The Scientific Basis of Tissue Transplantation

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Advances in Tissue Banking Vol. 5

The Scientific Basis of Tissue Transplantation

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PREFACE

This Preface need only be short, since the rationale and basis for the volume is given below in the Introduction. My objective now is to acknowledge the central role of Professor Aziz Nather in editing and planning this volume. As the Director of the International Atomic Energy Agency Training Courses in tissue banking at the Regional Centre at the National University Hospital in Singapore, he recognised the need for the tissue banker, not only to be well versed in the production techniques, but also in the scientific principles which underpin the entire subject. With such an interdisciplinary subject, access to the various scientific and medically-related materials is often difficult for the student. In the one-year National University of Singapore University Diploma Course which he initiated, Prof. Nather, therefore, introduced lectures by specialists which covered these associated subjects. It then became even clearer that the student did not have access to appropriate texts to study the subject in more depth. Consequently, this volume was conceived. It now provides another building unit to give the tissue banker and tissue user a foundation to the subject. He is uniquely qualified to pilot this volume, for he himself is both a tissue banker and user, and additionally a pioneering educationalist in the subject. The product in this volume will prove valuable to all involved in tissue banking and provide a ready reference to the various scientific basic parts of the field. We must all thank him and congratulate him and his colleagues on the outcome.

Glyn O. Phillips
Editor-in-Chief

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INTRODUCTION

AZIZ NATHER and GLYN O. PHILLIPS

1. Background

The International Atomic Energy Agency (IAEA) through its programme "Radiation Sterilisation of Tissue Grafts", produced a distance learning package on the procedures involved in tissue banking, particularly in the application of radiation to sterilise tissues (Nather, 1999a; 1999b; Phillips and Strong, 1999; Nather, 2000a; 2000b; Phillips, 2000). The individual modules are: 0 — Historical Background; 1 — Rules and Regulations; 2 — Organisation; 3 — Quality Assurance; 4 — Procurement; 5 — Processing; 6 — Distribution & Utilisation; 7 — Future Developments in Tissue Banking. This curriculum has been used extensively throughout the Asia Pacific region itself, and in other regions such as Latin America, Africa and parts of Europe.

The IAEA draft curriculum was first piloted in Singapore during the IAEA/RCA Workshop on Tissue Banking in September 1995. Consequently, IAEA established a Regional Training Centre in the National University Hospital, Singapore to train tissue bank operators in the Asia Pacific region using the curriculum. Since then, the training centre has conducted several distance learning programmes for tissue-bank operators in the region.

To enable this development to proceed effectively, the Singapore Government (Ministry of Environment) provided a grant to the NUH Tissue Bank through the National Science and Technology Board to develop the centre to be equipped with facilities for hands-on training. This grant also provided for sufficient funds to convert the draft curriculum into a multimedia curriculum. The National

University Hospital provided the space in which the NUH Tissue Bank was constructed. Both NUH and NUS contributed renovation funds for the building of a purpose-built tissue bank with a reception area, documentation room, wet processing and dry processing laboratories as well as a library for resource materials in tissue procurement and processing, and in tissue transplantation.

Simultaneously, the National University of Singapore (NUS) approved the development of a one-year distance learning Diploma Course in Tissue Banking to be conducted by the NUH Tissue Bank at the NUS Training Centre. The syllabus for the Diploma Course basically consisted of three components: the multimedia curriculum on tissue banking, a basic sciences component and a recommended textbook—the book selected being the series *Advances in Tissue Banking*. With these three components together, a comprehensive training could be provided.

With funds from the Singapore Government in April 1998, a multimedia element could be introduced. This required further editing of text from draft to module and the editing of illustrative materials into video demonstrations of not more than 30 minutes each. Special box containers were designed to house each module to include a booklet, accompanying videotapes and illustrative case slides from the region and available reference texts. With the first module, an audiocassette was introduced with instructions on how to use the distance learning package. The complete package—seven box containers in all, was distributed to all tissue banks in the Asia Pacific member states. In April 1998, a “Train the Trainers” workshop was held in Singapore to instruct the national trainers on the use of multimedia curriculum. Since then, this multimedia curriculum has replaced the draft curriculum as the first component of the syllabus for the Diploma Course.

The University Diploma Course is conducted over a period of one-year. First, the trainees attend a face-to-face two-week intensive training course in Singapore. Over the subsequent year, they are given progressive study of the curriculum, guided by National Coordinators. Over this period, they pursue a number of practical and written assignments which are then remitted to the University

for assessment. Finally, at the end of the year, they return to Singapore for the final examination. The overall diploma is awarded by continuous assessment over the entire one-year course.

Development has continued regularly. The seven videotapes have now been converted into two compact discs contained in a jewel case. The curriculum has been in great demand. The initial 100 sets produced were quickly exhausted. Therefore, another 250 sets were produced in April 2000. The multimedia curriculum package has been further redesigned to have all the seven module booklets conveniently housed in one specially printed box container, which contains the seven modules, two compact discs, an audiocassette and a new updated textbook as a companion volume to the multimedia curriculum. This new compact design makes the distribution of the curriculum more convenient. The updated volume *Radiation and Tissue Banking* (2000) was written by experts contracted by IAEA and printed with funds from the Singapore Government. It is an appropriate companion volume to the IAEA multimedia curriculum. It was released in July 2000 and provided free of charge to tissue banks in the member states throughout the world.

2. The Present Development

The basic sciences component of the syllabus for the Diploma Course, which is presented in the training course, includes subjects such as Anatomy, Matrix Biology and Physiology of Tissues, Microbiology, Sterile Techniques, Radiation Sciences, Biology of Healing of Allografts, Biomechanics of Allografts and Immunology. It was quickly realised that students found difficulty in obtaining basic text for this part of the Diploma Course curriculum. Available specialist textbooks on the diverse subjects addressed, such as Anatomy, Microbiology, Immunology etc., were too detailed to meet the needs of the Diploma students. It was therefore decided to produce a specifically-designed specialist textbook incorporating the various topics and to be directed at the appropriate level so as to address the specific needs of the Diploma Course students and generally that of the tissue banker, tissue procurer, tissue processor

and tissue transplanter. This textbook is written with this objective in mind. Authors were selected to write the various chapters, with specific instructions to address the needs of tissue-bank operators.

Section I: Anatomy

Tissue bankers need to have a basic knowledge of anatomy of the various regions ranging from the upper limb, lower limb, spine, pelvis to the maxillo-facial region. Several tissue-bank operators without a medical background will find this section especially useful when carrying out their daily work. Personnel with a medical background will also find this section a joy to read, rather than having to access detailed texts from anatomy textbooks since no textbook of anatomy for tissue-bank operators exists. Technologists too can now understand better the anatomy of the tissues they have been procuring or processing, and also the types of tissues that could be used for different anatomical regions.

Section II: Matrix Biology & Physiology of Tissues

The microscopic structure of tissues are detailed in this section, starting with the extracellular matrix, bone, cartilage, skin and amnion. Again, the major attractive feature is its descriptive nature with excellent illustrations. Worthy of mention is a special chapter on electron microscopy of the amnion, a tissue widely used in the Asia Pacific region.

Section III: Microbiology

Microbiology is a very important subject for tissue bankers and tissue transplant surgeons alike. The basic concepts in medical microbiology are carefully explained. Bioburden estimation itself merits one whole chapter. Equally important is the knowledge of the various transmissible diseases. Tissue bankers seek to maintain a high quality control standard to ensure safe tissue transplantation practice. No

efforts must be spared to prevent possible disease transmission during tissue transplantation. It is therefore important that tissue-bank operators have a good knowledge of the seriousness of these diseases, including AIDS, Hepatitis B and C, and syphilis.

Section IV: Sterile Techniques

To achieve high quality control standards, tissue procurement should be performed as far as possible under sterile conditions. One whole chapter is devoted to the principles of aseptic technique from scrubbing techniques, monitoring of sterility in the operating room to methods of sterilisation of equipment and materials. Another chapter is devoted to procuring tissues under sterile conditions and a third chapter to ensuring that the tissues transplanted are prepared in the correct aseptic manner so as to avoid the much dreaded complication of infection. Again, excellent illustrations have been used to make the text more readable and easier to understand.

Section V: Radiation Sciences

This section contains chapters written by three radiation scientists. The basic principles of radiation sciences are presented in the first chapter with good illustrations, so that technologists with medical background and no training in the radiation sciences can better appreciate the principles of ionising radiations. The second chapter deals with the effect of radiation on microorganisms and the third the effect of radiation on viruses, proteins and prions.

Section VI: Biology of Healing of Allografts

The biology of the healing of tissues is described, starting from the scientific basis of wound healing to the healing of the skin and amnion, and the healing of bones and ligaments. The role of various growth factors, including bone morphogenetic proteins and platelet-derived growth factor to promote bone healing, is also described and discussed in greater detail.

This section is important to surgeons who use allografts and who need to understand how the transplanted tissues heal so that they can choose more wisely the right type of graft for the various clinical conditions they encounter. In this way, better results can be obtained and complications minimised. Similarly, tissue bankers who prepare the tissue grafts will also better understand the functions of the various types of tissues they process.

Section VII: Biomechanics of Allografts

The first chapter is written by a mechanical engineer to introduce the basic concepts of biomechanics, and which could be readily understood by the tissue-bank technologists. Ample illustrations have been used to make this section user-friendly. In another chapter, the structural requirements of bone allografts for the various reconstructions performed are described by an orthopaedic surgeon, covering deep-frozen cortical bone allografts for massive allograft reconstruction of lower limbs requiring weight-bearing functions, the adequacy of lyophilised cortical allografts for massive spine reconstruction and the adequacy of lyophilised morsellised bone allografts for packing cavities in bones.

Section VIII: Immunology

This last section, written by an immunologist, outlines the basic principles of the immunology of tissue transplantation. This is vital both for the end-users (surgeons), using the bone allografts to avoid the dreaded complication of immune rejection and resulting infection and for the tissue-bank operators who need to process the tissue grafts to eliminate as much as possible any immunogenic properties of the tissue graft products.

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