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ANTIBIOTICS AND BACTERIOCINS:

TWO TYPES OF ONLY SLIGHTLY DIFFERENT SUBSTANCES

Bacteriocins, basically, are proteinaceous molecules which, from an evolutionary point of view, are part of those substances that the bacterial world always employs to attack and defend. So from this point of view, they are not very different from the more well-known antibiotics with whom they also share another feature, that of being defined secondary metabolites. Just as in plants environmental stress conditions are the main cause for cells to produce secondary metabolites (polyphenols and terpenes, alkaloids, etc. are all secondary metabolites produced by plants primarily for defence), also in the bacterial cell stress induces or amplifies the production of secondary metabolites, primarily for defence scopes. It is not by chance that, for example, the same antibiotics are produced when the growth of the colony is in a stationary state due to, for example, lack of habitable space or scarcity of nutrients or the contemporary neighbouring growth of a different colony with which to be in environmental competition. But to attack and to defend itself, the colony must communicate. Communication, in fact, allows it to decide how to coordinate the defence and when to launch the attack. In order to be successful, aggression and defence must be coordinated through communication. Although it may seem trivial, it is useful to remember that prokaryotes and micro-organisms in general have no eyes to see or voice to be heard or hands to signal or even fingers to count themselves. In the single-cell world communication, absolutely necessary to organise a valid defence or launch a successful attack, resorts to "signal molecules", precisely to bacteriocins. These, in addition to having antibiotic-like valence, also work as signals defined by specific quorum sensing. Note how also in the legal field quorum is the minimum numerical value necessary to make a decision. Once they have reached

the quorum, bacteria can take to alternative decisions: attack or defence. But to delve definitively into the world of bacteriocins, we must consider the great similarity of the roles of antibiotics and bacteriocins. One might wonder if they are not basically the same thing. Both are of microbial origin and possess an antibacterial action and, a certainly lesser known fact, both are involved in the communication network between microorganisms. Both groups of substances share entirely the antibiotic purpose and fundamental role in quorum sensing. Between the two, however, there are also important differences. In particular, the action spectrum is widened for antibiotics and restricted for bacteriocins. Also the chemical structures are different. Although both belong to the so-called "secondary metabolites" which are produced by bacteria under environmental stress, all bacteriocins have exclusively protein structure while antibiotics often feature molecular structures of a non-peptide type. Therefore, to establish whether or not they belong to the same pharmacological class, we must look at evolutionary issues and dwell mainly on the peculiar aspect of the diverse range of their action spectrum. Why is the antibiotic action of bacteriocins so restricted and so dependent on the ecological niche? Why is it not widely spread like that of antibiotics? There are many possible answers, but just one is most likely. Most probably antibiotics evolved before bacteriocins, when the environments were less varied. Bacteria are in fact billions of years old and were around long before the plant and animal worlds developed into what we know today. The primordial environment did not provide the environmental varieties we know today, so rich in substrates like animal and plant tissues. So not necessarily the antibiotic action had to be environment-restricted. There were few environments to which to conform. At this stage, evolution forms what we call antibiotics. With the appearance of animal and plant tissues, the number of possible ecological niches increased exponentially determining, as a priority, the need for specific antimicrobial action in a given environment. So this appears to be the evolutionary purpose of bacteriocins. We can use them today for prophylaxis turning to antibiotics as treatment. Let us see how and why.

CURRICULUM VITAE PROF. FRANCESCO DI PIERRO

Biologist, pharmacologist and PhD in immunology, he was born in Turin on February 20 1967. Author of more than 400 popular science articles, more than 130 of a technical-specialistic nature and about 50 industrial patents, he is a lecturer at several Italian Universities (Camerino, Milan, Pavia) concerning the teachings of nutraceutical, phytotherapeutic and biopharmaceuticals circles. Member of the scientific editorial boards of several international journals (Journal of Alternative and Integrative Medicine; Core Evidence, International Journal of Physiology, Pathophysiology and Pharmacology; International Journal of Case Reports and Images; American Journal of Digestive Disease), from 2015, is Editor-in-Chief for Nutrafoods (Springer/CEC). Author of "Topics in Phytotherapy biopharmaceutical" (2014, Publisher CEC); of "Bacterial Therapy Topics" (2015, Publisher CEC) and "Nutrition and Dietetics. Clinical aspects of food" (2015, Zanichelli Editore), was honoured for his research by the French Society of Cosmetology Chemistry and the Spanish Society of Chemistry. He started his career as a researcher, firstly as a postgraduate at the Institute of Microbiology in Turin (1990-1993), then later qualified as Head of Laboratory at the Research Centre Italfarmaco (1993-1996), then as Senior Scientist at the Science Directorate Indena (1996-2002), Scientific Director at SIIT Pharmaceuticals (2002-2007) and finally as Scientific and Research