Stem Cells – The Very Short Introductions Podcast – Episode 66

Rebecca Parker 00:07
Welcome back to The Very Short Introductions Podcast. From public health to Buddhist ethics, soft matter to classics, and art history to globalization, we'll showcase a concise and original introduction to a wide range of subjects, for wherever your curiosity may take you. So here is today's very short introduction.

Jonathan Slack 00:26
My name is Jonathan Stack. I'm a developmental biologist and that means somebody who's interested in how embryos develop, or how tissues in the adult animal or person regenerate. In the past, I was head of biology at the University of Bath in England, and later I was director of the Stem Cell Institute at the University of Minnesota, in the USA. The title of my VSI is Stem Cells: A Very Short Introduction. So what are stem cells? They're defined as cells that can both reproduce themselves by dividing to form more stem cells and the ability to differentiate to form functional cell types, for example, liver cells, or nerve cells or heart muscle cells. So they can both divide to make more of themselves and they can divide to make functional, differentiated cells. There are two principal types of stem cell, the embryonic stem cells, which can form any cell type, and things called tissue-specific stem cells within our bodies that can form their own tissue type, and which are responsible for cell renewal in normal life. And stem cell biology is both a fascinating area of research in its own right in terms of the properties of stem cells and what they do, and it's also of great interest because it's the source of cell transplantation therapies for a whole variety of diseases.

Jonathan Slack 02:03
Why did I first get interested in stem cells? Well, as a developmental biologist, I spent a great deal of my career, trying to understand how embryos work, how they develop in cellular and molecular terms, how a single cell can become a complex animal body containing a head, trunk and tail, and all sorts of different body parts and tissue types. And it's turned out that there's a lot in common between different sorts of animal embryo. So I'm mostly worked with frog embryos, but you can learn a lot about human development by studying frogs, or, indeed, mice or fish embryos. There's a great deal of mechanism in common. And in the 1980s, I was very fortunate to be involved in the discovery of a group of substances that act as key signals, controlling development at an early stage. And we call these substances inducing factors, or morphogens, and they're released by one group of cells, have effects on the neighboring cells, and they're absolutely critical for forming the body plan and the different tissue types in embryos. So over the decades since then, by work of many thousands of people around the world, the broad outlines of the mechanisms of embryonic development have become quite well understood. And, once we got to that point, I became more interested in potential practical applications.

Jonathan Slack 03:33
And in many ways stem cell research actually is applied developmental biology, not least because the methods for causing directed differentiation of embryonic stem cells depend entirely on what we

learned about embryos. You need to treat the cells with a succession of different substances, which are these inducing factors, or morphogens, that we discovered, or drugs which mimic their activities. So we needed to know all that science in order to work with stem cells. And when I was in Minnesota at the Stem Cell Institute, I was engaged in quite a variety of projects and I got to know about the broad outlines of the subject, and, because I not only had my own work to do, but also I had a supporting role in everybody else's project. Myself, I was involved especially in looking for novel therapies for diabetes, essentially, making insulin, secreting cells from other cell types. And also a more sort of fundamental science problem, trying to understand limb regeneration or why limbs in some animals regenerate and other animals don't.

Jonathan Slack 04:53
So what does everyone need to know about stem cells? Well, oddly enough, the first thing I feel compelled to say is that if you look for stem cells or stem cell therapy on the internet, most of what you'll find is, I'm afraid, complete rubbish. And the reason for that is that there's a huge industry of miracle cures peddled by unscrupulous clinics all over the world. These treatments essentially involve injecting cells of rather dubious and unknown origins into part of the body that suffers from some disease, and hoping that there'll be some miraculous repopulation of the diseased body part by the injected cells to create a wholly new and functional organ or tissue. This doesn't happen; it's complete nonsense, and you shouldn't believe in it. If you want to find out about real stem cell research and real stem cell therapies, the best place to look is the patient website of the International Society for Stem Cell Research. And you can find that easily on the internet, just search for International Society of Stem Cell Research. And that's a very useful source of information.

Jonathan Slack 06:12
So now we've got the bogus stem cell research and stem cell therapy out of the way, I should stress that there is also real stem cell research, performed by real scientists and real or responsible clinicians, and that this is what my book is about. So the first thing, as I've already mentioned, is that there are two basically different sorts of stem cell. There are the embryonic stem cells and the tissue specific stem cells. Embryonic stem cells are the ones that all the controversy was about, and they're cells grown in culture, in bottles in artificial media, from very early embryos, and they're taken at an extremely early stage when the embryo is just a tiny ball of a few dozen cells. And embryonic stem cells have remarkable properties. They can grow forever in tissue culture. And it's hoped that the ability to make unlimited amounts of human cells of particular types will enable both the use of the cells in-vitro for things like drug safety testing, which is actually very important industry, and also provide the material for new cell transplantation therapies for numerous diseases.

Jonathan Slack 07:30
So why was embryonic stem cell research controversial? It's only human embryonic stem cells that are controversial. And the reason is that the cells do originate from early embryos. Now, even though these embryos just contain a few featureless cells, some people believe that they are, from the moment of conception, human beings with a fully formed human personality and human rights. And if you believe that, then you don't believe anything should be done to early embryos at all, and that growing cell lines from them is a bad thing and a violation of human personhood. I think it's fair to say the majority view, and, certainly, the overwhelming majority view among scientists, is that personhood is something that

develops gradually during development, develops while the embryo is growing, maturing; things like the brain don't exist when embryonic stem cells are taken; it develops later on; becomes more complicated as the fetus matures; things like the immune system, which encode the individuality of the organism, develope quite late in fetal life. So, aspects of personality develop over a long period, and are cumulative, ending up with a fully formed human being. And, I think, most certainly the people who work with embryonic stem cells, view them more like other human cells growing in culture than they do like actual, intact human beings.

Jonathan Slack 09:17
Now, when I first went to America, the controversy was still going on, quite actively. And it's a common misconception among people abroad that in America stem cell research is not allowed, or certainly was a presumption in those days, and they, about 2007 when I first went there. Actually, this has never been the case. And the Americans have a peculiar system whereby they, they don't ban things. I think virtually nothing is banned by the government in the USA. What they do do quite frequently, however, is to say that something they disapprove of, or something Congress disapproves of, cannot be done using federal funds. And because a lot of the money for scientific research comes from federal funds, stopping you using that for human embryonic stem cell research is quite a handicap. And, in fact, during the time of President Bush, who introduced these restrictions, it wasn't prevented altogether, but the number of cell lines you could use was very limited. And in the time of President Obama, it is generally thought that he lifted all these restrictions but that's not really true. He simply enabled people to use more different cell lines for their work. However, it still wasn't possible to actually make new cell lines in the USA with federal funding. If you have private funding, you could do whatever you liked; private funding means from industry or from rich donors, we can essentially do anything you like with that, including making embryonic stem cell lines from embryos.

Jonathan Slack 11:02
So anyway, the, all this legal hoo-ha in the USA didn't actually handicap the development of the field as much as is often been thought. While we're talking about embryonic stem cells, I should say that there's now available another type of stem cell, which are essentially the same. And these are called induced pluripotent stem cells, or IPS cells, and they were discovered in Japan about 15 years ago. And these are made from taking ordinary cells from your, usually from your skin or your blood, and putting in some genes, some special genes, which are known to be important for function of early embryo cells. And these cells can then become what's called pluripotent, that means they behave like stem cells, they'll will grow without limit, and they can develop into any cell type in the body. So IPS cells are now widely available and can be used instead of embryonic stem cells for essentially all the purposes that might be required. And I think their availability has served to damp down the controversy quite considerably. And scientists are mostly interested in finding out how things work or they're sometimes interested in things like developing new tests for drug safety, but the general public are really mostly interested in therapy. And the general public wants to know how stem cells are used to treat disease.

Jonathan Slack 12:34
Well, there are stem cell therapies in use today. And the most important, by a long the way, is the what's often called a bone marrow transplant, or more accurately, a hematopoietic cell transplant. Hematopoietic means blood forming, and relates to the hematopoietic stem cells, which live in the bone

marrow and which are one of the types of tissue-specific stem cells, the ones that make the blood. And bone marrow or hematopoietic transplants have been used for several decades now. And they're quite widely employed about 130,000 grafts are done every year around the world. So just to finish off, I guess, the principal message is that the miracle cure type of stem cell, which you see on the internet, doesn't exist, but real stem cells are even more interesting than that, both for what they tell us about our own biology, and because of their actual and potential role in treating disease. I hope this very brief introduction to stem cells will help you to develop an interest in the field, conduct more reading on your own; look at the internet, but look at it with critical faculty after having read the patient website of the International Society of Stem Cell Research. Thank you.

Rebecca Parker 14:01
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