Artificial Life

The ultimate expression of biotechnology is to *create* life from non-living matter. At a reductionist level, there seems to be no barrier to this; if we can line up all the molecules in the right configurations, it would be impossible to distinguish a natural organism from a created one. This would take superscience technology, as the number of molecules to be arranged will defeat anything less. There are shortcuts, though.

Tissue Engineering

Tissue engineering is the first step in producing artificial organisms. It uses stem cell cultures (p. 22) grown on biodegradable scaffolds in a suitable biochemical environment to produce organs without having to grow an entire clone body.

Transplant Organs (TL8)

Tissue engineering can be used to grow organs suited for transplantation (p. 141). The patient donates a sample of DNA, which is then used to grow the required organ. At TL8, organs must be grown attached to a living animal so they are supplied with the required nutrients, but smaller versions of cloning tanks may ultimately replace them at TL9. Cosmetic tissue such as ears and noses is the simplest to grow (TL8), followed by simple organs such as kidneys and livers (TL9). These would take four weeks to grow. Entire limbs and complex organs like hearts, lungs, and eyes would become available later, and take up to eight months to grow.

Fauxflesh (TL9)

NAPANEE (AP) – Acting on an anonymous tip, Ontario Provincial Police raided a factory building on the outskirts of Napanee. They found what one officer called a "disgusting scene, right out of the 20th century": live pigs and chickens being slaughtered and packed by modified agribots for the black-market meat trade. "I thought I'd seen everything in my 10 years on the force," said OPP officer Bill Mackenzie, "but this really turns your stomach, eh?" Police made six arrests.

Gengineered cells from livestock are cultured in growth tanks and supplied with nutrients. This creates a continuously growing biomass of lean meat tissue, which is harvested whenever food is required or it gets too big for its vat. Fauxflesh meat comes in oddly regular shapes, but is otherwise indistinguishable from natural meat.

Initially there is likely to be consumer resistance to fauxflesh as "unnatural," but this may be overcome by relative cheapness, concerns for animal welfare, or a population outpacing its food supply. Once established, fauxflesh may ultimately make raising animals for meat socially unacceptable or illegal.

Mimicking Biology

For most of our scientific history, we've thought of life as plants and animals and, more recently, microbes. These provide plenty of patterns on which we could base artificial living organisms.

Biogenesis (TL10)

Biogenesis is tissue engineering (above) taken to the point where biological molecules can be assembled into a viable organism. Nanomachines lay down a polymer or carbon composite scaffolding and assemble bone, muscle, nerves, and other tissues on this framework. The cells are controlled by artificial chromosomes, designed to produce the proteins and enzymes needed by the resulting organism. Often the designers will take shortcuts, using clusters of nanofactories to produce required proteins that couldn't be coded into the genes, either because of lack of understanding or development time. The result is that the organism is a mixture of biological parts and artificial components.

Biogenetic organisms come in all sizes, from insect-sized up to building-sized or larger. Since construction throughout the organism is simultaneous, they all take around the same time to build: four to six weeks. Larger organisms require more nano and raw materials, however, and thus are proportionately more expensive. Biogenesis can be used to create a wide variety of organisms, including copies of animals, designer lifeforms such as the skullcat (p. 96), and biogadgets (p. 95).

Any biogenetic organism will have Unusual Biochemistry (p. B160).

Bioroids (TL10)

Bioroids (short for biological androids) are humanoid beings created using biogenesis. Although they can be made to resemble humans, deep differences will be apparent if the cells are examined. Baseline bioroids are designed to accept artificial chromosomes, with "slots" into which genetic engineers can easily plug specific modules of genes. Much redundant material, such as introns, is left out of bioroids.

A basic bioroid design is similar to a genetically upgraded human. Initially they will be sterile, though some female models will be able to act as surrogate mothers. This limitation can be overcome with implanted or *in situ* tissue-engineered reproductive organs grown from human DNA.

Early bioroids will have limited intelligence, restricted to instinctive actions, but as the technology matures designers will be able to produce learning and reasoning capability. Since bioroids are produced in a fully grown form without passing through childhood, they will require intensive learning programs to achieve human levels of intelligence in a reasonable time; they would be ideal candidates for deep learning technology (p. 143).