Extreme Tissue Engineering
Companion website

This book is accompanied by a companion website:

www.wiley.com/go/brown/tissue/engineering

The website includes:

Figures and Tables from the book for downloading
Contents


1 Which Tissue Engineering Tribe Are You From?, 1
   1.1 Why do we need to engineer tissues at all?, 1
      1.1.1 Will the real tissue engineering and regenerative medicine please stand up?, 2
      1.1.2 Other people’s definitions, 3
      1.1.3 Defining our tissue engineering: fixing where we are on the scale-hierarchy, 4
   1.2 Bio-integration as a fundamental component of engineering tissues, 7
      1.2.1 Bio-scientists and physical scientists/engineers: understanding diversity in TERM, 8
   1.3 What are the ‘tribes’ of tissue engineering?, 10
      1.3.1 Special needs for special characteristics: why is networking essential for TERM?, 13
   1.4 Surprises from tissue engineering (Veselius to Vacanti), 16
   1.5 So, really, is there any difference between tissue engineering and regenerative medicine?, 20
      1.5.1 Questions never really asked: repair versus regeneration?, 20
      1.5.2 Understanding the full spectrum: tissue replacement, repair and regeneration, 23
   1.6 Conclusions, 27
   1.7 Summarizing definitions, 28
   Annex 1 Other people’s definitions of tissue engineering, 29
   Annex 2 Other people’s definitions of regenerative medicine, 30
   Further reading, 31

2 Checking Out the Tissue Groupings and the Small Print, 33
   2.1 Checking the small print: what did we agree to engineer?, 33
   2.2 Identifying special tissue needs, problems and opportunities, 37
   2.3 When is ‘aiming high’ just ‘over the top’?, 39
   2.4 Opportunities, risks and problems, 41
      2.4.1 Experimental model tissues (as distinct from spare-parts and fully regenerated tissues), 41
      2.4.2 The pressing need for 3D model tissues, 42
      2.4.3 Tissue models can be useful spin-offs on the way to implants, 42
2.5 Special needs for model tissues, 44
   2.5.1 Cell selection: constancy versus correctness, 44
   2.5.2 Support matrices – can synthetics fake it?, 45
   2.5.3 Tissue dimensions: when size does matter!, 46
2.6 Opportunities and sub-divisions for engineering clinical implant tissues, 46
   2.6.1 Making physiological implants: spare parts or complete replacement?, 47
   2.6.2 Making pathological and aphysiological constructs: inventing new parts and new uses, 47
   2.6.3 Learning to use the plethora of tissue requirements as an opportunity, 48
2.7 Overall summary, 49
   Further reading, 49

3 What Cells ‘Hear’ When We Say ‘3D’, 51
   3.1 Sensing your environment in three dimensions: seeing the cues, 51
   3.2 What is this 3D cell culture thing?, 54
   3.3 Is 3D, for cells, more than a stack of 2Ds?, 55
   3.4 On, in and between tissues: what is it like to be a cell?, 58
   3.5 Different forms of cell-space: 2D, 3D, pseudo-3D and 4D cell culture, 62
      3.5.1 What has ‘3D’ ever done for me?, 62
      3.5.2 Introducing extracellular matrix, 63
      3.5.3 Diffusion and mass transport, 65
      3.5.4 Oxygen mass transport and gradients in 3D engineered tissues: scaling Mount Doom, 66
   3.6 Matrix-rich, cell-rich and pseudo-3D cell cultures, 69
   3.7 4D cultures – or cultures with a 4th dimension?, 71
   3.8 Building our own personal understanding of cell position in its 3D space, 73
   3.9 Conclusion, 75
   Further reading, 75

4 Making Support-Scaffolds Containing Living Cells, 77
   4.1 Two in one: maintaining a synergy means keeping a good duet together, 77
   4.2 Choosing cells and support-scaffolds is like matching carriers with cargo, 78
   4.3 How like the ‘real thing’ must a scaffold be to fool its resident cells?, 80
   4.4 Tissue prosthetics and cell prosthetics – what does it matter?, 83
   4.5 Types of cell support material for tissue engineering – composition or architecture?, 85
      4.5.1 Surface or bulk – what does it mean to the cells?, 85
      4.5.2 Bulk material breakdown and the local ‘cell economy’, 85
4.6 Three generic types of bulk composition for support materials, 86
   4.6.1 Synthetic materials for cell supports, 88
   4.6.2 Natural, native polymer materials for cell supports, 90
   4.6.3 Hybrids: composite cell support materials having synthetic and natural components, 98

4.7 Conclusions, 100
Further reading, 101

5 Making the Shapes for Cells in Support-Scaffolds, 103
   5.1 3D shape and the size hierarchy of support materials, 104
   5.2 What do we think 'substrate shape' might control?, 106
   5.3 How we fabricate tissue structures affects what we get out in the end: bottom up or top down?, 107
   5.4 What shall we seed into our cell-support materials?, 110
      5.4.1 Cell loading: guiding the willing, bribing the reluctant or trapping the unwary?, 111
      5.4.2 Getting cells onto/into pre-fabricated constructs (the willing and the reluctant), 114
      5.4.3 Trapping the unwary: Seeding cells into self-assembling, gel-forming materials, 115
   5.5 Acquiring our cells: recruiting the enthusiastic or press-ganging the resistant, 118
      5.5.1 From cell expansion to selection and differentiation, 121
   5.6 Cargo, crew or stowaway?, 124
      5.6.1 Crew-type cells: helping with the journey, 124
      5.6.2 Cargo-type cells: building the bulk tissue, 125
      5.6.3 Stowaway or ballast-type cells, 128
   5.7 Chapter summary, 128
Further reading, 129

6 Asymmetry: 3D Complexity and Layer Engineering – Worth the Hassle?, 131
   6.1 Degrees of tissue asymmetry, 133
   6.2 Making simple anisotropic/asymmetrical structures, 134
   6.3 Thinking asymmetrically, 137
   6.4 How do we know which scale to engineer first?, 140
   6.5 Making a virtue of hierarchical complexity: because we have to, 144
   6.6 Cell-layering and matrix-layering, 147
   6.7 No such thing as too many layers: theory and practice of tissue layer engineering, 151
      6.7.1 Examples of layer engineering, 153
   6.8 Other forms of tissue fabrication in layers and zones, 158
      6.8.1 Section summary, 158
   6.9 Familiar asymmetrical construction components: everyday ‘layer engineering’, 159
   6.10 Summary, 160
Further reading, 160
7 Other Ways to Grow Tissues?, 163

7.1 General philosophies for repair, replacement and regeneration, 163

7.1.1 What does reconstructive surgery have to teach us?, 165
7.1.2 Clues from the natural growth of tissues, 166

7.2 What part of grow do we not understand?, 167

7.2.1 Childhood growth of soft connective tissues: a good focus?, 169
7.2.2 Mechanically induced ‘growth’ of tissues in children, 170
7.2.3 Mechanically induced ‘growth’ of adult tissue, 171
7.2.4 Growth has a mirror image – ‘ungrowth’ or shrinkage-remodelling, 172

7.3 If growth and ungrowth maintain a tensional homeostasis, what are its controls?, 173

7.3.1 Tension-driven growth and tensional homeostasis – the cell’s perspective?, 174
7.3.2 Mechanically reactive collagen remodelling – the ‘constant tailor’ theory, 177

7.4 Can we already generate tension-driven growth in in vivo tissue engineering?, 178

7.4.1 Mechanical loading of existing tissues, 178

7.5 Conclusions: what can we learn from engineered growth?, 179

Appendix to Chapter 7, 179
Further reading, 182

8 Bioreactors and All That Bio-Engineering Jazz, 185

8.1 What are ‘tissue bioreactors’ and why do we need them?, 186

8.1.1 Rumblings of unease in the smaller communities, 186
8.1.2 Hunting for special cells or special cues, 187
8.1.3 Farming – culture or engineered fabrication, 188

8.2 Bioreactors: origins of tissue bioreactor logic, and its problems, 190

8.2.1 What have tissue engineers ever done for bioreactor technology?, 190
8.2.2 The 3D caveat, 191
8.2.3 Fundamental difference between biochemical and tissue bioreactors: 3D solid material fabrication, 193
8.2.4 Why should a little thing like ‘matrix’ change so much?, 194
8.2.5 The place of tissue bioreactors in tissue engineering logic: what happened to all the good analogies?, 195

8.3 Current strategies for tissue bioreactor process control: views of Christmas past and present, 199

8.3.1 Bioreactor enabling factors, 200
8.3.2 Cell and architecture control, 203
8.4 Extreme tissue engineering solutions to the tissue bioreactor paradox: a view of Christmas future?, 209
  8.4.1 In vivo versus in vitro tissue bioreactors: the new ‘nature versus nurture’ question?, 209
  8.4.2 Do we need tissue bioreactors at all?, 210
8.5 Overall summary – how can bioreactors help us in the future?, 212
Further reading, 214

9 Towards 4D Fabrication: Time, Monitoring, Function and Process Dynamics, 217
  9.1 Controlling the dynamics of what we make: what can we control?, 218
  9.2 Can we make tissue bioreactor processes work – another way forward?, 222
    9.2.1 Blending the process systems: balancing the Yin and the Yang, 224
    9.2.2 Making the most of hybrid strategies: refining the timing and sequence, 226
    9.2.3 A real example of making tissues directly, 230
  9.3 The 4th dimension applied to bioreactor design, 232
    9.3.1 Change, change, change!, 232
    9.3.2 For bioreactor monitoring, what are we really talking about?, 233
    9.3.3 Monitoring and processes – chickens and eggs: which come first?, 234
  9.4 What sort of monitoring: how do we do it?, 238
    9.4.1 Selecting parameters to be monitored, 238
    9.4.2 What is so special about our particular ‘glass slipper’?, 241
  9.5 The take-home message, 245
  Further reading, 246

10 Epilogue: Where Can Extreme Tissue Engineering Go Next?, 247
  10.1 So where can extreme tissue engineering go next?, 247
Index, 249

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The most important first task of any User’s Guide is to dispel possible misconceptions of what the ‘user’ might reasonably expect. In this case, there can be a small ambiguity in the title for those who are unfamiliar with ‘tissue engineering’. So, if you are skimming through this book, expecting to learn how you could engineer extreme (or weird) tissues, it is recommended that you pop it back on the shelf and move to the science fiction movie section. On the other hand, if you want to learn how emerging concepts and strategies might be blended to revolutionize how we engineer (very familiar) tissues, then read on.

This is an unusual textbook in a field rich in books which come from the many sectors of activity which make up ‘tissue engineering’. It is different, not least, because it tries to integrate these diverse viewpoints, rather than giving just one perspective. This tends to set it apart because of things that it is not. It does not come from the direction of explaining specific technologies or particularly useful cell types. Neither does it aim to describe specific control mechanisms or target tissue applications. The logic here is that there are far too many applications, body sites and permutations to treat them all in just a few hundred pages (and there are already many thousands of written pages out there anyway). It is also not a multi-author book, with single, specialist, research-level chapters.

It does seem to be unique in the field, as a single-author, basic textbook of advanced tissue engineering concepts, across disciplines. It does aim to enable newcomers (or the puzzled-but-interested) to understand much better what that mass of facts and data out there might really mean. First, though, it aims to provide a unified introduction, whether your original training is in cell biology, engineering, biomaterials, surgery or other contributing specialities.

It is illuminating to ask why, in two decades, there have been so few (if any) basic-concept texts, especially as the underlying idea seems to be so simple. Understanding this (discussed at length in Chapter 1) begins to explain what makes tissue engineering so special and, indeed, illusive. The answer is grounded in its position at the touch-and-merge point of so many well established disciplines.

It is arguable that tissue engineering barely exists unless its activity includes some form of integration or merger of ideas from two or more of its more established component subjects. These ‘components’ include cell biology, materials science, surgery or sensor biophysics, protein chemistry and bioreactor technology, to name a few. If this is true, then we cannot avoid the logic that the work we do in this subject overlap zone called tissue engineering, must be integrated or merged. We cannot claim that our new hybrid subject is generating real synergies if we work away at cell biology in January, materials science in February and surgical science in March, etc.

Worse still, it has proved all too easy to toil deeply within one of the single-component disciplines to solve questions which, in the end, have little logical value when applied outside that discipline. Imagine, for example, how far sustainable cities would be advanced if the Norwegian civil engineers developed new insulation for homes in Oslo with the aim of linking this with findings from the Turkish seismic geologists on tectonic plate movements around Istanbul. If we claim to generate synergies between disciplines, deep integration is an essential.

By analogy, those of you who have experienced the London public transport system in a hot summer rush hour will understand more clearly the critical
importance of the 2–3 mm that separate ‘close’ from ‘touching’. Arguably, the social, legal and emotional effects of being tightly squeezed into physical contact on the 6:00 pm Victoria Line tube in Central London are similar to those where academic disciplines merge at their edges. **Both events have more to do with anxiety and imagination than subject-matter or cold logic.**

This is why a complete chapter is dedicated to exploring what tissue engineering actually is, and where it originates. After all, if you must grapple with the Victoria Line tube, it is good to know about your fellow travellers.

The core trouble is that the tissue engineering ‘concept’ is, in effect, based on combinations of knowledge packets which are drawn from the simpler parts of its component disciplines. As a result, it is terminally tricky in tissue engineering to explain the same, very basic topics to individuals who have had a wide range of specialist training, for the simple reason that, at any one time, one or more sets of your readers will almost certainly become seriously bored. For example, where the text explains the basic concepts of one contributing discipline (e.g. cell culture, aimed at engineers, or stress-strain measurement to biologists) it becomes laughably simple – and terminally boring – for the expert group. However, leaving out any of these basic parts immediately compromises our aim of a single, integrated set of concepts (and we have already glimpsed the importance of integration).

Consequently, it is almost guaranteed that some readers will be bored (while others are learning) – and this is a seriously undesirable publication plan. Suddenly, it is easy to understand how we reach our present position of having a plethora of focused, specialist texts. Yet there is clearly a broad need for just such a ‘doomed’ textbook, explaining and integrating the basic concepts from each of the component fields, often pulling together pairs of traditionally distinct subjects. At the same time, it actively approaches topics from new angles, drawing its logic threads from colourful starting points and illustrating this with recurring analogies. Wherever possible, these analogies bring to life abstract concepts by drawing on the everyday human world and its artefacts, or on familiar animals and plants. All of this allows us to understand tissue engineering from new perspectives (hopefully tracking where it is going) and why it must become *extreme* to get there. Indeed, the very process of producing a coherent explanation for tissue engineering logic inevitably highlights its paradoxes and identifies questionable assumptions.

On some occasions, these illustrative analogies help us to see the inherent flaws in current strategies. In others, they point us towards possible solutions. In all cases, their aim is to stimulate your own ideas on the problem and to cement the issues in your memory. First and foremost, it should be fun, refreshing and easy to remember.

But this all leads to a rather distinctive, even unfamiliar style. It really should generate controversy in areas where concepts and approaches are deep-rooted. For this reason, it is important that discussions around the logic and content are separated from reaction to its style, which is just a necessary tool for engagement. Where it makes our field easier to understand and explain, especially to newcomers, it may make a significant long-term contribution. If and when it successfully challenges or redirects worn and suspect strategies, it will have performed
Text Box 1  Author’s personal note

I recently spoke at the Cheltenham National Science Festival to an enthusiastic lay audience. They were keen to hear about how tissue engineering and regenerative medicine could help in the health of ordinary people. Once our small panel had finished its story of enthusiasm and promise, we took questions. As many of us have found before, these questions were poignant and hit at the nub of chronic health problems, which we still tend to skirt around or back away from. Gradually, it became clear that some members of the audience were themselves threatened or were caring for treasured spouses, parents or birth-damaged children. These are the real issues we must have in mind as we set loose our personal optimisms on a desperate world. We must be sure we can deliver before we speak – and not just under the ‘scientific-eventually’ caveat. Equally, it clearly becomes our duty, once we speak of these aims, to deliver to the very best intellectual level we can. In the face of false hopes offered to the mother of a damaged child, it is not enough only to point to long hours in the lab and a healthy grant income. Only extremely clear, joined-up thinking will do.

Through the length and breadth of the book, you will find examples and analogies. Some are designed to inform, some to bring an idea or concept to life – even where it is not your favourite topic. Yet others are just embarrassing, even silly, as such images are perhaps the most effective way to lodge ideas and facts in the mind. An example of this mnemonic effect can be found in a highly successful UK/European advert series for car insurance. Clearly, insurance is one of the more challenging products when advertisers are required to generate ‘customer excitement’ or ‘brand identity’.

For example, those of you who have experienced one recent campaign will now be deeply imprinted with a completely abnormal image-association based on the word ‘meerkat’. You will almost certainly recall an image of fluffy Russian-accented puppets angry at a car insurance company for stealing their website name. Clearly, before this rather silly series of ideas were imprinted, the word would have brought to mind a more realistic image of jerky, mongoose-like mammals, sitting tall in the African veldt (if it is not shown in your area, you can get the gist from the campaign’s website: www.comparethemeerkat.com).

Tissue engineering is too young to be brittle, and too much in need of successful translations to be a more immediately useful role. Clearly, both objectives must be good for a subject as new and uncertain as tissue engineering. This is especially true where our list of success stories is so modest – and so impatiently awaited (see Text Box 1).

In short, this book is designed to leave you with an in-depth understanding of the overriding questions and problems of tissue engineering. As a bonus, you may also discover a selection of the possible solutions and routes to reach our tissue goals. It should transform how you see the rest of tissue engineering. In particular, it should make it easier for newcomers to understand and interpret the rich collection of specialist textbooks already produced by the many tribes of tissue engineering.

There is a liberal use of text boxes and footnotes throughout. These are included as ‘asides’ and caveats, designed to colour and enrich the logic without deflecting the reader from its main track (for example, see Text Box 1 above). Where these are successful, they will make it easier to follow the thread and to remember its key points.

In places, there are simple questions aiming to draw your thinking to new places after you have put the book down. These are designed not for repetition of message, nor to save your professors work; rather, they give you a chance to carry on with or extend the concept on the train going home, or when you are out enjoying the park. There are many sectional and chapter summaries which should allow you to recap on the main points at regular intervals and understand better where they are leading us.

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1You have just experienced an example of the very illustration under discussion. Hopefully, this circle-within-a-circle helps you to appreciate how potent these illustrations can be in leaving recallable ideas in our minds.