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Biomedical applications of lasers

Medicine has two prime objectives; first to detect disease at an early stage before it becomes difficult to manage and second, to treat it with high selectivity and precision without any adverse effect on uninvolved tissues. Lasers are playing a very important role in the pursuit of both these objectives. Due to their remarkable properties, lasers have made possible ultraprecise, minimally invasive surgery with reduced patient trauma and hospitalization time. The use of lasers in surgery is, by now, well established and spans virtually the entire range of disciplines: ophthalmology, gynaecology, ENT, cardiovascular diseases, urology, oncology, etc. The use of lasers for biomedical imaging and diagnostics and for phototherapy using photoactivated drugs is receiving considerable current attention and is expected to have profound influence on the quality of health care. Laser spectroscopic techniques have the promise to provide sensitive, *in situ*, near real time diagnosis with biochemical information on the disease. These developments have the potential to change the way medical diagnosis is presently perceived. Instead of a means of solving an already known clinical problem, the diagnosis may in future screen people for problems that may potentially exist. Further, any potential risk factor so detected can be corrected with high selectivity by the use of drugs that are activated by light. Because these drugs are inert, until photoexcited by radiation with the right wavelength, the clinician can target the tissue selectively by exercising the control on light exposure (only the tissue exposed to both drug and light will be affected). A good example is the fast-developing photodynamic therapy of cancer. There are indications that selective photoexcitation of native chromophores in the tissue may also lead to therapeutic effects.

The articles in this special section present some facets of use of lasers in medical diagnosis and phototherapy. Of the laser spectroscopic techniques being used for medical diagnosis, fluorescence spectroscopy and Raman spectroscopy are the two most prominent approaches. van de Poll *et al.* (**page 934**) describe the present status and the potential of the use of laser-induced fluorescence spectroscopy for detection of human atherosclerosis. Ullas and others (**page 908**) describe the use of Raman spectroscopy of tissue, cells, and body fluids for early diagnostic applications. The use of surface-enhanced Raman scattering (SERS) can push the detection limits of Raman spectroscopy down to single molecule levels. Kneipp *et al.* (**page 915**) describe some of the recent results which illustrate the potential of SERS as a biomedical spectroscopic technique. Yamamoto and co-workers (**page 894**) describe the present status of photodynamic therapy, which is fast emerging as the therapy of choice for some early stage cancers. Gupta and Bhawalkar (**page 925**) describe the activities at Center for Advanced Technology (CAT), Indore on the development of medical laser systems and fluorescence diagnosis of cancer of different organs. They also provide an overview of some of the studies carried out at CAT and Choithram Hospital and Research Centre (CHRC), Indore, on the effect of laser irradiation on cellular cultures and animal models. These studies are motivated by the need to understand the mechanisms responsible for a variety of therapeutic effects of laser irradiation being used on a routine basis at several hospitals including CHRC, Indore. Das and Alfano (**page 885**) have given an exhaustive treatment of ultra-fast photonic methods for non-invasive biomedical imaging. Agarwal *et al.* (**page 904**) report on trans myocardial revascularization (TMR) in view of the fact that this technique, though partly surgical, is not aimed at removal of tissue, but is carried out for revascularization, as the name indicates.

We hope these articles will give the research scientists of this country an overview of the capabilities of laser applications in medical diagnosis and phototherapy and enhance interaction between scientists and medical professionals, for faster development of this promising area. It is pertinent to emphasize here that the R&D activity on the development of biomedical applications of lasers is multidisciplinary by nature. A very active interaction between medical professionals and research scientists is necessary for the success of this endeavour.

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