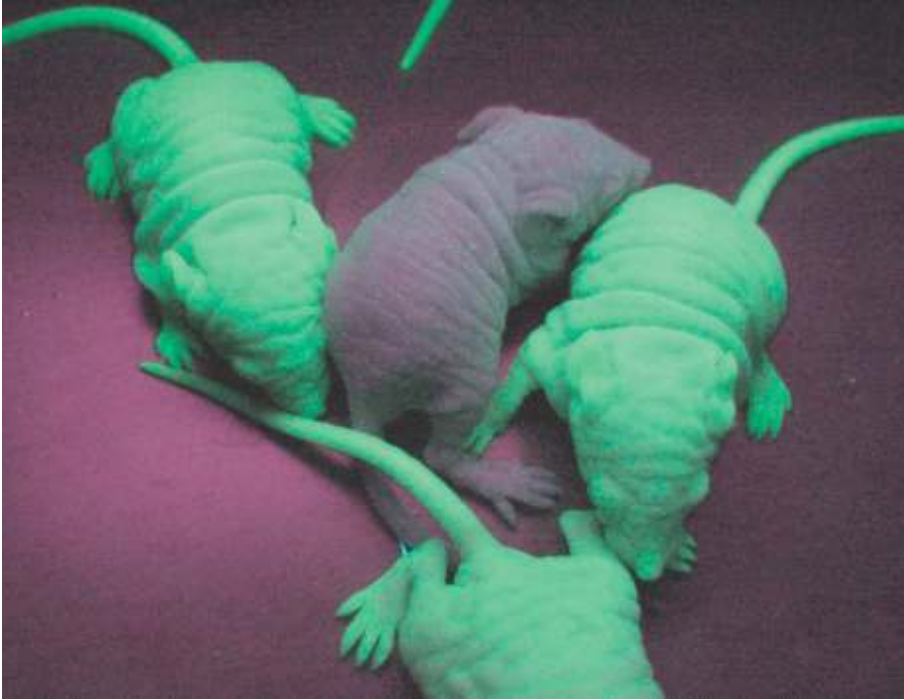


Biotechnology



"WARNING -- OK GENETIC ENGINEERING has not received permission to release this organism from NIH. We used a Stanford patent without paying the license fee, and we do not know how to file an Environmental Impact Statement. We are distributing HLIV free. Please make your own decision whether or not to release these organisms."

<http://futuryst.blogspot.com/2008/01/human-lust-inducing-virus.html>

Biotechnology was the defining technology of the mature internationalist world in the early 2030's, before neogenetics turned everything upside down. The idea that life is somehow different from everything else had already weakened, and taboos against genetic engineering or tissue culturing were rapidly disappearing. That was 70 years ago. By 2100 most people do not see biotechnology as anything but a branch of engineering – engineering of soft, complex and self-building matter. While some people still have deep concerns about changing humans too much or in certain ways, very few think that it is wrong to change nature. After all, it was all bioengineered from the start by the Dragons.

Agrotechnology



Figure 1: Bel-Air (Mathieu Lehanneur)

The move towards space, the massive dislocations of people, climate change, the retreat from dragon zones and the numerous ecological insults have turned agriculture into a design science. To farm in a traditional way is rare and usually not done in the same place as the practices originated – the traditional French wines come from Africa, the breadbasket of the United States is in Mexico.

Farming is often done using telepresence. It began in aquaculture and forestry (where people use telepresence to control tree-harvesting machines), but as the technology got more convenient it expanded into more and more areas. These days it is rare for farmers to be close to the actual plants or animals they tend. The idea that somebody might have *touched* the food is disgusting to some; to others the ultra-traditional ways are worth paying an exorbitant extra price.



Figure 2: Arcology with hydroponic farming. (Timelinks)

Hydroponics and aquaculture are common in major cities and space: plants are grown in nutrient solution inside agriscrapers, often combined with fish farming that allows recycling of green waste as food and fish waste as plant nutrients. As the systems developed they became the characteristic “aeroponic” farms seen in many settlements, modules held aloft to gather moisture and sunlight to power the farm units.



Figure 3: Remediation village (Super Nafta Land)

Bioremediation of hazardous zones is common but cumbersome. It requires careful ecological monitoring, spreading designer plasmids or organisms and often physically changing the

landscape. There is also much money in it, as various nations are increasingly regarding the safety and diversity of all biomass within their borders as a key part of national security. This has led to the growth of remediation villages, where the remediation personnel live and work. Over time the remediators have become a noticeable subculture: mobile between different projects, used to the relative hardships of hazardous zones, with a can-do attitude and expertise in handling the messy problems in large-scale ecotech.



Figure 4: Locally eco-grown bioengineered produce for the connoisseur (Wired)

Much food production takes place in the biofactories of space habitats: low-gravity environments where plant and animal cells are cultured in nutrient solutions produced by other bioreactors. These cells are then used either directly in food printing to make food, or as nutrients for fish farming. Hydroponic plantations are also common but require more radiation protection. Space cuisine has long diverged from traditional earth food anyway, and demand for “real” plants is declining. However, the Lunar Japanese take pride in traditional dishes and are rich enough to pay for orbital produce when necessary.

In neogenetically oriented places like the tropics farming has melded with industry as people and dragons reshape nature into an environment to their liking. In South America the PanPec units are Banyan-based plant-factories growing desired equipment, often together with hardtech microfactories, 3D printers and assembly telepresence for hybrid objects. In Africa various adaptations of dragon castles are found in wetlands. Surrounding these growth/manufacturing units there are large regions of plantlife that serve to supply them with energy, nutrients and raw materials using a dense underground rhizome network.



Figure 5: One of the earliest anti-caloric sodas (Laura Moorhead, Wired)

Much food is engineered to have other effects than just taste and nutrition. It is a popular way of taking immunity plasmids, change metabolism, improve cognition and mood. People eat probiotics, prebiotics, nanobiotics and artibiotics in addition to delicious chococetuals. Some regions such as east Africa has seen a renaissance in building neogenetic herbal treatments – the Vicala Fellowship has introduced over 100 herbs that have very strong effects on everything from radiation poisoning to seasickness to leukaemia.



Figure 6: Chococentials has been one of the major successes of functional food. (Jennifer Kahn, Wired)

Neurocomputers

One of the biggest applications of biotechnology is “living computers”. Neural tissue is great at pattern recognition, associative memory and animal-like cunning. That it is also slow, energy consuming and requires life support is a slight drawback. Over the years neurocomputers have gone from something that requires enormous specialized life support systems to neat modular units that are almost as robust as pure optronics or electronics.

A typical neurocomputer consists of sheets of artificial cerebral cortex grown in a grid of nanofibers. The fibers provide input/output and nutrients, as well as anchoring that makes the neurocomputer resilient against sudden accelerations. A modern nanofiber lattice is far more resilient than a biological brain. The neurons of the cortex grow according to genetic programs into useful architectures, often “borrowed” from different species, scanned individuals or generated using biosimulation algorithms.

A neurocomputer unit roomy enough to run a humanoid AI weighs about 2 kilograms. About half is the neurocomputer itself, the rest is an extremely compact life support system, interface software and hardware, and shielding. Smaller controller neurocomputers can be a few cubic centimetres large, and the dreamblobs and netwhales used for massive creative datamining and imagery can reach cubic meters (as do full syntronic brains, mainly because they are equipped with far more protection than normal neurocomputers).

Neurocomputers must be trained to be useful. Often this consists of running thousands of newly grown computers through massive virtual reality simulations, subjecting them to suitable

learning, reward/punishment signals and eventually fixating their neural structure into an “adult” form. Experienced neurocomputers are valuable like experienced working animals: they know tricks, they do not fall into easy traps and they might have imprinted strongly on their owners. Neogenetic treatments have been developed to give them long lifespans, and today a neurocomputer can last many decades if it is treated carefully.

Body Ornament

Body decoration is popular: in many societies there is no point in competing by looks or fitness anymore, since they can be fixed. But having impeccable body aesthetics allows enough fashion, expense and sensuality to keep the social games interesting.



Figure 7: Animated tattoos (Philips)

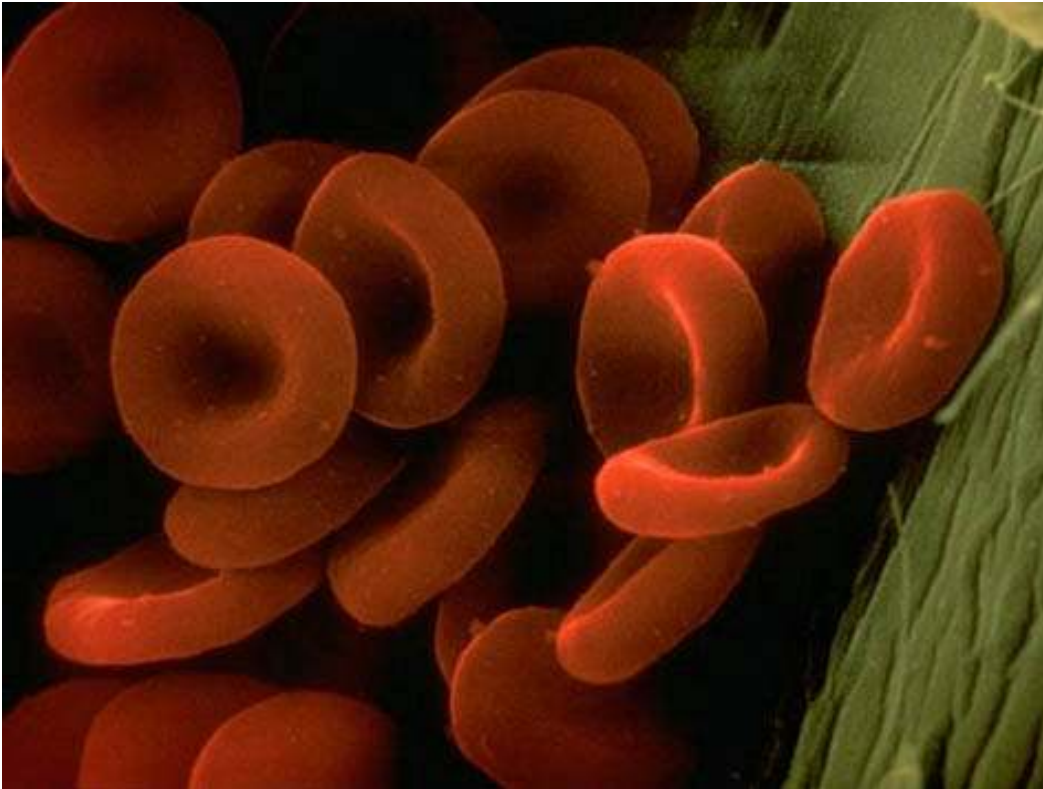
Mere traditional, inert tattoos are utterly out (until they become a fad again). Smart nanoparticles allow tattoos that can change colour or shape depending on programming. Various nanoparticle models allow rapid colour-switching, optical effects such as phosphorescence or fluorescence, interactivity or social linking (the patterns tend to coordinate across a group, move from person to person or do other social signalling tasks). Rather than painfully inject them with a needle they are just injected in the bloodstream and migrate to the designated skin area (although there was a fad in GEO for a while with unseen tattoos on internal organs).

Atramentum, nanotattoo ink, is often used on pets and plants to make them more interactive Lunaside. Certain radical subcultures Earthside deliberately allow Spam to infest their nanotattoos, carrying it as their “bodypet”.

Neogenetics allows control over skin pigmentation. In Africa many Hosts are easily recognizable by the distinct patterns they create on their skin. The Voices of the Dragons go even further and have vivid patterns suitable for coral reef fishes on their bodies. But neogenetics seldom has the control to produce figurative shapes. On the other hand it can allow entirely new kinds of body ornaments – fur, horns, spines, scales, scent glands or even flowers.

The real fashion among body-aesthetes today is truly living tattoos: symbiotic organisms living under the skin. They are either artilife or neogenetically modified organisms. Unlike nanoparticle tattoos they take time to develop and form a bond with the owner. Both have to learn to respond properly to each other, and this takes effort – showing who is serious about their looks and who is just buying the latest organism.

Healthcare



Health beat energy, weapons, food and sex as the largest industry sometime during the century. Protecting the health of people is a political motivation that allows almost anything (consider the escape of Japan) and drives the fiercest political disagreements (enhancers vs. nonehancers, Indigos vs. neogenetics). Healthcare corporations have to a large extent merged with insurance and finance, linking the health of people with the health of the economy – and vice versa.

The greatest advance in medicine over the 21st century was the development of the automec – the combination of AI and robotics that allows automation of simple diagnosis and treatment. This has made even fairly advanced medical treatment much cheaper by allowing nurses and doctors to focus on the important and hard cases. However, the problems with AI Earthside has led to an enormous growth of preventative medicine and do-it-yourself treatments that do not rely on fragile robotics

Health monitoring



Figure 8: health monitoring system (Chris Baker, Wired)

All space societies runs continuous health monitoring: implanted or worn devices check the current medical state of the body, warning when something looks amiss. Depending on how much privacy a polity uses this might mean the monitor directly contacts the authorities (for serious threats the emergency services will come anyway). Such monitoring is used not just for health but to create associations in life recordings, update exercise profiles

Similarly pathogen, plasmid and chemical sensors are scattered through the environment. If anything unusual or dangerous shows up they will react.



Figure 9: (Dunne & Raby)

“Know thy cell, know thyself”

Gene testing was the start. Today the genome of a cell sample can be sequenced in a few minutes and automatically annotated. This allows personalized medicine, some preventative medical predictions and detection of genetic edits. Most people have their genome map somewhere, and undergo occasional rescans to check for edits.

The two real challenges are to understand *what* discovered edits mean and to discover edits hiding in just a few cells. To handle the first there is a big business of mapping out genetic modifications, deviations, plasmids and epiphenomena. Online forums have experts and amateurs poring over new pieces of genetic variation, testing out simulations and elaborate comparisons to untangle what they actually do. Interesting edits can cause rapid cluster formation as the genome nerds of cislunar space get excited and form highly competitive ad hoc research teams. Sometimes this is very useful, such as the 2097 discovery of the Electric Lady Peptide, and sometimes merely embarrassing.

To handle the second challenge most serious tests tries to get samples of all kinds of cell types. This usually requires somewhat more invasive methods – usually described as nanotech tentacle rape. This is a major reason many people do not wish to risk their biological classification code, since a thorough investigation is usually the only way to regain access to a closed biosphere.

Phage sprays

Mid-century, tailored bacteriophages were the main method of fighting bacterial epidemics. As the technology developed tailored phages became a ubiquitous tool to deal with unwanted microorganisms. Today advanced bathrooms have phage dispensers that download the latest sequences from immune companies and add them to the soap and toothpaste. Together with

antibody soaps and immune patches, a modern person has an amazing distributed immune system at their service.

Life extension

"Traditional" high tech medicine can reduce ageing damage and slow ageing using CR mimetics (if one accepts their numerous limitations and side effects), gene therapy, junk removal, aggressive stem cell control therapies and some metabolic engineering. To do this well requires relatively expensive medical monitoring, but "youth pills" are for sale in even the most primitive parts of the world.

Most developed parts of the world add modified stem cells and nanoimplants, as well as targeted plasmids to modify the ageing mechanisms. This is usually a one-time treatment, although it is common with yearly follow-ups. When it works best (i.e. in young people) it can essentially stop ageing and reduce the biological age of people.

Neogenetic societies have people who can control their bodies on a deep level and often rewrite the ageing of others. Unfortunately the general riskyness and craftsmanship aspect of neogenetics make many leery of such methods. As the saying goes, there are brave Hosts and old Hosts, but no brave and old Hosts.

Life extension is causing a population boom, especially in space. However, this is outweighed by the very low birth rate. Many societies are not just turning gray, they are positively white.

The split between the "last mortals" and "first immortals" is getting clear. Many of the old internationalists are glum about their chances: they were too old to really be helped by the new treatments, so their health is slowly slipping. The generation after them is doing fine, and younger people clearly expect not to die at all (at least not of ageing).

Reproduction



Figure 10: (Sean Hamilton Alexander, Wired)

Most modern nations take reproduction very seriously. Reversible sterilization is common or mandatory, and getting reproduction and parenting licenses requires societal oversight.

One reason is the spread of nasty neogenetic infections, especially Gamete Replacement plasmids that replace the genome of the gametes with another payload. Genetic testing is generally advised and giving birth to certain genetic variants are even illegal in some jurisdictions (nobody wants another case of the Bristol Baby Bombs of 2051). Another reason is the spread of genetic selection and enhancement, which has made uncontrolled natural reproduction viewed as best as irresponsible and at worst abusive. When genetic enhancement began to spread many countries instituted safeguards to prevent “hyperparenting” where parents would be trying to impose too much control over their offspring; these restrictions gradually morphed into dissuading unsuitable parents from getting children.

Long before the neogenetic revolution birth rates were going down, but since the chaos in the 40's they have plummeted. The restrictions, the total separation of sex and reproduction and lingering uncertainty have kept them down. If life extension had not come around populations would likely have imploded, now they keep up around replacement levels in most societies.

While children are rarer, they are reliably wanted and pampered. Methods of not just monitoring and enhancing children have been developed, but also techniques to get them to thrive and

develop optimally. In many places such as Lunar Nippon this has led to changes in the school system, since the number of extremely young but already fairly mature schoolchildren has increased: 13-year olds are not uncommon in highschool. Ambitious parents can potentially create child prodigies, although their eventual success remains somewhat dodgy.



Figure 11 (Mondolithic studios)

Exowombs are in occasional use, although many parents do not trust them. In a few places where the environment is too problematic they are used, such as the most neogenetically active parts of Africa and Asia, as well as in remote space settlements.

Enhancement

People have been enhanced for many decades by now, and it is rare for parents not to consider how to give their kids a better start in life than they had – or how their own lives could be improved one way or another.

Enhancements are of six major types:

- **Genetic selection:** your embryo was selected from others to have the best possible traits. Such enhancements can only bring up any trait to the maximum normal of the human range, and cannot introduce anything totally new. On the upside, selection does normally not count against ones biological code.

- **Germline enhancement:** your embryo was transfected with genetic cassettes containing new genes. This allows not just beyond-traditional range abilities, but also biologically based new abilities such as having night vision or being able to synthesize vitamin C. You are at least Blue₂.
- **Gene therapy, implants, surgery:** Enhancements added in adulthood. Such enhancements can go beyond the normal range and even include nonbiological abilities such as neurointerfaces. Implants and some gene therapy can be neutralized. You are at least Blue₂.
- **Neogenetic enhancements:** Enhancements added using neogenetic changes. Like the previous categories, but only able to do biological things (however, a clever Host can stretch biology very far). You are at least Turquoise.
- **Passive Immunities:** protects you against neogenetics. You are Green.
- Active neogenetic enhancements: **Immunites** with minimal AM-nodes (such as Maponyo) or full **Hosts**. The character can produce biology-transforming plasmids, affecting themselves and possibly the surroundings. Orange₁ to Red₂

Different societies allow different enhancements. Most nationalist polities are fine with genetic selection these days, and may accept some (but definitely not all) germline and gene therapy enhancements. Immunities are widely accepted, but viewed with a sceptical eye Lunaside. Inside an immunity other immunities and Hosts tend to be regarded as risky outsiders. California is very open to neogenetic enhancement, but it better be done in a clinical setting rather than the witch doctor ceremonies of Maponyo or through a neogenetic mass.

Some enhancements are so common that they are almost not recognized as enhancements. The low gravity adaptation plasmid is given to everybody on Luna, making their bodies resistant to the weakening effects of the gravity. In space anti-radiation plasmids are very common, and obviously on Earth immunization plasmids are essential.

Exercise mimetics, sleep reduction drugs and various mild cognitive enhancers are common ingredients in high-tech foodstuff. The main problem is that different enhancers can interact: people often have to rely on their exoselves to warn them that a particular piece of cake may crash their concentration ability – and of course, many do not heed the warnings.

Cryostorage

These days numerous methods of placing people in suspended animation or inert storage are known and used. The most common hibernation protocol uses a programmed set of plasmids to induce a low-metabolism coma and the production of protective substances. In neogenetic habitats a symbiotic protective system is allowed to infect the person, allowing them to be brought to very low metabolic levels. Such hibernation is used on long space journeys, to give time for medical treatment or in emergency situations.

Real cryonic suspension and reanimation has been achieved, although the process tends to be risky. Usually nanomachines, biobots and/or symbionts are inserted and the body vitrified. The thawing process involves a very gradual heating and activation of the embedded systems; this usually requires high-tech monitoring and support.

Unfortunately for the people suspended before 2060, nanotechnology is not yet good enough to repair their cells. Some slice scanning has been done, however.

Pseudomedicine

The advances of medicine have not stopped the use of questionable or pseudoscientific medicine. An amazing number of people use traditional herbal remedies with no effect whatsoever beyond placebo, and virtual reality holistic healing is widespread. Practitioners place the clients in a pleasant VR environment and while sprouting suitable mumbo-jumbo massage/alter their avatar to improve their body.

In Lunar Nippon vacuum therapy is practiced. The idea is that many illnesses are due to the presence of inefficient or damaged mitochondria, and putting the person under mitochondrial stress will get rid of the weakened organelles. While some use the gentle method of having the client breathe a low-oxygen mixture, it is more popular to use a low-pressure environment. Air pressure is slowly lowered until hypoxia occurs, and then slowly returned. Several accidents have occurred where the hypoxia became too extreme, but many people swear vacuum is the key to real health.

The old Japanese pseudoscience of blood types indicating personality has blossomed into an elaborate system thanks to easy bioassays. Today it is not just the ABO system that is used, but also all sorts of tissue antigens such as the HLA type and rare blood types. "Serologists" predict relationship quality, job prospects, suitable professions or even good garden design based on antigen patterns – often in fierce competition with "geneticists" using full genome scans and behavioural data mining to make equally spurious predictions. Some people even undergo treatments to change their serotypes to become better.

Artlife

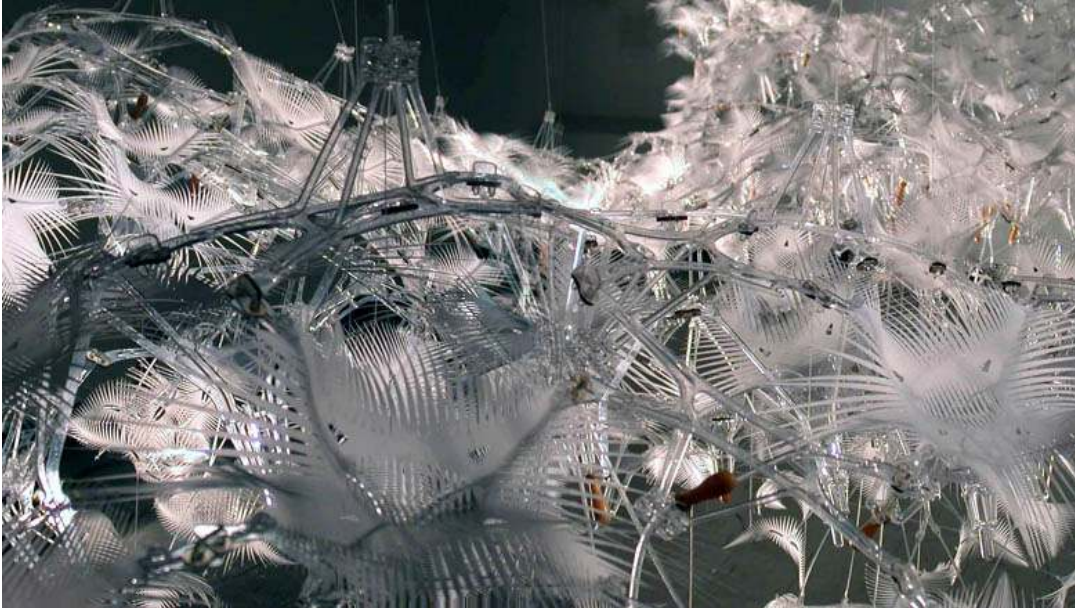


Figure 12: Orgone Reef (Philip Beasley)

Developed by the orbital biotech consortia, artlife is "alternate" life that is immune to dragon plasmids and might function differently from normal life. Recompiled cells are a crude form of artlife, merely using a different genetic code. Advanced artlife is more akin to nanotechnology: it can be programmed, it runs modular and well understood processes, and it can be based on very different biochemistries.

The most common form of artlife is the Green Value, a form of programmable cells based on alternative amino acids and totally dependent on certain organoboron compounds not found in nature. Macroscopic Green Value analogs to plants and animals have been developed, and are being further developed as buffer biomes to isolate dragon infestations. The Green Value organisms efficiently break down plasmids, turning them into harmless compounds. If necessary a chemical apoptosis signal can be given that causes the immediate breakdown of the artlife. Green Value looks and feels like plastic, forming notably regular structures reminiscent of ferns.

A closely related form is Anemiaion from Shinano, which is a form of "living smart dust", simple organisms that can survive in dry environments indefinitely as long as they get light, and can produce simple sensor networks. Anemiaion is intended to form a safer ecological monitoring system than the current nanodust particles.

Another up-and coming artlife is 095 from Zygonics. 095 is a silicone-based artlife that looks like thick, viscous goop in bright colours. It consists of artificial cells that form nanoscale signalling networks similar to the old crustal dragon plasmid network. This can be used for amorphous computing and smart surfaces. 095 life can be painted onto walls as "smart paint" that self-repairs and extends itself when needed; it can be used as a living smart building material even in space.

Organos from Suntory and Mabuchi Life Sciences is an artilife design intended for robotics and androids. While looking very much like mouldy plastic, it forms useful self-repairing musculature, nerves and sensory organs that can be covered with some more appealing skin. Organos robot bodies are being launched across Luna.

Artlife is a booming business. It can be tailored to different needs, it is robust and versatile, it seems to lack the dangerous potential of normal life and has none of the problematic ethical connotations of "real" life. Of course critics have pointed out that its safety is by no means proven (any replicator can be dangerous) and ethically it might be entirely equivalent to normal life.

Neogenetics



Figure 13: Launch of spore lamps in the Mogadishu zone (Daniel Dociu for ArenaNet, Inc. and NCsoft)

While traditional biotechnology allows the modification of life to produce desired products (or *become* the product), neogenetics allows much more rapid and profound change. Rather than waiting for a newly created organism to grow, plasmids are passed along that change all cells and make the organism change rapidly.

This has led to the use of certain "base organisms" which are used for a multitude of purposes. In the tropics various forms of quasibanyan are used for mid-sized structures and industrial bamboo for smaller ones. Rapidly growing algae and water hyacinths are used to gather biomass and energy for bigger projects, where digester organisms turn them into useful neogenetic biomass.



Figure 14: Ladder tree (Arbormsmith.com)

Antiplasmids

Substances that neutralize free plasmids have been developed and are in widespread use. Most simply denature any free nucleic acids, although more elaborate treatments also seek out plasmids in particular and chop them up. Given the spread of Blights and some plasmide weapons, this is very necessary. Space quarantine often involve repeated baths in antiplasmid solutions, both chemical and nanotechnological.



Figure 15: Willow house (Marcel Kalbrer)

Bioweapons



There are far too many nasty bioweapons around these days. Terrorists were already well on their way towards designer plagues when the Hosts showed up and made them look like toyguns. The main driver for the medical paranoia of today is not so much Dragon infection as the numerous strains of bioweapons circulating.

Although immunized nations cannot attack each other using neogenetics directly, there are many indirect ways. As demonstrated by the Shandong conflict in 2056-57, the ability to create or breed arbitrary biological monstrosities could well meet conventional military forces. The Chiang Rai rebellion 2060 showed how neogenetic creations could be used to selectively wreck ecosystems and certain technologies.

While immunities do help protect against neogenetic attack, they are not always able to stop other attacks – a cleverly designed bacterium, virus or parasite can get past them, and poisons are always poisons. The botox grass of Kazakhstan is quite deadly to all mammals, regardless of their immune system. The Immunities try to update their resistances using “patch plasmids”, but there are always something getting past. As recently as 2099 parts of Brussels had to be evacuated as a strain of nerve-gas producing fungi were found in the sewer system.

Zombie infection

Someone seems to have translated *Cordyceps unilateralis* to work on humans. The result is a fungus that spreads with spores. As they are breathed in the fungus takes root in the nasal mucous membranes and extend hyphae along the olfactory nerve. The symptoms are at first cold-like with the addition of olfactory hallucinations. As the fungus spreads it affects the brain, inducing paranoia and an intense desire for height. Victims often hide on roofs or in trees, convinced others are out to get them. Eventually the fungus kills the host and begins to extend fruiting bodies through the head, spreading the spores in the air.

Botox grass

Spread by the 2050's Kazakhstani government to prevent refugees to cross the border. The grass is normal, but produces Botulinum toxin. The result is that mammals moving through the grass develop paralysis and die. Unfortunately it has been quite successful, and is slowly spreading unpredictably on the steppes – as well as around survivalist compounds and in random patches almost anywhere. Spraying with targeted *Fusarium* can get rid of it, but the apparently innocuous grass has to be identified first.

Contagious schizophrenia

The Berlin 2039 strain is believed to have been invented by Black Lotus, and claimed several hundred victims before authorities found an effective countermeasure. Since then it has reappeared in various places, including attempts by the Wuhanese government to infect enemy soldiers.

Grim reaper

A truly nasty bioweapon, essentially a contagious progeria plasmid. Victims start to age at a rapid rate, suffering hair loss, wrinkled skin, weakened immune system and arteriosclerosis. Most victims die within a few months from stroke or heart attacks. Appeared in Sudan 2058 (where it was blamed on the Voices) but has since then cropped up elsewhere, including a very nasty attack in the *Mayfair* habitat 2099.

Coturnism

A bioweapon triggering fatal rhabdomyolysis. The muscles of infected people start to dissolve, flooding the bloodstream with breakdown products that can lead to acute kidney failure. The first symptoms are pain, tenderness, weakness and swelling. This often leads to compartment syndrome, reducing the ability to use the limbs. The toxic effects makes the urine tea-colored or blocks urine production, and can trigger disseminated intravascular coagulation. Unless serious medical treatment is given acute kidney failure develops within a few days and leads to death. Even if the treatment fixes the toxin issue the muscle damage can be permanently disabling.

Weaponized tourettes

A plasmid causing disinhibition, tics, pica (the eating of dirt) and stereotypical movements. This was likely a copycat attempt by Lotus Eaters to imitate the contagious schizophrenia of their idols. Spread among non-immunized Scandinavians in the 2080's, causing the expression "swearing like a swede".

The Sleepless Army

War crime committed by the Yangtze Republic. Military Hosts developed a plasmid that "reformatted" the brains of people it was injected into, placing them into a hypnotic state. They could be controlled using a color code sent via radio to their pocket terminals and "programmed" with fairly complex sequences of orders. The Sleepless were fairly inefficient soldiers but entirely expendable (the army simply "recruited" enemy soldiers and civilians); in the right situation they could do tremendous damage before their neurological alterations proved lethal.