

New Perspectives on Biocompatibility Pathways

David Williams, Wake Forest Institute of Regenerative Medicine, Winston-Salem, NC
dfwillia@wakehealth.edu

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It is an honor to be asked to speak during this event that acknowledges the award of the Acta Biomaterialia Gold Medal to Jim Anderson, who I have known for close to 40 years. It would be perverse of me not to select as the topic of my presentation the subject that Jim and I (in the company of a few other notable biomaterials scientists) have studied, discussed and argued about for most of those 40 years, and that is the phenomena of biocompatibility.

There is no need to rehearse here the history of the definitions of biocompatibility, nor to dwell on the ephemeral thoughts about putative mechanisms of biomaterial – host reactions that have appeared in our journals for past decades. Instead, I wish to emphasize a few fundamental points about biocompatibility that we have to recognize and adopt now if we are to avoid in the future the pitfalls and clinical problems that we have faced in the past.

Just to ensure that I am not misunderstood, it is absolutely clear that many biomaterials serve the clinical community very well and millions of lives are either extended or improved because of the performance that is derived from them. The questions are, could we have had even better performance and can we avoid future disappointments as biomaterials are used in increasingly diverse applications, including regenerative medicine, polymer therapeutics, nanoscale contrast agents and gene therapy.

There is an advantage in ceasing to have a research laboratory or group, and that is the ability to think creatively, unencumbered by one's own personal interests. This I have done for the last 5 years, my initial thoughts of new perspectives on biocompatibility mechanisms being published in 2008 [1], and now fully amplified in a textbook / monograph [2].

This presentation will cover four key parts to these perspectives. First is the emphasis on biocompatibility being a characteristic of a

system and not a material. All authors who submit papers to *Biomaterials* should know that there is no such thing as a biocompatible material; biocompatibility is a property of a host-material system, not just of the material itself.

Secondly, paradigms of biocompatibility that are described for implantable medical devices may not be relevant for different types of biomaterial-based health technologies, where the biomaterial may come into contact with components of the host in *ex vivo* environments or by injectable or infusion systems, where mechanisms based on the perturbation of wound healing do not apply. Instead we have to identify, for each system, the biocompatibility pathway that leads from the initial causative event to the clinical outcome.

Thirdly, our whole concepts of biomaterials have to change [3] since the specifications for tissue engineering templates (a much more relevant term than scaffold), for non-viral gene vectors and for contrast agents (microbubbles for ultrasound, quantum dots for optical imaging etc) are quite different to those for traditional metallic, ceramic and polymeric biomaterials.

Fourthly, we can no longer depend on traditional methods for so-called biocompatibility testing, which are represented in global standards that are predicated on procedures that identify and condone those materials that are chemically and biologically as inert as possible. The surface properties of a material that are good for implantable devices are likely to be inappropriate for materials used in stem cell bioreactors but we are mandated to test them in the same way.

Our understanding of biocompatibility is critical to the future of biomaterials science; let us hope that lessons are being learnt.

References [1] Williams DF *Biomaterials* 2008, 29,2941,[2] Williams DF 'Essential Biomaterials Science' Cambridge University Press 2013, [3] Williams DF *Biomaterials* 2009,30,5897.