a good team, instead of just running alone.*



**Valentina Dell'Oste** (Dipartimento di Scienze della Sanità Pubblica e Pediatriche), Università degli Studi di Torino, Via Santena 9, 10126 Torino, Italy). Research interests: Virus-host interactions, screening and characterization of new antiviral molecules, antiviral immunity. *Molecules* **2021**, *26*, 4579; doi.org/10.3390/molecules26154579.

**What are your suggestions for a young woman keen to become a successful scientist (in the field of bioorganic chemistry)?**

*I strongly believe that to become a successful scientist, but more generally, to reach your professional goals, you need to apply three critical rules: perseverance in work and study, to be multitasking, and favor teamwork. Remember always that your colleagues and your family are your best allies! Then, try to be always open to new experiences, since just in this way you can improve your knowledge and transfer it to the work.*



**Catherine Grosdemange-Billiard** (Chemistry), Université de Strasbourg/Institut de Chimie, 4, rue Blaise Pascal, 67081 Strasbourg, France. Research interests: Development of novel and unexplored types of antibacterial drugs by synthesizing MEP pathway protein inhibitors as well as small molecules involved in the intra- and inter-species mechanisms of bacterial communication. *Molecules* **2021**, *26*, 5111; doi.org/10.3390/molecules26165111.

**What are your suggestions for a young woman keen to become a successful scientist (in the field of bioorganic chemistry)?**

*Trust yourself and your passion for biomolecules and organic chemistry. Never give up but persevere the work you believe in and face obstacles with the right tools and by joining forces with scientist of other disciplines. Turn negative experiences into positives one. Share your knowledge and pass on your passion to the young scientists for keeping you inspired.*



**Camilla Matassini** (Department of Chemistry “Ugo Schiff”, DICUS), University of Florence, Via della Lastruccia 3-13, 50019, Sesto Fiorentino, Firenze (Italy). Research interests: nitrogen-containing glycomimetics; new oxidation methods, multivalency; gold glyconanoparticles; glycosidase inhibitors; lysosomal enzymes; pharmacological chaperones; Gaucher–Parkinson relationship. *Molecules* **2021**, *26*, 5864; doi.org/10.3390/molecules26195864.

**As a women chemist, which obstacles did you encountered in your career, and how did you face them?**

*In my experience, most of friends and relatives knew very little (and were even wary), about an academic career, especially a scientific one. When I had my PhD fellowship my mother told me that I had been very good convincing people to pay me for studying . . . However, I think that my passion for the laboratory life, my enthusiasm for chemistry and my curiosity for its application to biomedical issues, eventually convinced them that being a scientist was a real job! An added value? Being surrounded by inspiring and motivating mentors and colleagues.*



**Mariia Nesterkina** (Drug Design and Optimisation, Helmholtz Institute for Pharmaceutical Research Saarland, Campus E8.1, 66123 Saarbrücken, Germany). Research interests: Chemistry of natural compounds, investigation of penetration enhancers, pharmacology. *Molecules* **2022**, *27*, 206; doi.org/10.3390/molecules27010206.

**What is the secret of being a successful female bioorganic chemist?**

*As usually in science, success consists of 99% hard work and 1% luck. Bioorganic chemistry is no exception in this regard—you can spend several months in the laboratory synthesizing novel compounds that in the end were revealed as biologically inactive. Then a new path begins, new ideas and hypotheses are put forward needed to be experimentally confirmed. However, we understand the ultimate goal of our scientific research and its significance both for fundamental and applied investigations. Enthusiasm and inspiration for new discoveries and their potential importance to human society are the main incentives for success in bioorganic chemistry.*



**Cristina Prandi** (Department of Chemistry), University of Turin, via P. Giuria 7, 10125 Torino). Research interests: organic synthesis in non-conventional media, organometallic chemistry, synthesis of natural compounds. *Molecules* **2021**, *26*, 4579; doi.org/10.3390/molecules26154579.

**Have you ever felt disadvantaged in being a woman in your research field?**

*I have always felt that I would have to work much harder than my male colleagues to get the same recognition from the academic and scientific community, especially after the birth of my daughters. But, in the end, this turned out to be an advantage. I learned the value of time, to be more efficient and to combine family life with my role as a scientist.*



**Sara Sattin** (Dipartimento di Chimica), Università degli Studi di Milano, via C. Golgi, 19, 20133 Milano, Italy). Research interests: design and synthesis of small molecules tailored to interact with specific protein targets (host and pathogen receptors and enzymes mediating pathogen adhesion, virulence and bacterial persistence). *Molecules* **2022**, *27*, 3097; doi.org/10.3390/molecules27103097.

**What is the most important challenge for a woman working in the field of bioorganic chemistry?**

*I think the most important challenge I faced has been networking with peers and senior academic members of both organic chemistry and neighbouring fields. For instance, when I was already assistant or associate professor I often found myself in situations (e.g., conferences) where colleagues just assumed I was a student or a postdoc at most, rarely including me in relevant scientific or decision-making conversations. Women scientists should be more proactive in creating collaborative networks and advocating for female colleagues at all career levels.*



**Michela Simone** Newcastle, CSIRO Energy Centre, CSIRO, 10 Murray Dwyer Court, Mayfield West, NSW2304, Australia. Previously in: Discipline of Chemistry, University of Newcastle, Callaghan, NSW 2308, Australia and Priority Research Centre for Drug Development, University of Newcastle, Callaghan, NSW 2308, Australia. Research interests: carbohydrate chemistry, synthetic organic chemistry, medicinal and bioorganic chemistry, nuclear magnetic resonance, carbohydrate active enzymes, heterocyclic chemistry, renewable energy technologies. *Molecules* **2022**, *27*, 3447; doi.org/10.3390/molecules27113447.

**What is the secret of being a successful female bioorganic chemist?**

*I want to acknowledge the huge role my mother and my grandmother played in introducing me to scientific thinking and natural phenomena since I was a child. They also encouraged me to pursue excellence in everything I do. I owe them so much of what I have achieved, both in my private and public life. I found that the most important factors to being successful are a constant, ethical and honest approach to pursuing excellence, hard work, steadfast optimism, patience, good mentoring and cultivating fruitful relationships with a plethora of colleagues. Seek advice relentlessly, listen to all advice, read up as much as you can, but - at the end of the day - do your own thing, follow your instincts, be mightily proactive and do so fearlessly. It's difficult, but it's the only way forward. The other crucial message is: you don't have to choose between having a career and having a family. You can have both, if you want. There are no right or wrong times. It all comes down to how you manage what happens. Embrace anything that happens, be proactive, find ways of managing tough situations. Define your own success. Don't be afraid to restart from scratch (I have done so several times). Focus on the most important aspect of life: human relationships (especially with the children in your care).*



**Francesca Spyrakis** (Department of Drug Science and Technology), University of Turin, Via Giuria 9, 10125, Turin, Italy. Research interests: Drug Design. *Molecules* **2021**, *26*, 4579; doi.org/10.3390/molecules26154579.

**What is the most important challenge for a woman working in the field of bioorganic chemistry?**

*According to my opinion and personal experience, the most important challenge I found, and I still find, has been combining the professional life and commitments with the family ones. In other words, finding the right time to spend with my daughter and my partner. In the years I have learned to optimize time and to handle only fundamental commitments, while delegating the other ones. Also, I have found very smart collaborators, who help me in handling the research and teaching activities. Time is always short, when you are enjoying, but now I can get the best of it!*

**What are your suggestions for a young woman keen to become a successful scientist (in the field of bioorganic chemistry)?**

*To young women willing to become scientists I would recommend to never give up! Even when things seem to be going wrong, there is always an opportunity around the corner. The important is to be ready to catch any occasion and not be scared to get in the game!*



**Caterina Viglianisi** (Dipartimento di Chimica "Ugo Schiff" (DICUS), Università degli Studi di Firenze, Via della Lastruccia 3-13, 50019 Sesto Fiorentino, Italy). Research interests include redox chemistry with design and synthesis molecular, macromolecular and nano-supported antioxidants and the study of their potential applications in the medical field and new materials. A further research area is the synthesis and evaluation of the optoelectronic properties of condensed heterocyclic systems. *Molecules* **2022**, *27*, 1160; doi.org/10.3390/molecules27041160.

**What is the secret of being a successful female bioorganic chemist? What are your suggestions for a young woman keen to become a successful scientist (in the field of bioorganic chemistry)?**

*A young chemist must always remember that becoming a successful scientist requires countless hours of work, although we are in the exciting world of discovery, so work hard and enjoy your job!*



**Yulia Volkova** (Laboratory of Steroid Compounds, N. D. Zelinsky Institute of Organic Chemistry, Russian Academy of Sciences, 47 Leninsky prosp., 119991 Moscow, Russia). Research interests: Design and synthesis of novel heterosteroids promising as anticancer agents against hormone-dependent cancers such as breast and prostate cancer. *Molecules* **2020**, *25*, 3499; doi.org/10.3390/molecules25153499.

***What is the most important challenge for a woman working in the field of bioorganic chemistry?***

*Women were legally allowed to pursue careers in science just over 100 years ago. Having received new opportunities, women retained the old responsibilities. Today the main challenge women scientists' face is to find a work-life balance. The social burden of raising children and running a household in many countries is still regarded as predominantly female. Many women scientists are forced to take a break from their work or significantly reduce their work hours due to the above responsibilities. On this account, women in science are flexible, highly efficient, multitasking, and the able to quickly rearrange themselves.*



**Janis Ya-xian Zhan** (School of Pharmaceutical Science, Guangzhou University of Chinese Medicine, Guangzhou University Town Waihuan East Road No. 232, 510006 Guangzhou, China). Research interests: Traditional Chinese medicine pharmacology, traditional Chinese medicine molecules, oxidative stress, immune inflammation, aging, environmental chemistry, pharmacokinetics. *Molecules* **2022**, *27*, 2517; doi.org/10.3390/molecules27082517.

***Have you ever felt disadvantaged in being a woman in your research field?***

*As a female scientist, I am full of enthusiasm and interest in my research field. In the course of my research, I encountered many difficulties and setbacks. But fortunately, I have not been treated unfairly since I am a woman. Many colleagues and friends around have given selfless help and care. This makes me stick to my own research path and make continuous progress.*