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Low Temperature Plasma Medicine

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Ionized gas plasmas near room temperature are used in a remarkable number of technological applications mainly because they are extraordinarily efficient at exploiting electrical power for useful chemical and material transformations near room temperature. In this tutorial address, I will focus on the newest area of low temperature ionized gas plasmas (LTP), in this case operating under atmospheric pressure conditions, in which the temperature-sensitive material is living tissue. LTP research directed towards biomedical applications such as sterilization, surgery, wound healing and anti-cancer therapy has seen remarkable growth in the last 3-5 years, but the mechanisms responsible for the biomedical effects have remained mysterious. It is known that LTP readily create reactive oxygen species (ROS) and reactive nitrogen species (RNS). ROS and RNS (or RONS), in addition to a suite of other radical and non-radical reactive species, are essential actors in an important sub-field of aerobic biology termed "redox" (or oxidation-reduction) biology. I will review the evidence suggesting that RONS generated by plasmas are responsible for their observed therapeutic effects. Other possible bio-active mechanisms include electric fields, charges and photons. It is common in LTP applications that synergies between different mechanisms can play a role and I will review the evidence for synergies in plasma biomedicine. Finally, I will address the challenges and opportunities for plasma physicists to enter this novel, multidisciplinary field.