Muscle-Powered Mechanical Blood Pumps

THE EVOLUTION OF MECHANICAL BLOOD pumps has been every bit as tortuous as McCarthy and Smith suggest in their Viewpoint "Mechanical Circulatory Support—a Long and Winding Road" (Bodybuilding: The Bionic Human, 8 Feb., p. 998), and there will certainly be plenty of twists and turns in the road ahead. With rapid advances in the field of tissue engineering and the shift in emphasis toward miniature axial-flow pumps, current technology portends the emergence of several new species of assist devices, but which variety will come to dominate remains a matter of speculation. McCarthy and Smith contend that "[t]he future most likely includes two scenarios: small, magnetically suspended blood pumps that are completely implanted and powered through transcutaneous energy sources; and the 'synergistic' combination of these pumps with new biological therapies." However, there is also a third scenario: namely, the use of biomechanical blood pumps powered by electrically stimulated skeletal muscle.

Although transplantation techniques aimed at harnessing muscle power for cardiac assist have now been largely abandoned because of mechanical inefficiencies and problems with ischemia, lessons learned from these disappointing trials have recently spawned a promising new approach. Rather than repositioning the latissimus dorsi (LD) to pump blood directly, methods are now being devised to use this powerful muscle to better advantage as an endogenous power source by preserving its blood supply and natural anatomic motion. Indeed, studies have shown that "trained" LD left in situ can generate work at levels comparable to the heart's main pumping chamber without fatigue and may therefore be used—at least in principle—to power a mechanical blood pump (*1*, *2*). To this end, an implantable device designed to tap this perpetual wellspring of biological energy is currently being developed under the auspices of the National Institutes of Health (*3*) and is already undergoing animal implant trials.

Fueled by the same metabolic processes that drive the heart itself, muscle-powered blood pumps could potentially breathe new life into the field of chronic circulatory support by breaching an important barrier—lack of a safe, unobtrusive power source—that has long prevented current devices from becoming a viable, cost-effective means to treat congestive heart failure.

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Response

TRUMBLE AND MAGOVERN ARE CORRECT IN pointing out the potential of using electrically stimulated skeletal muscle for circulatory support. Prior clinical attempts using cardiomyoplasty, pacemaker-stimulated latissimus dorsi muscle that was wrapped around the heart, demonstrated improvement in some patients. However, generally it was not a reliable and vigorous response, and clinically it has been abandoned.

The new skeletal muscle pumps are still early in development, and in our Viewpoint we concentrated primarily on mechanical devices, in particular, ones that have migrated from use in animals to use in humans.

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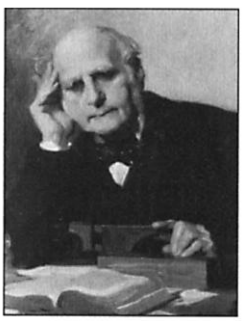
Did Sir Francis Galton Have a Sense of Humor?

IN HIS REVIEW OF NICHOLAS WRIGHT GILLham's book, *A Life of Sir Francis Galton* (Books *et al.*, 19 April, p. 472), W. F. Bynum states that "Galton firmly kept any lightness out of his published writings." There is at least one example that undermines this conclusion. In *Natural Inheritance*, Galton discussed the measurement of variability, for which he introduced the quantile function, an idea that I believe is more fundamental and far-reaching than correlation.

Galton wrote, "It is difficult to understand why statisticians commonly limit their inquiries to Averages and do not revel in more comprehensive views. Their souls seem as dull to the charm of variety as that of the native of one of our flat English counties, whose retrospect of Switzerland was that, if its mountains could be thrown into its lakes, two nuisances would be got rid of at once" (*1*, p. 62).


Sir Francis Galton

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Human Embryos: Potential Humans?

CARL FELDBAUM'S POLICY FORUM "SOME history should be repeated" (*Science*'s Compass, 8 Feb., p. 975) demonstrates several common conceptual errors in the debate on cloning [or somatic cell nuclear transfer (SCNT)].

To say that an embryo has the "potential" to become a human being is dangerous. A sperm has the potential to become a human being, as does an oocyte. The human zygote, however, is more than merely "potentially" a human being. If a human embryo only has the potential to become a human being, then when precisely does the embryo become a human being? There is no more pivotal point in the biologic growth and development of a human than the moment of fertilization when 23 chromosomes from the mother join with 23 chromosomes from the father to form a new, genetically unique individual. Similarly, in cloning, what stages of development impart "more" humanity to an embryo than the moment that the SCNT transfer stimulates an oocyte to divide?

Perhaps more dangerous is the concept

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that it is not a precise moment, but a gradation of human worth. With this model, a fetus at 3 months is somewhat of a human being, but a newborn is more of a human being. So is a 10-year-old more of a human being than a 1-year-old? Is a politician or athlete more of a human being than a wheelchair-bound paraplegic? Can we really stratify intrinsic human dignity and worth? Is human equality a myth? This sort of thinking forms the basis for demeaning entire classes of people, ultimately denying them their humanity. The 20th century has not been without ample evidence of the depravity of such thinking. Some history surely should not be repeated.

"To say that an embryo has the 'potential' to become a human being is dangerous."

Furthermore, it is an error to contend, as Feldbaum does, that it is a "faith-based belief that the cloned embryo's potential to become a person entitles it to legal and moral status as a person." No, the intrinsic dignity of a human person is not "faith-based"; it is a truth grounded in natural law, not theological exegesis. It is not a faith-based belief that a human embryo's potential to become a person entitles it to legal and moral status. It is a part of the fabric of natural law that the human embryo's actuality of being human entitles him or her to legal and moral status.

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Response

ULTIMATELY, SCIENCE CANNOT WIN AN argument with those who look at a sick person and a microscopic cluster of undifferentiated cells side by side and see the same thing: two human beings. But most people, regardless of religious or scientific background, intuitively recognize a difference between the two, as well as the gradations in development that Baumgartner finds so disturbing.

Baumgartner asks, "If a human embryo only has the potential to become a human being, then when precisely does the the embryo become a human being?" I cannot answer that question, although some scientists have suggested that the appearance of the primitive streak is an important demarcation. Implantation in the uterus is an important step as well, and that is where federal legislation that the biotechnology industry supports would draw the line.

The accusations of eugenics—particularly against the disabled—are inappropriate, given that the scientists engaged in this research are dedicated to helping patients with debilitating and deadly diseases.

"...science cannot win an argument with those who look at a sick person and a microscopic cluster of undifferentiated cells side by side and see the same thing..."

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Letters to the Editor

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Human Appropriation of Net Primary Production

THE FRACTION OF TOTAL PLANT GROWTH OR net primary production (NPP) appropriated by humans, often referred to as human appropriation of net primary production (HANPP), is among the most widely used measures to assess the "human domination of Earth's ecosystems" (*1*). S. Rojstaczer *et al.* ("Human appropriation of photosynthesis products," Reports, 21 Dec., p. 2549) find large margins of error associated with many parameters needed to estimate HANPP, resulting in a HANPP range from 10 to 55% of global terrestrial NPP.

According to Rojstaczer *et al.*, one of the parameters adding the most uncertainty to HANPP estimates is productivity of agricultural land. The database (*2*) used to estimate these error ranges, however, contains studies of very different quality that unduly inflate uncertainty (*3*). Error ranges on agricultural productivity could be reduced by using harvest indices (*4*, *5*) that relate NPP on agricultural land to commercial harvest. Data on commercial harvest are readily available in Food and Agriculture Organization (FAO) statistics (*6*). These data are available on the national level, which makes them a good starting point for spatially more explicit analyses (*3*).

Agricultural land is also a useful example to discuss problems in defining HANPP (*7*–*9*). The decision by Rojstaczer *et al.* not to consider land-use–induced changes in NPP as part of HANPP can yield problematic results. For example, aboveground productivity on Austria's agricultural land increased by a factor of 2.6 from 1830 to 1995 and by a factor of 1.8 from 1950 to 1995 (*10*, *11*) because of changes in agricultural technology (fertilization, irrigation, and so forth). If one were to use the definition used by Rojstaczer *et al.*, one would find considerable increases in HANPP expressed in absolute values (e.g., tons of dry matter or carbon).

Increased agricultural productivity, however, allowed for a reduction of Austria's agricultural area by 25%, whereas forests grew by 22% from 1830 to 1995. This meant that about 23% more aboveground NPP remained in ecosystems, despite an increase in harvest of 73% during the same period (*10*). If we define HANPP as the difference between potential NPP and NPP remaining in ecosystems after harvest (*9*, *11*), we find that aboveground HANPP fell from about 60% of potential aboveground NPP in 1830 to about 50% in 1995 (*10*). We find this latter definition more useful than the convention proposed by Vitousek *et al.* (*7*), and also used by Rojstaczer *et al.*, which regards all NPP of forest plantations and human-managed grasslands as appropriated: Even in forest plantations, a considerable fraction of the NPP remains in the ecosystem and supports food chains not directly controlled by humans. Such inaccuracies should be avoided because they have already been used to question the HANPP concept altogether (*12*).

By using methods such as those suggested here and elsewhere (*3*), uncertainty of HANPP appraisals can be considerably reduced. This would improve the usefulness of HANPP for studying human-environment interaction.

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