

## How to Make an Alien

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You have seen all the movies, read all the books, and have now decided to make your own alien so how would you go about it? To add fuel to the fire you just finished watching the *Outer Limits* TV episode, *The Architects of Fear*, where they tried to create their own alien, a Thetan. After watching you decide that you could do better. After all, you somehow managed to have your own functioning biomedical lab and after years of astrobiological research and being inspired by the Thetan you finally decided to create your own alien. So, what would it take to make an alien? Is it as easy as 1-2-3?

### Decisions, decisions

Initially you must decide what sort of alien you want to make. Do you want to create an alien that will unite the world, one that will do your bidding, or perhaps some other sinister purpose? A friendly alien or a not so friendly alien? Good, evil? Primitive or advanced? Human-like or physically different? How will your alien act? Will your alien have its own language or English? Simply stated, if you know *why* you want to create an alien then you will know what sort of alien to make. After all, the lofty intent of a group of scientists featured in the above mentioned *Outer Limits* episode, though misplaced, was to present an alien threat that would hopefully unite mankind to focus on the alien and thereby bring peace so their alien represented this concept. With a different intent then the design will also be different. For such an exercise it may be useful for you to create a back story about your alien so you can better plan your work in deciding what type of alien to make.

In creating your alien you will need to decide what design specifications are necessary to achieve your goals. To properly analyze all these questions we must not only understand the motivations of the scientist (purpose and use) but also what he ultimately wants to do with the alien. Because of all of the complex biological interactions that manifest themselves as the final product or beast then great care must be taken to insure the correct development of the alien. Many things can go wrong (and often do) so it is important to understand each and every step of the project and be able to make quick decisions as to what to do next; often it is improvisation.

Like life itself there are several levels of complexity that must be considered. A key point to be emphasized is that biological systems (aka, your alien) are much more than the sum of their parts. One note of caution, however, is that the larger the alien you want to create then the more complex will be its physiology. To better control the alien then you must have a thorough understanding of the

alien's peculiar biology and to counteract what can potentially go wrong (which we all know is exactly what will happen).

### Not of This Earth (NOTE)

First, we must understand what "alien" really means which, for our purposes, is 'Not of this Earth' or NOTE. As a limitation we will be referring to a corporeal alien and not a non-corporeal form such as gaseous or liquid. In other words, an alien with some sort of body, small or large. That being said it would be helpful to provide an appropriate point of reference, namely natural life here on planet Earth. If you make your alien on this Earth then can you legitimately say, "NOTE"? This impacts the definition of alien, both scientifically and philosophically.

It should be noted that life on Earth can encompass an amazingly wide range of living forms so we have plenty of examples to analyze. On Earth life thrives everywhere from the coldest to the hottest to the wettest to the driest to the acidic to the salty environments. Life seems to be teeming no matter where you look, even hydrothermal vents. Earth life forms that thrive on these edges are called extremeophiles. And with such diversification this gives us much real world examples of what life and DNA can really do.

### Molecular Biology 101

What is DNA? DNA, or deoxyribonucleic acid, is the hereditary material in humans that makes up genes, the master blueprint of our 'nature'. Our genes are composed of DNA. Just about every cell in a person's body (and most likely your alien) has the same DNA. Though most DNA is located in the cell nucleus there is a small amount of DNA also found in the mitochondria. (Note: mitochondria are organelles within cells that convert the energy from food into metabolic fuel.)

The information in DNA is stored as a code and made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). Human DNA contains about 3 billion bases and more than 99% of those bases are the same in all people. As in humans the order or sequence of these bases determines the information available for building and maintaining life. This should also apply to your alien.

DNA bases pair up with each other, A with T and C with G, to form units called base pairs. Each base is also attached to a sugar molecule (ribose) and a phosphate molecule. Together, a base, sugar, and phosphate are called a nucleotide. Nucleotides are arranged in two long strands that form a spiral called a double helix. The structure of the double helix is somewhat like a ladder, with the base pairs forming the ladder's rungs and the sugar and phosphate molecules forming the vertical sidepieces of the ladder, the rails.



Yours truly at his home office, also known as The Inner Sanctum of Awsomeness, holding a molecular model of DNA showing the internal base pairs and the outer supporting sugars and phosphates.

An important property of DNA is that it can replicate, or make copies of itself. Each strand of DNA in the double helix can serve as a pattern for duplicating the sequence of bases. This is critical when cells divide because each new cell needs to have an exact copy of the DNA present in the old cell. Even sterile animals like the mule (and perhaps your alien) has DNA that replicates so gene replication is different from whole animal/alien reproduction; DNA replicates all the time but the animal may not (alive but sterile). Replication, which occurs all the time at the cellular level, is different from infrequent reproduction which requires more complex biological interactions.

In the scheme of things DNA transcribes its code to RNA (a different more user friendly form of DNA) which in turn translates its code to protein. As goes DNA so goes protein and at the core all proteins are made by DNA. Therefore, for your alien, its DNA will transcribe alien RNA which in turn will make alien protein.

At least on the cellular scale. At the organism level different factors need to be considered (see below).

#### How life started

Two scientists, Stanley Miller and Harold Urey, conducted a series of experiments in abiogenesis – how life formed – in 1952 (same year yours truly was born) with a primordial soup of simple carbon molecules and appropriate weather conditions that a lightning storm would produce during primeval Earth. The end result was the creation of organic molecules of life so the primordial conditions of early Earth were conducive to making biomolecules which over eons and millenia formed life. This was a window into how the Universe creates the molecules of life.

#### Nurturing DNA

On Earth life uses carbon compounds for basic structures and metabolism, water as a universal solvent, and DNA/RNA to control and define forms. In the broadest sense, all life on Earth is based on DNA, our inherent nature. In addition to this we also have 'nurture' which is a little more flexible than nature. Nature is well defined whereas nurture is a moving target. Humans (or any life form on Earth) and a viable alien may have the same nature (DNA and protein based) but certainly do not have the same nurture. We can attempt to create an alien nature but what we can not do is define alien nurture. An important component of nurture are instincts. What are the natural instincts of your alien? Top on that list would be survival. Instincts and nurture will influence much of your alien's behavior.

#### Elements of the Universe

Based on the chemical elements found in the Periodic Table, which are the same ones found in the universe by cosmologists, then alien life is more than likely also based on these same elements, the molecules of the universe, the building blocks of the cosmos. These elements behave in certain ways which should be the same for Earth species or any alien. There are no other elements so *any* life, no matter where and what degree of sophistication, must be based on these same elements. And the easiest way to formulate life is one based on carbon, hydrogen, oxygen, and nitrogen (CHON). These are the building blocks of life. And from that the best way to make life happen is through some form of DNA or genetic blueprint that ensures fidelity of reproduction, *the* hallmark of any life!

As famed astronomer Carl Sagan said, "The nitrogen in our DNA, the calcium in our teeth, the iron in our blood, the carbon in our apple pie were made in the interiors of collapsing stars. We are made of star stuff." Since humans are made of "star stuff" then so are aliens and we may have more in common with them than not.

#### Carbon chauvinism

The element carbon has many properties that make it ideal for life's molecules. It is very versatile. An analog of carbon, silicon, is similar but molecules based on silicon are not as stable. Though silicon is more abundant on Earth than carbon the cosmic abundance of carbon to silicon is about 10 to 1 suggesting the versatility of carbon is preferred. Since carbon is far more abundant in the Universe than silicon it seems reasonable to assume that most if not all life forms are based on carbon. Life evolves and exists out of convenience so the easiest path is the one most chosen by Nature and that is carbon.

### Silicon

Silicon, element 14 on the Periodic Table, is in the same group as carbon and, like carbon, is tetravalent. Silicon atoms are larger than carbon atoms, have a larger mass and atomic radius, and have difficulty in forming chemical double bonds, a fundamental necessary pattern of life. Even so, silicon is essential for plant life but its use in animals is unclear. Though silicon itself is non-toxic some forms, such as asbestos, can cause cancers. Silicon is the second most abundant element on Earth (oxygen being the most abundant) and primarily found as silicon dioxide (SiO<sub>2</sub>), commonly known as sand, the primary component of glass. It has been postulated that alternates to carbon and silicon to form life may be germanium which is also tetravalent.

### Astrobiological observations

Astrobiologists have so far discovered 84 different molecules based on carbon and only 8 based on silicon, an analog of carbon. In general, as mentioned, compounds formed from silicon are not as stable as those formed from carbon. Even so, to make your alien it would be best to make use of the most abundant elements available and focus on carbon-based life forms.

### Alien in disguise

If you made a man with a sixth finger (like another *Outer Limits* episode), an alien compared to the rest of the population, then would it be a true alien? The sixth finger man was a man of the future, thousands of generations from now, so could he be considered alien in the 21<sup>st</sup> Century? This raises the question of how much different from *Homo sapiens* must the alien be to be considered alien? Is partly alien, such as looks human but has three eyes, enough to be considered alien, like the mutant, 'Marty', from *The Day the World Ended*? Or must the alien be totally and radically different from humans? Back to the Thetan. Even this being started out as a human and was transformed by a series of surgeries and hormonal treatments so NOTE has a different meaning here. Like the emperor with new clothes. No matter what he is wearing he is still the emperor. And, strictly speaking, no matter what our 'alien' looks like as long as there is Earth-derived DNA, like the Thetan, then it is truly not alien. To complicate the picture when a true NOTE alien does appear or is identified and it has DNA very similar to Earth life forms then the meaning of alien does indeed blur.

Even so, we have to start somewhere so using Earth-derived DNA is acceptable if for no other reason that *any* life form in the Universe will be based on DNA so Earth's is just as good as any one else's. As noted in the film, *E.T. The Extraterrestrial*, after examining the alien a scientist proudly exclaims, "It's got DNA!", suggesting the likelihood that any life form in the Universe will also be based on DNA.

Though based on Earth DNA the animals from the island of Dr. Moreau are certainly not human. Could it be argued that they are alien even though their basic DNA came from Earth? These animals may not look like a human but at the DNA level they would 'read' exactly as human with all the associated traits. Are they therefore truly alien? And then there is Klaatu from *The Day the Earth Stood Still* who is indistinguishable from other humans though his DNA should be quite different.

#### Alien biology

Most likely your alien will have complex biology and may even be a technological advancement, all of which would be DNA based. It is unknown how much alien DNA will be different from Earth DNA though there could be similarities. The (alien) Martians from H.G. Wells', *War of the Worlds*, both book and film, must be based on DNA. In order for these aliens to succumb to Earth's "tiniest creatures" and die from bacterial infections then there must be some compatibility in their DNA with Earth's DNA. The only way Earth's microorganisms could inhibit and destroy Martian life is by having similar DNA. The biomolecules made from Earth microorganism DNA inhibited or poisoned key metabolic processes in the Martians causing their deaths. Most likely, your alien will have some sort of susceptibility to Earth's diseases, germs, and viruses due to DNA compatibility so this must be taken into consideration.

What are the biological features of your alien? Alien life should be chemically similar to that found on Earth so can your alien adapt to life on Earth? Though there is the possibility of making an alien with quite different biochemistry using different classes of carbon compounds and other elements along with different solvents instead of water (non-water solvents), such as ammonia, various organics, and hydrocarbons such as benzene, ethane, and methane, most likely your alien will be CHON based. Technological advancement and biological complexity of your alien will still ultimately be dependent upon the limits of DNA.

Another consideration is what are your alien's needs? What will be your alien's living environment? If possible you should make an alien according to its perceived world to match its 'normal' environment. Does your alien have a place to stay or perhaps will live in the woods/jungle/desert/abandoned mine/cave/haunted house/lab/underground/etc? You will need to house your alien so accommodations will have to be made.

Some have speculated that there may be life on Titan, a moon of Jupiter. Such conditions as methane lakes and other liquid environments are capable of sustaining some sort of primitive life. If so, then it is doubtful such life forms could survive the conditions on Earth's surface, vastly different from those on Titan or any other such world. Therefore, for your alien to survive on Earth then it must adapt to Earth's conditions.

#### Form follows function

For life here on Earth form follows function and life being life, irrespective of where it is from, then most likely your alien will also follow these same underlying principles. If you want to make a flying alien then it would have a slim and lightweight body; for a water alien then streamlined for swimming; for a mountain climber then strong legs; for high altitudes then strong lungs; for a powerful alien then one with strong bones and muscles. Whatever feature you want there are most likely examples here on Earth to use as a starting point. Many arms, many legs, and many eyes are all possible for your alien.

To walk on land an alien would have some sort of leg or an ability to slither. In water, an alien, if large enough, must have some ability to propel in water. If an alien microorganism then this life form is subject to such vagaries as water currents and weather. On such a micro scale then the environment is important. Salinity, slime, water, soil (dry or humus), and smooth surfaces become central. Otherwise, for larger aliens, animal-sized or larger, the terrain becomes less important.

#### Starting material

Yes, to make your alien you will have to start with DNA but whose? There is the option of making synthetic DNA to start life but that would require extensive lab skills, materials, and equipment. (In the real world this has been done. Scientist Craig Ventner completely synthesized all the DNA for a mycoplasma organism that successfully reproduced. Furthermore, a completely synthetic DNA organism was created by computer that also reproduced.) To make the work easier it would be best to start with some sort of life form and this will be determined by why you want to make an alien. If you choose human-like then you start with human DNA. If you want to make an alien plant (what type) then you should start with plant DNA. Same with other life forms like birds, reptiles, insects, and microorganisms. How about an alien virus (like *The Andromeda Strain*)? Whatever function you want in your alien it would be best to 'steal from Nature' and use what is already provided. You can then mix and match genes that already exist and combine them to create your alien.

#### Reverse engineer

Instead of making an alien from scratch perhaps it would be easier to change one life form, ala Thetan, into another. If so, then how much to change? Is 10% enough? Man has about 21,000 genes so how many of these would you have to change to make it not human? Just a measly 1.5% change, about 300 genes,

separates man from ape so you do not need much of a change to make a significant difference.

To reverse engineer you will need the DNA (i.e., genes) of what special structure or need you choose and be able to insert it into the genome of your developing alien. For example, if you want to add wings then you will need the appropriate genes from the bird species of choice and integrate this into your alien, similar to how fly DNA was integrated into a human in the film, *The Fly*. The same molecular biology procedure or process will also be used for any other reverse engineer adaptation you want your alien to have.

By taking the reverse engineer DNA gene(s) and inserting it into your alien this would then be considered forward engineering in that you are adding genes (via DNA) or functions that will then create a new organism.

#### Communication

How will you communicate with your alien and how will it communicate with you and others? Will your alien speak or perhaps communicate via scent or body language? Does your alien have its own language? An ability to read and write? Will you need to spend some time teaching your alien to communicate? Part of communication is having sensory capabilities. Will your alien have all senses? If so, are any of them enhanced such as a keen sense of smell, more clarity of vision, and the ability to detect a wider range of sound?

#### One caveat

If you want to make an alien and have it live on Earth then the creature must obey some of Earth's 'rules'; air, water, heat, salinity, atmospheric pressure, oxygen, gravity, and sunlight are examples. If you make a true alien then can it survive on Earth? Does the alien need to be compatible with Earth forms to 'live'?

#### Size of alien

In aliendom size does indeed matter! There are five major size categories to consider. The first is micro-size and means anything not seen with the naked eye. Next is insect-size and means anything that is less than 150mm (about six inches long). Animal-sized is anything visible by the naked eye up to about 10Kg or about 22 pounds. The fourth category is man-sized and means anything between 10Kg to 250Kg (about 550 lbs). The last category is macro-sized and means anything above 250Kg. To place these five categories in terms applicable to making an alien we will use micro-sized, insect-sized, animal-sized, man-sized, and giant-sized. Considerations involve a single-cell alien to complex organisms, something Lilliput to Brobdinagian, a virus to Godzilla-sized.

Motivations for each of these sizes would also be different. A micro-sized to insect-sized alien would most likely be designed to be disseminated. An animal-sized alien could be made as a pet or guard alien. A human-sized alien could

have many purposes depending upon a single alien, a group, or an army. A giant-sized alien would be a destroyer.

Micro aliens always have the problem of “escaping into the atmosphere” which could mean the scientist and/or his staff could be unwanted targets. For small to moderate sized aliens these may be considered as pets since their size would be easy to contain in a good cage. Macro aliens, due to their size (and supposedly strength), must be contained in something very sturdy and easy to control. Our annoyed scientist would have to be very assured of himself to undertake such a project. The motivation here would have to be special since the scientist is potentially putting himself at great risk. Knowing this the annoyed scientist should engineer in some sort of ‘kill switch’ into his alien to control such extreme events.

#### Alien niche

All organisms, from micro to macro, live in niches or specific environments that are conducive to their health, survival, and reproduction. Depending upon your alien then its specific niche or proper environment must be identified and utilized for its optimal survival. Being able to duplicate this on Earth may be easy or problematical.

#### Nutrition

With a complex alien comes complex biochemistry. If your creature has true alien biochemistry, and therefore is truly NOTE, then where does the alien get energy and nutrition? What would be its food source? Moving, growing, reproducing, and any other activity is work and work requires energy. Energy can be obtained from a variety of sources. Other than the ingestion of food for energy there is also the possibility of obtaining energy from the sun by photosynthesis (where plants obtain their energy), or from heat. Solar energy is converted to chemical energy by plants (via sugar molecules). If the muscles of your alien use sugar as fuel then this can convert chemical energy to kinetic energy or movement (“nine tanna leaves gives him movement”). Even so, other elements could be needed for nutrition (the equivalent of bio-salts, bio-metals, co-factors, minerals, and vitamins) and your alien would have to have these available. An example is the Ymir from the film, *20 Million Miles to Earth*, an alien from Venus who does not eat vegetation or animals (goat) but eats raw sulfur (sulfur is the 8<sup>th</sup> most common element in human bodies). Seemingly, the Ymir could be a vegetarian and not a meat-eater. No matter what the diet incoming nutrition must be digested so some sort of gastrointestinal (GI) system is necessary since there are always metabolic breakdown products that must be eliminated and for complex aliens the easiest way to do this is by a GI system.

Based on the metabolic needs of your alien a food source could be something common on Earth (natural foodstuffs) or something unique like the Ymir who fed on raw sulfur. Based on the history of SF cinema most aliens appear to have no

problem seeing humans as food. (Maybe your alien could be something like 'Audrey' from *Little Shoppe of Horrors* that feeds on humans.)

An important component of nutritional energy use is oxygen. If your alien is aerobic and needs oxygen for metabolism (most likely) then the alien must have the ability to collect, distribute, and utilize the element. How does your alien carry oxygen? Does it need the equivalent of lungs to capture oxygen and the equivalent of blood to carry oxygen (and therefore a cardiovascular system to move blood around)? Lastly, what sort of brain or mind will your alien have? Will it have independent thought or do everything on (alien) instinct?

If oxygen is not needed for nutrition, though energy is needed for metabolism, then anaerobic mechanisms will be needed in which growth can occur without oxygen. Anaerobic growth conditions are strict, often sluggish, and many are inhibited by the presence of oxygen. Botulism is an example of anaerobic microorganism growth where toxins are made that are poisonous to humans.

#### Expenses

Three level of expenses are considered. The first is what it would cost to start and operate a small lab. The second is what it would cost to start and operate a medium sized lab and the third is what it would cost to start and operate a large laboratory. All this will of course depend upon what type of alien you want to make, micro to macro.

There are both fixed and variable expenses. The biggest expense no matter the size of the lab is the initial capital expenditure on equipment. Disposable supplies are used (and ordered) when needed. However, if there is a lot of clandestine work required then you might need to stockpile a large supply of necessary materials and keep an inventory for ready availability. With a sizeable inventory then storage space will be needed. All these issues will need to be considered. (And if large wagons of "scientific equipment" begin arriving at your secret lab then you can be sure the local villagers will take note and get their torches ready...)

#### Staff

Though most annoyed scientists are single-minded in their work and many do work in isolated environments they do need help. These lab assistants can vary considerably from a none to minimal education to well educated fellow scientists and physicians. Lab assistants can be either a benefit or a bane.

#### Failures and mistakes

During the development of your alien there will be the inevitable failure and/or mistake (or two...) and you must dispose of this (it? them?). Depending upon the particular phase of your program the problem could be one of a small nature and possibly just washed down the drain or flushed down the toilet and if of a

significantly large enough size then either incinerated, buried, fed to animals, pulverized, chemically or enzymatically destroyed, or otherwise disposed of.

There could be various levels of mistakes and failures that will have to be individually analyzed primarily so they won't be repeated again. In this regard you will have to use some sort of risk management assessment during the development of your alien, the particular phase of development it is in, and the means and methods necessary to deal with the problem. What are the potential risks (will it escape? Cause damage to others and surroundings?) leveraged against whatever possible gains can be had (and only in the eye and mind of the annoyed scientist) and what will be necessary to achieve the end goals?

Where to begin?

The smallest micro-sized alien you could make would be a virus. These are small pieces of DNA or RNA, often encapsulated for some protection, with the ability to overtly or covertly enter cells and disrupt cellular processes. What distinguishes viruses from true life forms is that viruses can not self-replicate; they need a host for this. Making an alien virus is probably the simplest form to make but for what purpose? Viruses are meant to infect and if you want to launch an alien invasion then starting with a virus would be the easiest way to go. If so, then what or whom do you want to infect with your alien virus? And to protect yourself you better have an antidote to the effects of the virus.

Encapsulation

At the micro scale, once you have your bit of alien DNA, it will need to be encapsulated with some sort of membrane to create a living cell. This membrane can be oil droplets, various hydrocarbon structures called micelles, or some other lipid soluble compound. Once the cell is created it will need to be propagated which can either be in a test tube or a living host.

For anything larger than micro do you want to start by making an alien egg or go to a fully formed and mature alien? Growing an alien will require nurturing which may not be of interest to you. One alternative is to start with an adolescent alien that can grow into an adult. The *why* you want to make an alien would dictate what age or maturity your alien will be and where to start.

Living forms must be able to separate biological functions from the environment. The most convenient way to do this is as a cell which contains all the necessary biochemical processes to sustain and reproduce. For complex life then cells must specialize such as bone cells, muscle cells, blood cells, and brain cells. These alien cells must also be self-replicating and self-replication requires some complex biology; many genes will have to work in unison for proper function.

Alien genetics, physiology & anatomy

For these biological parameters, anatomy, genetics, and physiology, we can only speculate since until we actually find one we really do not know what is truly

alien. Or even a little bit alien. For example, as mentioned, Klaatu from the film, *The Day the Earth Stood Still*, looks, acts, and behaves very much like a normal caucasian human. No one knows who he is. Ming the Merciless looks more human than alien. Though composed of human DNA, the above mentioned "Marty", the three-eyed human mutant from the film, *The Day the World Ended*, looks more of an alien than Klaatu.

Even the aliens from the film, *Alien*, are partly made up of human DNA so the definition of truly alien to Earth is indeed a moving target. The same for the alien in *The Thing From Another World*. These aliens could easily assimilate human/Earth DNA (even animals like a dog) so their DNA must have some sort of compatibility with all forms of DNA.

The comment in many popular films, "we want to mate with your women" implies genetic compatibility, a very strict requirement here on planet Earth (one of the reasons why elephants and birds don't mate, not to mention all the fish in the sea; they are all genetically incompatible) which is most likely why alien-human conception will not happen.

On Earth the look of an alien is more important than his DNA sequences. A gender transexual may look like a particular gender but they can not hide their DNA from their birth genes. So, here on Earth, for better or worse, we judge aliens by how they look and not by what they are.

#### Invertebrate vs vertebrate

A key early decision to make is once you decided your alien will be larger than micro-size then will it have a spine or not. All vertebrates have spines whereas invertebrates do not and examples are worms, insects, and some aquatic life (jelly fish, octopus). The genes necessary to make a spine involve many physiological support structures.

#### Skeleton vs exoskeleton

If your alien is insect-sized then an exoskeleton would provide adequate support and protection. For anything larger than 150mm an exoskeleton would not be sturdy enough so an internal means of support is necessary and the easiest way to do this is with a skeleton. Skeletons are made of bone and cartilage so considerations must be made for bone design. Bones for support and bones for movement and manipulation will need to be designed.

Furthermore, if your alien is animal-sized or man-sized then is clothing or some protective outerware necessary? To be considered here are the influence of internal heat and warmth which can influence body shape/physiology and help determine whether clothing is needed. Internal heat and warmth are due to metabolism; some aliens could have higher levels than others (on Earth, compare warm-blooded to cold-blooded animals; the difference is metabolism).

Will your alien contain or use any sort of robotics? Will your alien be a pseudo-android composed of robotic components as well as living (alien) tissue, something similar to the main character in the film, *The Terminator*?

Finally, anything needing a skeleton, from animal size on up, some sort of skin (thick? thin?), plating, scales, or otherwise covering will be needed over the bones. The bones will determine the shape whereas this 'skin' will ultimately determine the look of your alien.

#### Radiation

If your alien has a need for radiation (for example, the alien from the film, *Kronos*, was in search of radiation) then this will have to be satisfied. Radiation could serve as a source of energy for your alien. However, life forms based on carbon are susceptible to mutations with exposure to certain radiation sources so this could be a double-edged sword.

#### Laboratory to create an alien

To make your alien you will need a place to do the work and a laboratory would be the best suited environment. So, what sort of lab do you need? Well, the type of lab will depend upon what sort of alien you want to make. If you make something small (molecular alien?) then perhaps a small space is needed. If you make something large that may require a cage and/or sophisticated life-support equipment then a larger space is needed. Maybe something outside a formal lab like an enclosed terrain (or an isolated island) is necessary if your alien needs to roam. Important to consider here is the relative aggressive nature of your alien. Will it be passive or aggressive?

In many respects you do not need a sophisticated lab to do the work, just functional. A kitchen or garage would be sufficient for some procedures. Fundamentally making any life form will require biology. With biology you will need some sort of cold environment (refrigerator/freezer), a sterile environment, and equipment to measure and monitor your work and progress which could be simple to elaborate depending on the level of work needed.

Some of the proposed work will go in stages or perhaps phases and the building of your lab can reflect this. Most likely early phases of the work will involve bench work, some more elaborate and sophisticated than others, which may not require much space. As your research and your alien progress then perhaps additional space and relevant equipment may be necessary and you will have to expand where needed (and have the resources to pay for it). Another stage is taking your alien out "into the field" for evaluation and further experimentation. As your alien develops you may be getting more and more away from a lab setting.

If any manufacturing is to be done in the lab then space will have to be available for this. Both space for the hardware and processing steps will be necessary.

### Source of water

Here on Earth water is life and without it life would not exist. Water is also the universal solvent. Water is a polar molecule that forms hydrogen bonds which give it its unique properties. Water can exist in three different physical states at the same time: ice, liquid, vapor. All of life's DNA-based chemical processes could not occur without water.

Water is a key component to any biological lab and there are various sources of water available. The purity of water is measured by how well it conducts electricity as measured in ohms. With more impurities the electrical conductivity of water dramatically changes and therefore, easy to detect and measure. Absolutely pure water ("ultrapure water") has a measure of 18 ohms. It is 18 ohm water that is mixed with drugs intended for injection in patients. The Food and Drug Administration (FDA) that oversees all drugs in the US require water for injection to be at 18 ohms. Tap water, nowhere near considered pure water, can have 10,000 times higher electrical conductivity and seawater still more with up to 50,000 times higher. Even water currently obtained in plastic bottles, purported to be "pure" is about 20 times higher than 18 ohm water. To create 18 ohm water in your lab you need a series of ion exchange cartridges and a water purifying system in place. This is not that difficult to do and many labs have such a water system. However, the annoyed scientist need not worry too much about the purity of his water. As long as he is reasonably close to 18 ohms this should satisfy most of his requirements.

### Chemicals

The list of required chemicals can be simple to the extensive. Fortunately, there are many readily available chemicals, some obtained from chemical companies to ordinary household products, so no matter what sort of experimental work you propose there are chemicals that can help. Most of these are for buffers and commonly used liquids and reagents. Like many household items that require special storage conditions (in refrigerator/freezer, out of direct light, not near an open flame, etc) those chemicals that react with each other should also be kept separate for storage.

Some general chemicals that will be necessary for just about any application are common salts of sodium and potassium, some common acids like hydrochloric acid (HCl), sulfuric acid (H<sub>2</sub>SO<sub>4</sub>), and acetic acid, some common bases like ammonium hydroxide (NH<sub>4</sub>OH), and some common solvents like alcohol and methanol.

For some molecular biology procedures a special set of buffers and enzymes are necessary to deal with the many variants of DNA and all the "molecular tools" and "molecular scalpels" necessary to deal with this. Also, for organismal biology a different set of chemicals are necessary and if you start at the DNA level and end at the animal-size or larger alien level then you will need all of the above.

### General lab equipment

No matter the level or degree of the proposed work there are some general pieces of equipment you will need such as a microscope, Bunsen burner, syringes, glassware (beakers, flasks, test tubes), fire extinguisher, computers, and a refrigerator/freezer. You will need a means to measure and weigh various materials and chemicals. You will also need a centrifuge (the type and style will highly depend upon the proposed work), and a spectrophotometer (an instrument which measures various wavelengths of light). Most likely during the work you will need to separate molecules and mixtures from each other (for example, removing contaminants) and the most common way to do this is by various chromatography procedures. All of this will require sufficient electrical power to operate.

### Specialized lab equipment (which is specific to which alien you make)

The nature of your alien will determine whether you will need any specialized pieces of equipment such as a cage(s), autoclave, specialized glassware, liquid nitrogen, tissue culture capability, plant soil analyzers, seawater containers and tanks, temperature control units, specialized spectroscopy, a surgical suite, and some sort of containment facility.

### Jack of all trades

To do all the work you must be a master of the various pieces of equipment you use to conduct your research and carry out your experiments. You must not only know what pieces of equipment are needed you must also be able to troubleshoot and repair them when they malfunction. Some sophisticated pieces of equipment can be very temperamental and difficult to maintain in top condition requiring constant attention and in some cases constant use. And, of course, you will need tools and equipment to build, fix, repair, and modify the various lab instruments. (Now, where is that Phillips screwdriver?)

### More questions

To make your alien supplies will be necessary. What supplies do you absolutely need and what can you do without? What sorts of “substitutes” can you use if resources are limited? To economize are there any items that can be repurposed as dual use items? In addition, there is equipment which will depend upon the type of alien you want to make. Can any of your procedures be outsourced or will all of it be ‘in-house’? If you need privacy then your work can be done in a garage, kitchen, storage unit, isolated cabin, castle, or even your lone island, all depending upon your resources.

### Success! Now what?

Lastly, once you make your alien what are you going to do with it? Was the making an end in itself or a means to an end? These are questions that only the alien creator can answer. Once you make one, and survived the process, then are you going to make another? Afterall, in the making process you learned

much and can now apply this knowledge to another project. What will you choose?

Based on the many science fiction aliens in films many of the scientists do not survive an alien encounter so caveat emptor, buyer beware. These scientists typically meet some sort of scary grizzly end exacerbated by these aliens. Knowing this, you should take extra precautions to make sure you too survive!

Alien examples

Some of the author's favorite examples in film:

Small-size (micro-size to insect-size)

An alien virus (*The Andromeda Strain*). *Last Man on Earth* microorganism. Tribbles from TV's *Star Trek*. The 1994 film, *Mosquito*, in which an Earth mosquito lands on a just crashed alien, sucks its blood, thereby making an alien mosquito. Triffid seeds that arrived on a comet.

Medium-size (animal-sized to human-sized)

Dog alien from *Alien 3* to *The Thing From Another World's* imaginative blending of alien DNA with human DNA. Full-grown Triffids, alien plants from *The Day of the Triffids*. Klaatu. Aliens from *It Came From Outer Space*. *Independence Day* aliens. *War of the Worlds* martians. The aliens in the film, *Alien*, and its sequels. And many examples of TV SF aliens: *Star Trek*, *Doctor Who*, *Space 1999*, and, of course, anything from the *Star Wars* universe.

Large-size (anything bigger than human)

Space Godzilla; King Ghidra; Blob; *Starship Troopers* warrior 'bugs' (from planet Klendathu)

## Summary

In one respect alien life that is NOTE can never be made on Earth since all forms of Earth life, from single-celled to man, are all based on the same DNA and metabolic processes. A true alien could have DNA but have a totally different biology and metabolism (for example, the ability to eat tree bark). It would be difficult to imagine any sophisticated life form, alien or otherwise, not formed from DNA. Genes are genes, earth-bound or alien, but how they get expressed, regulated, and ultimately nurtured could be, well, very alien.

Humans have traces of at least 60 chemical elements in our bodies; oxygen being the most abundant with carbon in second. Other elements include calcium, sodium, potassium, chlorine, sulfur, iron, and magnesium. Believe it or not humans even have some naturally occurring radioactive elements in our bodies, all a part of Nature. If humans have all this then the likelihood that any alien species would have them too is high. As such, these elements will most likely also need to be incorporated into your alien.

Even so, DNA is DNA irrespective of where it is in the Universe so making an alien may not be as foreign as you may think. The molecules of life: carbon, hydrogen, oxygen, and nitrogen (CHON) are the building blocks of the Universe and life anywhere will have some composition of CHON elements. We and aliens are made of the same CHON star stuff.

So, is it as easy as 1-2-3? Even for micro scale aliens the task is not an easy one though certainly one within reach. Larger aliens are more problematical since a true alien would be out of its environment and comfort zone and in unknown situations means unknown behaviours and perhaps deadly consequences (which happens in just about every SF film). Therefore an alien environment would bring out alien nurture.

If you are successful in making your alien then most likely we will hear about in the press. Hopefully, it won't be the obituary page! [headline: Scientist who created alien killed by same]

Thank you for reading. It's back to the lab for me. Stay healthy and eat right.