Host factors, the “Simon Says” for microbial biofilms

Microbes change their behavior, i.e., phenotype, in response to environmental clues. Since microbes, e.g. normal flora and pathogens evolved with their respective hosts, being able to recognize host-derived chemical signals provides a distinctive advantage. This is particularly the case if the phenotypic change is one that is protective from host immune factors and antimicrobial drugs. Once such phenotype that fits these parameters is the formation of biofilms.

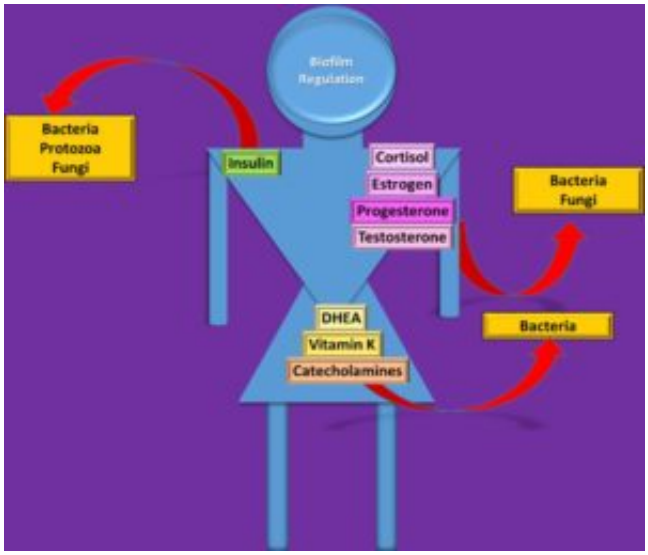

Fig. 1. Host steroid, peptide, monoamines and vitamins which can function as host-derived quorum signaling chemicals which induce biofilm formation.

Biofilm formation is one of the most significant microbial protective phenotypic changes. The development of biofilms includes colonization of specific host body sites, adhering there with the formation of an extracellular matrix and eventual departure. A signal is required for organisms to alter their phenotypic behavior from that of a planktonic population to that of a colonizing biofilm. Biofilm microbial communities make up our microbiome, as well play a role in over half of all infectious processes. Under normal environmental conditions this behavioral shift occurs as the result of microbial cell recognition of endogenously produced chemical signals, i.e., quorum signaling compounds. These chemical signals are continuously excreted into the environment. When there is a high enough signal concentration the population undergoes phenotype shifting. The typical way to achieve signal strength is for the bacterial population size to grow until a high enough level of individual cells, i.e., a quorum, is reached. However, this pathway can be circumvented if the signal is present exogenously in high enough concentrations. This is accomplished when microbes colonize the host, either as normal flora or invading pathogens, through recognition of host derived factors.

The ability to recognize chemical signaling compounds of xenobiotic origin indicates to microbes their geographic location in the body. In addition, it warns them of imminent danger from the host and their need to form protective biofilms. This quorum independent shift in phenotype is highly advantageous to the microbe, since these smaller microbial populations are able to resist the phagocytosis, and soluble innate immune factors as well as antimicrobials. Thus, microbial formation of protective biofilms prior to the population being of sufficient size results in their enhanced survival prospects. It is now recognized that a wide variety of host factors can alter microbial adherence and induce biofilm formation in the absence of a bacterial population quorum. These factors include such diverse chemicals as insulin, a peptide hormone, steroid hormones, e.g. progesterone, estrogen, dehydroepiandrosterone (DHEA), and cortisol, as well as monoamines, (epinephrine, norepinephrine) and essential vitamins, including vitamin K. Thus, these chemical signals act as the microbial equivalent of a GPS system that both indicates location as well as the need to put on an extra coat of protection (biofilm) if they are to optimize their survival in a hostile host environment.

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