Help Topics

Creature poses: Summary
Facial Expressions

The Genetics Kit

Genetics Kit Applet for Windows 95, Windows 98 and Windows 2000.

Written by Toby Simpson and David Bhowmik, based on the original Gene Editor by Steve Grand.

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Documentation by Toby Simpson, Eric Goodwin, David Bhowmik and Gavin Buttimore, graphics by Sean Nicholls.

Help file version and build information

This is a complex application. We accept no responsibility for any loss of data incurred as a result of using this software.

Genetics and the Genetics Kit

The information required to build real living systems is held in a molecule called DNA (*d*eoxyribo*n*ucleic *a*cid) – a long string of individual instructions, named genes. One of these strings of genes is called a chromosome, and a complete set of chromosomes (humans have 46, Norns have one) is called a genome. Creatures has a similar, albeit simpler, system that is comparable to DNA which we call Digital DNA (D-DNA). In nature, each cell carries a complete set of genes to build an entire organism. In Norns however only one D-DNA strand is kept for each creature. The genes in Creatures code for organism structure, with genes describing the chemical reactions, physical structure, brain layout, instincts and so on. The behaviour of your Norns is not specified by genes, instead, just as in real life, behaviour *emerges* from the structure. In the normal course of events, Norns breed, and a new creature is created from the D-DNA of the two parents ith some random mutations to make it unique.

Intended Audience and Further Learning/Reading

The Genetics Kit is a complex piece of software, and requires patience and an investment of time in order to achieve the best results. This help file does not attempt to teach you the biological principles of genetics, but we do recommend some excellent books and papers should you wish to learn more:

- *The Cartoon Guide to Genetics (Revised),* by Larry Gonick and Mark Wheelis. Harperperennial Library, 1991, ISBN 0-0627-3099-1.
- *Creatures – Strategies and Secrets*, by Toby Simpson. Sybex Inc., 1997. ISBN 0-7821-2202-7. See http://www.sybex.com.
- *Creatures 2 – Strategies and Secrets*, by Toby Simpson. Sybex Inc., 1998. ISBN 0-7821-2440-2. See http://www.sybex.com.

Introduction

Real living systems are incredibly complex. Your DNA contains the instructions for synthesising the amino acids necessary to construct the proteins that eventually make your cells—all ten trillion of them. You have around 100,000 genes, or instructions, and each of the cells in your body carries a complete copy of them. Your genes code for *structure* rather than specific behaviour. There is no gene that allows you to walk to work, for example. This is something that emerges from the systems created from your DNA. Whilst in Creatures it has not been possible to model genetics at a protein level, we have stayed true to the principle of genetics—in that we code for structure, not behaviour.

The Creatures system consists predominantly of three parts, all of which are genetically specified, and subject to mutation over generations:

- **Biochemistry**. As life is dependent on reactions in a soup of complex chemicals, Creatures contains a biochemistry modelling system. This is used throughout a creature to handle a wide variety of systems, such as the digestive, reproductive and immune systems as well as providing the vital structure for creature learning. These systems are contained within organs in the creature's body.
- **Brain**. The control centre of animals is the brain, a collection of neurone cells arranged in "networks" out of which intelligence (and in the case of humans, consciousness too) emerges. Neurones "learn" by strengthening or weakening their connections as a result of chemical feedback. Creatures has a brain model inspired by real biological brains.
- **Morphological and Creature features**. Creatures are bipedal, and because their individual body parts are drawn, there is minimal scope for massive physical changes in them. However, the parts themselves can vary (there are several sets in circulation), as can their animation sequences (poses) and colour tinting.

Supporting the systems in this list is Digital DNA—the genetic code that specifies it all. There are 19 gene types in total (Click here for a full list), divided amongst the above three systems (and the organs containing the biochemistry). In the following few chapters, we go through these in more detail and discuss how they are applied within Creatures to build the Norns, Ettins and Grendels.

The Genetics Kit allows the Creatures genetic code to be edited, and new eggs and creatures created.

Users already familiar with the Genetics Kit for Creatures 2 may wish to look at a summary of the major changes.

Notes for users familiar with the Creatures 2 Genetics Kit

The Genetics Kit for Creatures 3 operates substantially the same as the original product for Creatures 2, so you will find the user interface familiar.

Many new features have been added to aid in the development of large genomes and handle new features in the Creatures 3 system such as neuro-emmiters and brain tracts.

Some general points for experienced Genetics Kit users:

- Brain lobe functionality is now completely soft encoded using a new SVRule system.
- Dendrites are encoded in their own gene type that groups them into brain tracts that describe connectivity and functionality. Functionality is completely soft encoded using SVRules.
- New gene types for brain tracts, neuro-emmiters and facial expressions are provided.
- Improvements to the user interface. Specifics include: Improved presentation of general information including brain summary and brain variables.
- Receptors can now bind to the reaction rate locus as well as organ clockrate locus, to allow individual control of enzyme reaction rate.

What can you do with the Genetics Kit?

The Genetics Kit allows you to display and manipulate the genetic codes that describe Norns, Ettins and Grendels, and generate new eggs and Digital DNA (D-DNA). In summary, you can:

- Create Digital Clones of existing D-DNA.
- Breed existing D-DNA strands to produce new eggs.
- Edit a wide range of individual genes.
- Remove add or edit certain genes

What can't you do (and why) with the Genetics Kit?

The Genetics Kit imposes some limitations on how some genes can be edited. These limitations are designed to prevent the construction of organisms that could not live in the Creatures world.

Don't expect miracles

Evolution took 3.7 billion years to come up with human beings, and a whole lot of generations. Even with the benefit of copying nature, it took us nearly two years to come up with the D-DNA behind the Norns in Creatures. Having said that—anything is possible.

Structure, not behaviour

Bear in mind that you are tinkering with the structure of life, and that genetics dictates a creature's structure, from which behaviour naturally emerges. **If you reduce the structure, you'll reduce the behaviour.** This means that if you are planning on using the Genetics Kit to create immortal Norns that do not need to eat, or that can give birth in seconds, then you're barking up the wrong tree. By removing genes such as those in the immune, reproductive or digestive systems, you **will** make stupider Norns. If you really want to make super-Norns, you would be better off improving the genetic structure, and enhancing the component parts of the Norn physiology, such as the digestive system. By doing this you can open new possibilities and new structures, out of which improved behaviour could emerge.

You may slow Creatures down

The D-DNA of your initial Norns, i.e. those for the eggs in the Hatchery consist of 810 genes. It is likely that by increasing the gene count substantially, or increasing the neurone count, you will slow your program down. You will need a fast computer to run Norns with a couple of thousand neurones (a "generation one" Norn contains about 970 neurones).

You could crash Creatures

It is possible to specify systems genetically that the Creatures application cannot build because they are either impossible, or were never intended. Should this happen, check carefully that you have all critical genes that you need before reporting the issue as a bug. Also, see Notes on creating genomes from scratch.

Remember! The keys to using the Genetics Kit are ***patience*** and ***care and attention***.

Genetics Kit: Page and menu summary

The Genetics Kit consists of a number of pages for manipulating D-DNA, and injecting the results into the Creatures world. Through the menu you can access specialised on-line help:

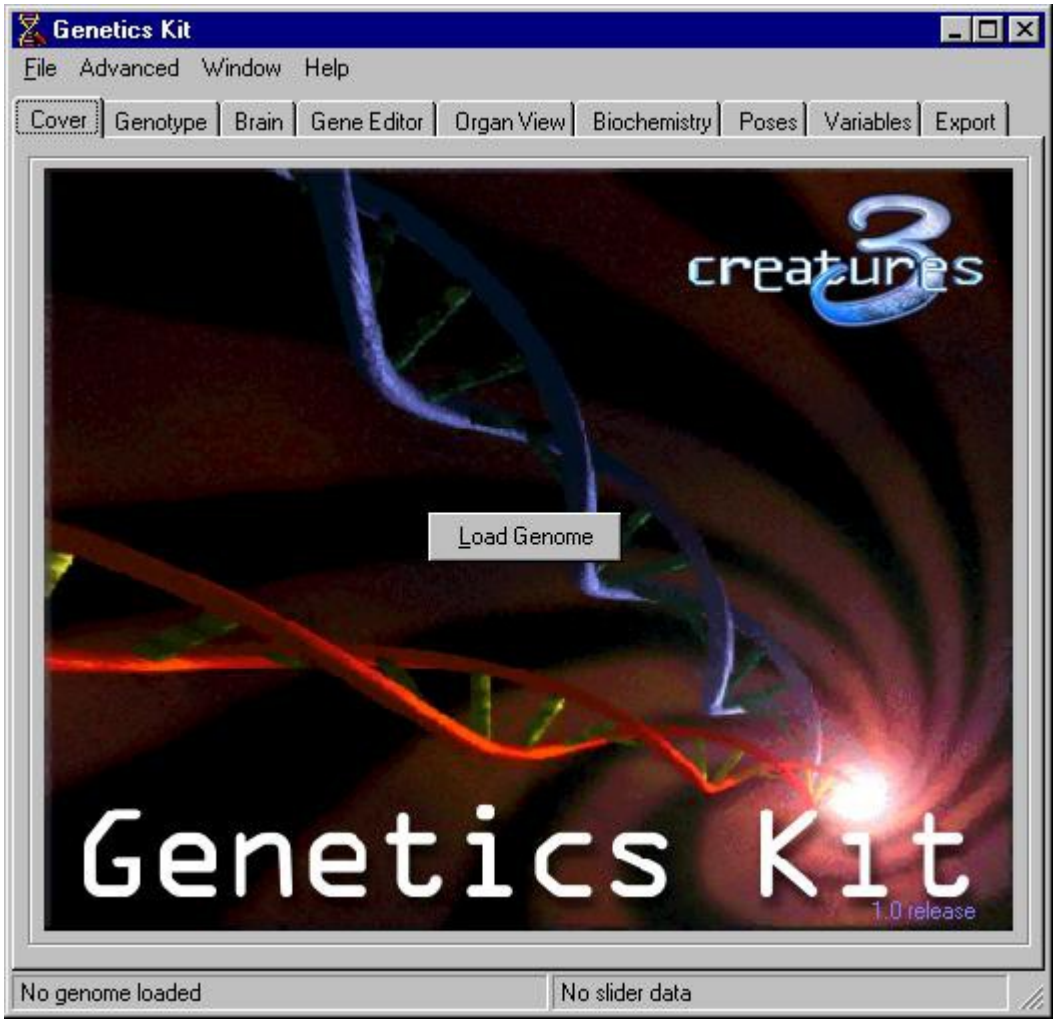
Click here for a reference table of all menu items.

Page Reference

Cover	Cover page, and a button to load genomes. Version information is also displayed.
Genotype	Genetic summary of different gene types in the loaded D-DNA strand.
Brain	Summary of brain genes in the loaded D-DNA strand.
Gene Editor	Full list of genes, with buttons for deleting and renaming. Also has a control for editing genes, and creating new ones.
Organ View	List of genes inside organs. This is restricted to receptors, emitters and reactions and allows you to navigate your genome by organ.
Biochemistry	A list of all the chemicals in Creatures with descriptions. You can also add new chemicals from this page.
Poses	Display and editing of the pose names used to describe the positions of limbs for specific poses.
Variables	A list of brain variables with editable variable names for use in lobe and tract SV rules.
Export	Controls for creating new eggs from the loaded D-DNA, or even breeding it with existing D-DNA. Also includes basic macro language execution.

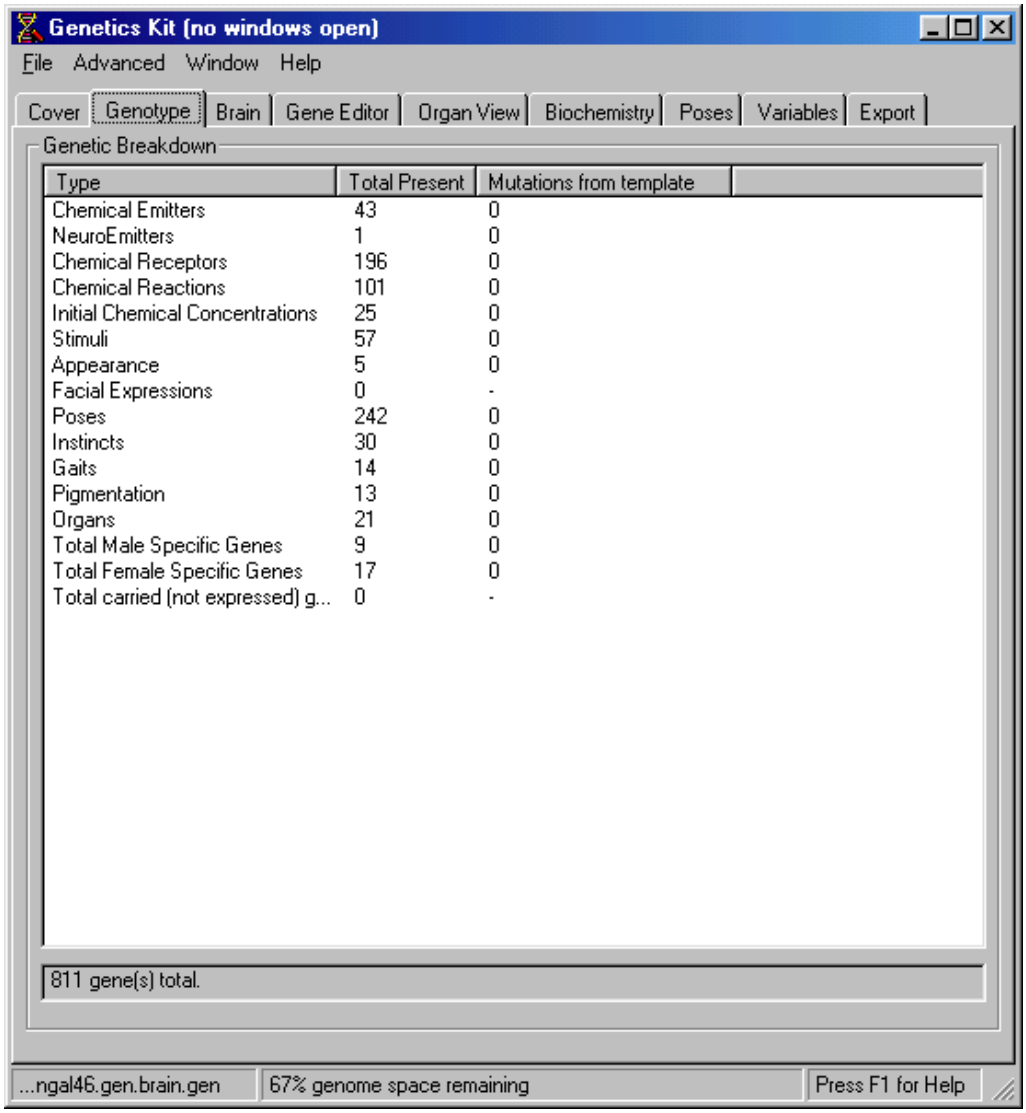
Cover

Genetics Kit cover-page. Version is shown bottom right, and a button for loading a genome appears at the base of the title image. This button mirrors the "Load Genome" menu option on the File menu.



Genotype

Shows Genetic Summary of different gene types and brain composition.



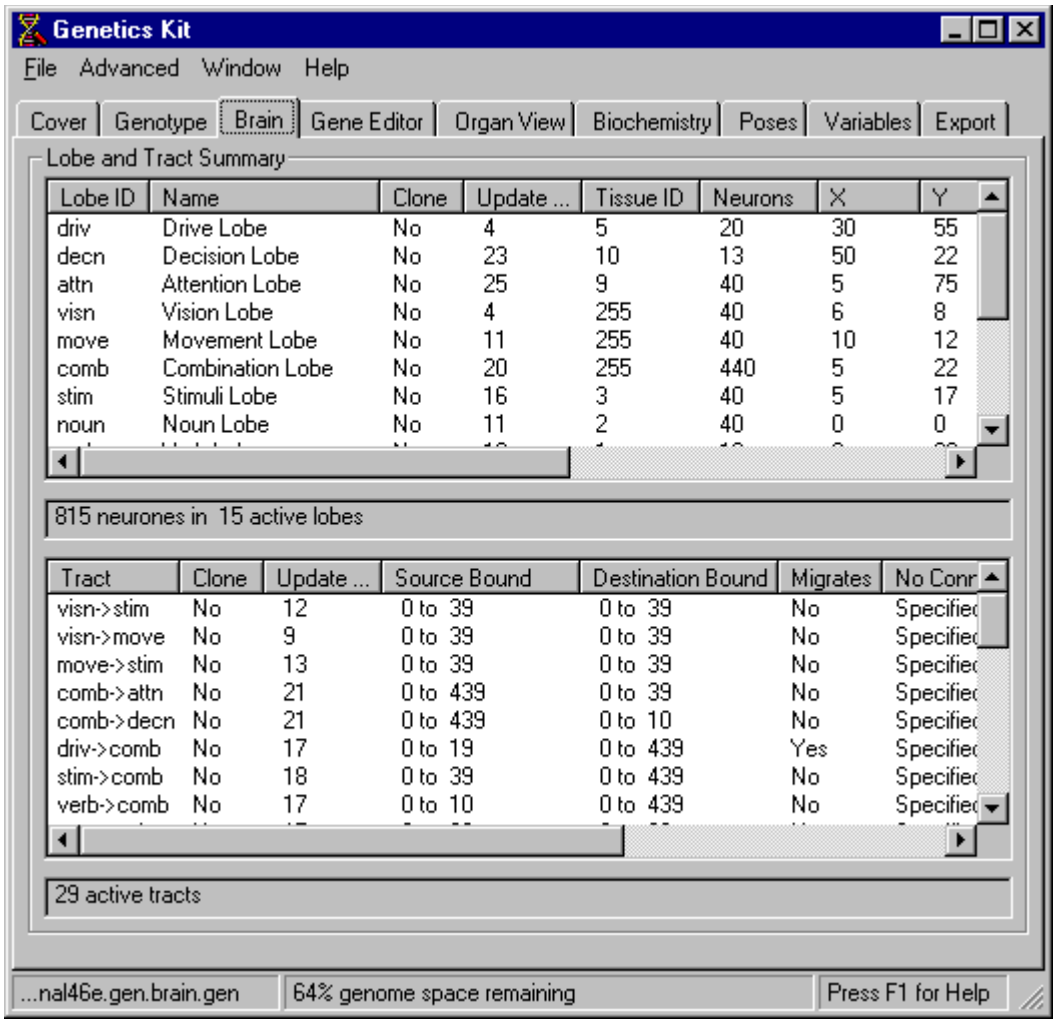
The frame shows a summary of the currently loaded genome. It summarises the genetic makeup, and total quantities of each type of gene—also showing the exact number of male or female specific genes.

Note on "Mutations from template" column:

The value in this column of the **Genetic Breakdown** frame shows the difference in gene count between a template Norn and the currently loaded genome. This is based purely on gene type counts rather than an individual nucleotide comparison.

Brain

Shows Genetic Summary of different brain gene types and brain composition.

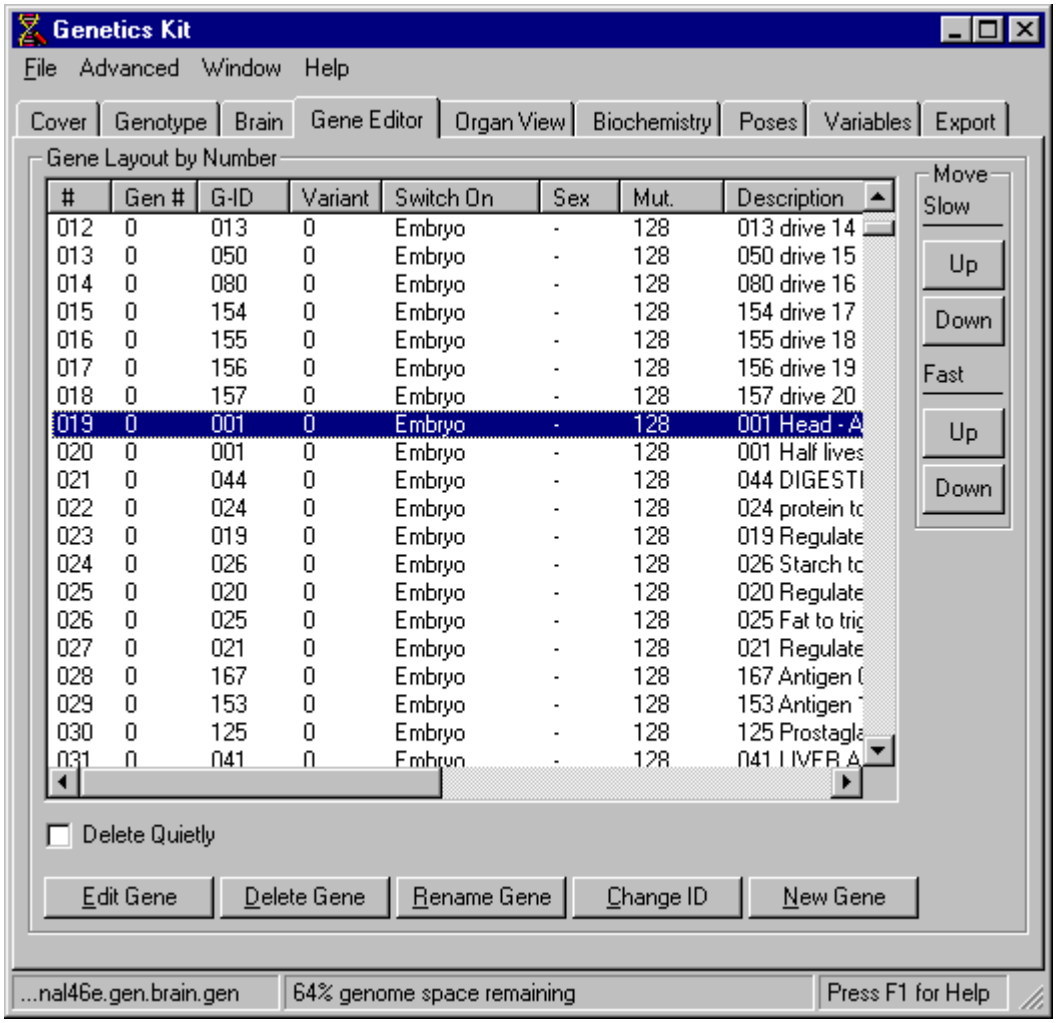


The top frame breaks down the brain structure into individual lobes, and shows critical information concerning each lobe. This includes the **Width** and **Height** in neurones, the total number of neurones present, **Update times** and the state rules. Click here for more information.

The bottom frame breaks down the brain structure into individual tracts, and shows critical information concerning each tract. This includes the connectivity**, Migration**, **Update times** and the state rules. Click here for more information.

Gene Editor

Main Gene Editor window allowing the complete gene list to be viewed and modified. Genes can also be deleted or created from scratch.



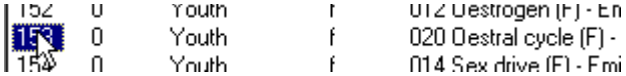
Primary Gene Editor page. All editing, creating and deletion of genes takes place on this page. Genes can be selected by clicking on them. A gene must be selected before using **Edit Gene**, **Delete Gene** or **Rename Gene**. No selection is required to create a new gene using **New Gene.** Specific genes can also be edited by double clicking on them in the gene list. Right clicking on them will bring up a context sensitive menu:

- Edit gene
- Rename gene
- Delete gene
- Create a new gene

In summary, the buttons and their purposes are:

Edit selected gene

Edits the currently selected gene by opening its gene window. This operation can also be achieved by double-clicking on a gene in the main list:



Delete Gene

Delete selected gene

Deletes the currently selected gene. Confirmation is required. Once the gene is deleted, it is removed forever and cannot be recovered unless restoring from a backup genome file.

Rename Gene

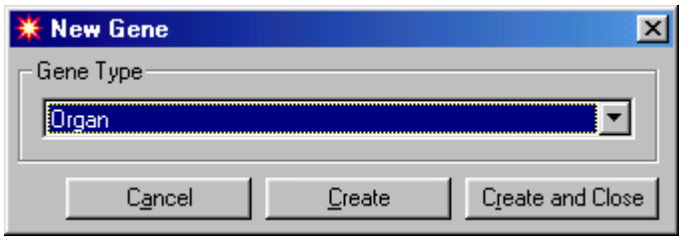
Rename selected gene

Rename the user description for the currently selected gene. See warning below.

New Gene

Create new gene

Opens the "New Gene" window allowing for one or more genes to be created:

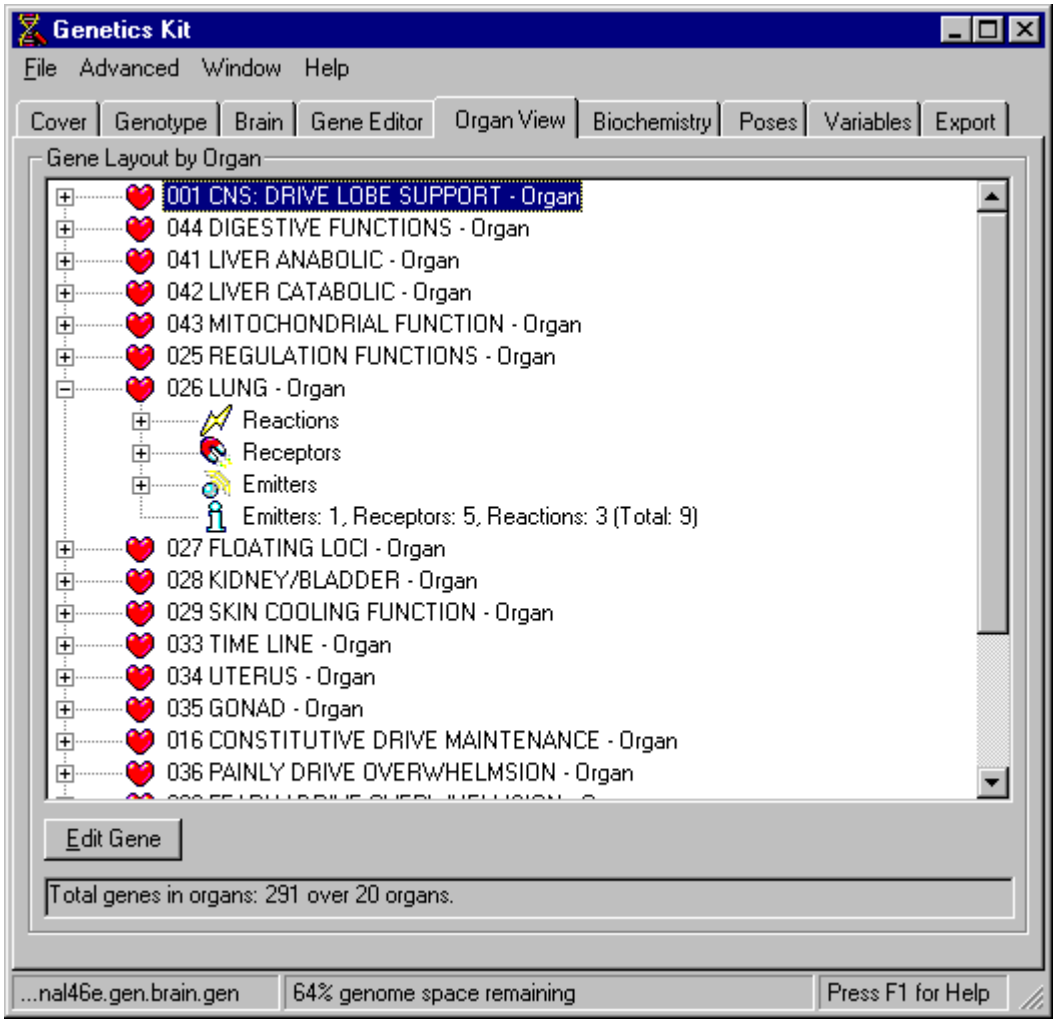


There are 19 gene types. To create a gene, select the type from the drop-down box and click on the **Create** or **Create and Close** button. Using **Create** will leave the New Gene window open, allowing you to create lots of genes in one session.

Gene name information is **not stored** inside the genome itself, as that contains just the genetic data. Instead, all gene names (called "captions") for any given species (Grendels, Norns, etc.) are stored in a special file called "species.gno". When you create your own Digital DNA, new "GNO" files are made and stored in the genetics directory for each genome you make. If this cannot be found, or is separated from the original D-DNA, then the default (species.gno) is loaded and a warning issued.

Organ View

The organ view window shows all the organs in the genome, and allows the display of individual genes (Receptors, Emitters and Reactions) by organ.

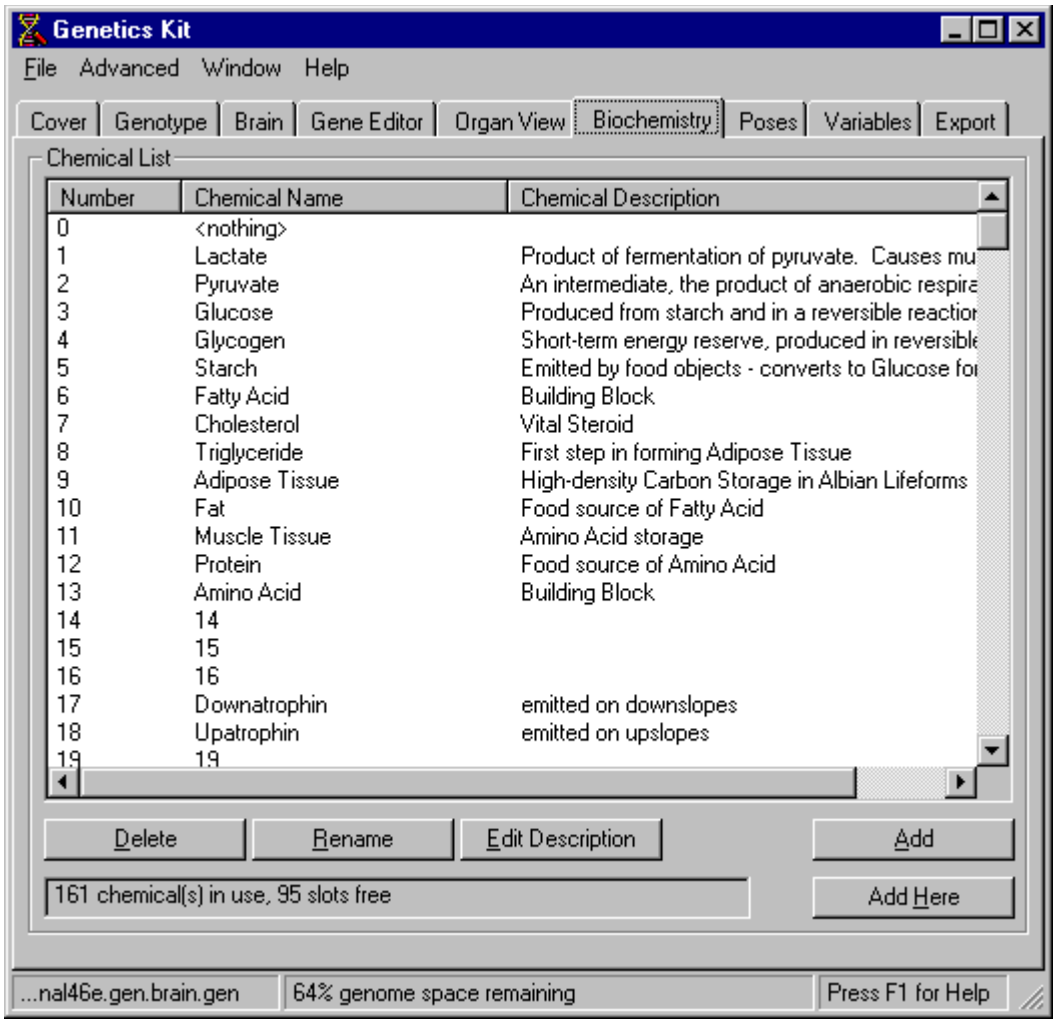


This displays all the genes that are found in Organs (receptors, emitters and reactions) inside the appropriate organ. Genes can be edited from this page in two ways:

- By double-clicking on a gene.
- By selecting a gene and clicking on the **Edit Gene** button.

Biochemistry

Display and edit the complete Creatures global chemical list.



Shows a complete list of all chemicals in the Creatures biochemistry system, along with their numbers and descriptions. These come from a file called "chemicals.txt" that is stored in the Genetics Kit folder.

Chemical processing is done numerically inside Creatures, so this naming procedure is only to make the system more human friendly. **Deleting the name of a chemical will not remove any genetic reactions that use that chemical!** If the chemicals.txt file cannot be loaded, chemicals are represented numerically.

WARNING!

Chemicals are global! If you create one in slot 80 called "Oxygen", and someone else also creates a chemical in slot 80 called "Deadly Poison" then **any genes you create to react with this new chemical will react in conjunction with other genes that also use chemical 80, even though it is for a different purpose.**

Actions can be initiated from buttons, or using the context sensitive menu (Right mouse button).

Delete selected chemical

This deletes the text name for the selected chemical. It does **not** delete any of the reactions with this chemical. **Be careful not to delete existing names.**

Rename selected chemical

Allows the entry of a new text name for a chemical.

Edit description for selected chemical

Changes the detailed description for the currently selected chemical.

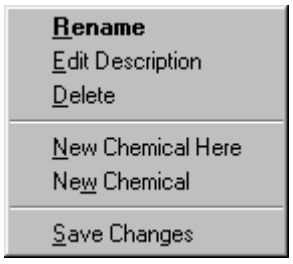
Add new chemical

Adds a new chemical into the first available chemical slot.

Add new chemical here

Adds a new chemical into the selected slot. This gives you the option to overwrite the existing chemical.

All the above options and an option to save changes to the chemical list are available from the pop-up menu. Click with the right mouse button:



These menu items echo the button controls. **Save Changes** is only valid if changes have been made to the chemical list, and is functionally the same as the **Save Chemical List** option on the **Advanced** menu:

To insert new chemicals into Creatures

Before you can view the levels of your new chemicals in the Biochemistry Set applet, you will have to edit the 'chemicalnames.catalogue' file in your creatures catalogue directory, and save it.

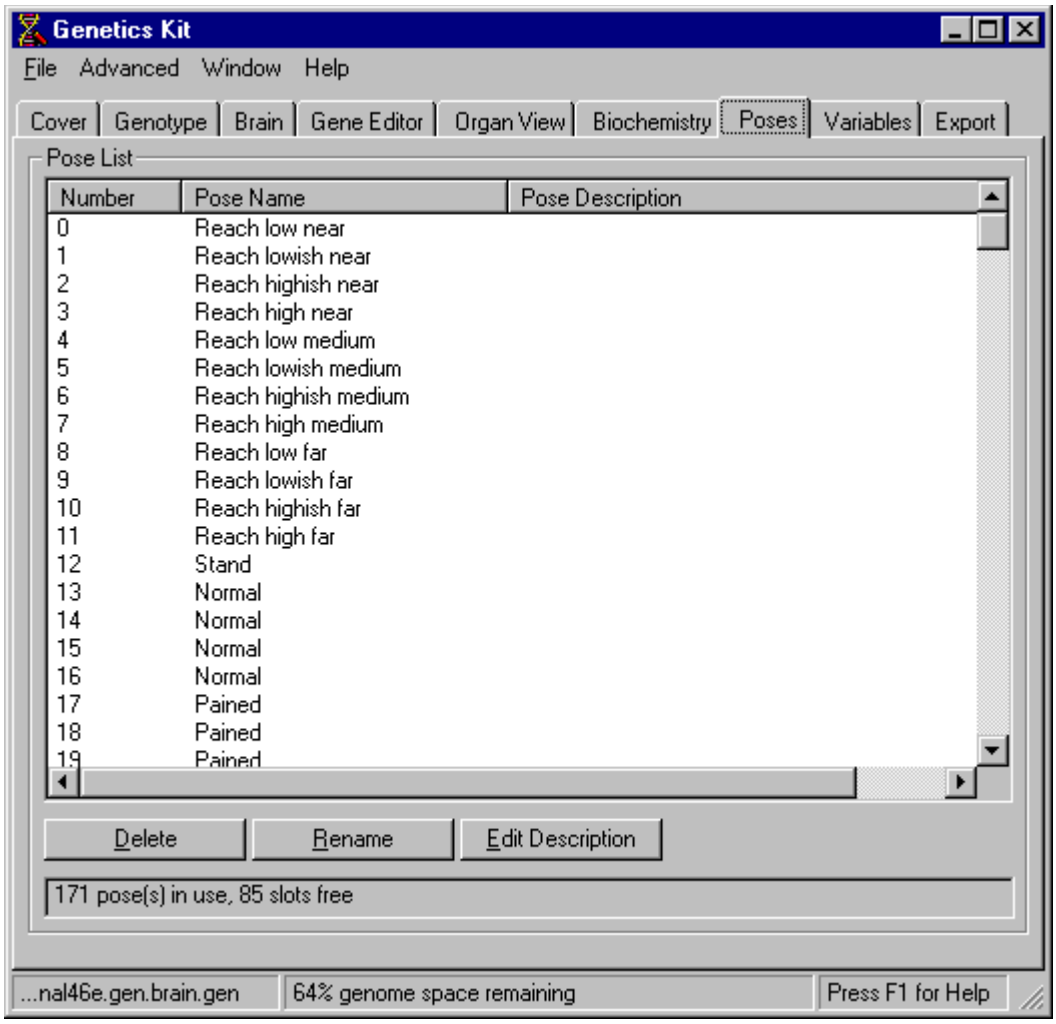
Please note that any new reactions will be working regardless of whether you have edited the chemical catalogue. The catalogue is required only so the Biochemistry Set is able to assign names to the chemical numbers.

Saving the Chemical List

The chemical text name list is not saved automatically. You must use the pop-up menu, or the "Advanced" menu. You will, however, be prompted on program exit if there are unsaved changes. **Saving the chemicals does not make them available to view inside Creatures—you must edit the chemical names in the catalogue file** (see above).

Poses

Display and edit the complete Creatures global pose-name list.



Shows a complete list of all pose names in Creatures, along with their numbers and optional descriptions. These come from a file called "posename.txt" that is stored in your Creatures folder. Pose names are **global**, so altering this list will affect all creatures. New poses can be added, and existing ones removed.

WARNING!

Adding new poses? You'll want to read this:

If you add a new pose and create new genetics to allow Norns to use it, you may clash with other users performing the same action.

Pose processing is done numerically inside Creatures, so this naming procedure is to make the system more human friendly. If the "posename.txt" file cannot be loaded, poses are represented numerically. **Pose names are used only in the Genetics Kit to make it easier to understand. Creatures uses the numerical representations.**

Adding a new pose will require new genetics to represent the pose in addition to creating a name and description here.

Deletes the selected pose

This deletes the text name for the selected pose. Genes using these poses will not be affected, only the text name is removed.

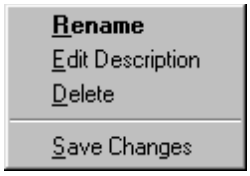
Renames the selected pose

Allows the entry of a new text name for a pose, and can be used to assign a name to a currently un-used slot.

Edits description for selected pose

Changes the detailed description for the currently selected pose.

All the above options and an option to save changes to the pose name list are available from the pop-up menu. Click with the right mouse button:



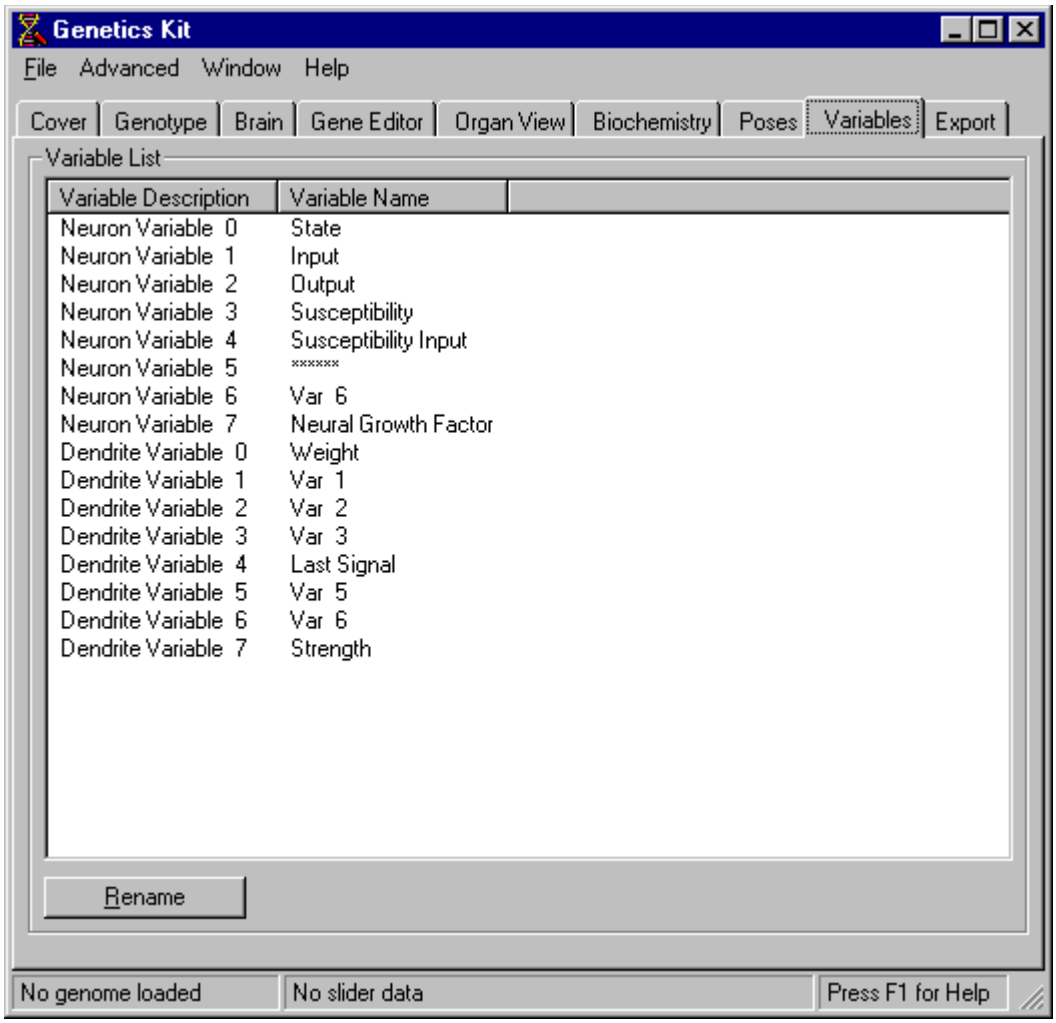
These menu items echo the button controls. **Save Changes** is only valid if changes have been made to the pose name list, and is functionally the same as the **Save Pose Descriptions** option on the **Advanced** menu:

Saving the Pose Name List

The pose name list is not saved automatically. You must use the pop-up menu, or the "Advanced" menu. You will, however, be prompted on program exit if there are unsaved changes.

Variables

Display and edit the complete Creatures global brain-variable-name list.



Shows a complete list of all brain variable names in Creatures, along with their numbers. These come from a file called "variablename.txt" that is stored in the Genetics Kit folder. Variable names are **global**, so altering this list will affect all creatures. There are eight lobe variables and eight tract variables. You can use these variables in SV rules to store values and perform calculations. You can not add or delete from the list but may change the names in order to make SV rules more meaningful to the task you encode them to perform.

Variable processing is done numerically inside Creatures, so this naming procedure is to make the system more human friendly. If the "variablename.txt" file cannot be loaded, variables are represented numerically. **Variable names are used only in the Genetics Kit to make it easier to understand. Creatures uses the numerical representations.**

Rename

Renames the selected variable

Allows the entry of a new text name for a variable, and can be used to assign a name to a currently un-used slot.

All the above options and an option to save changes to the pose name list are available from the pop-up menu. Click with the right mouse button:

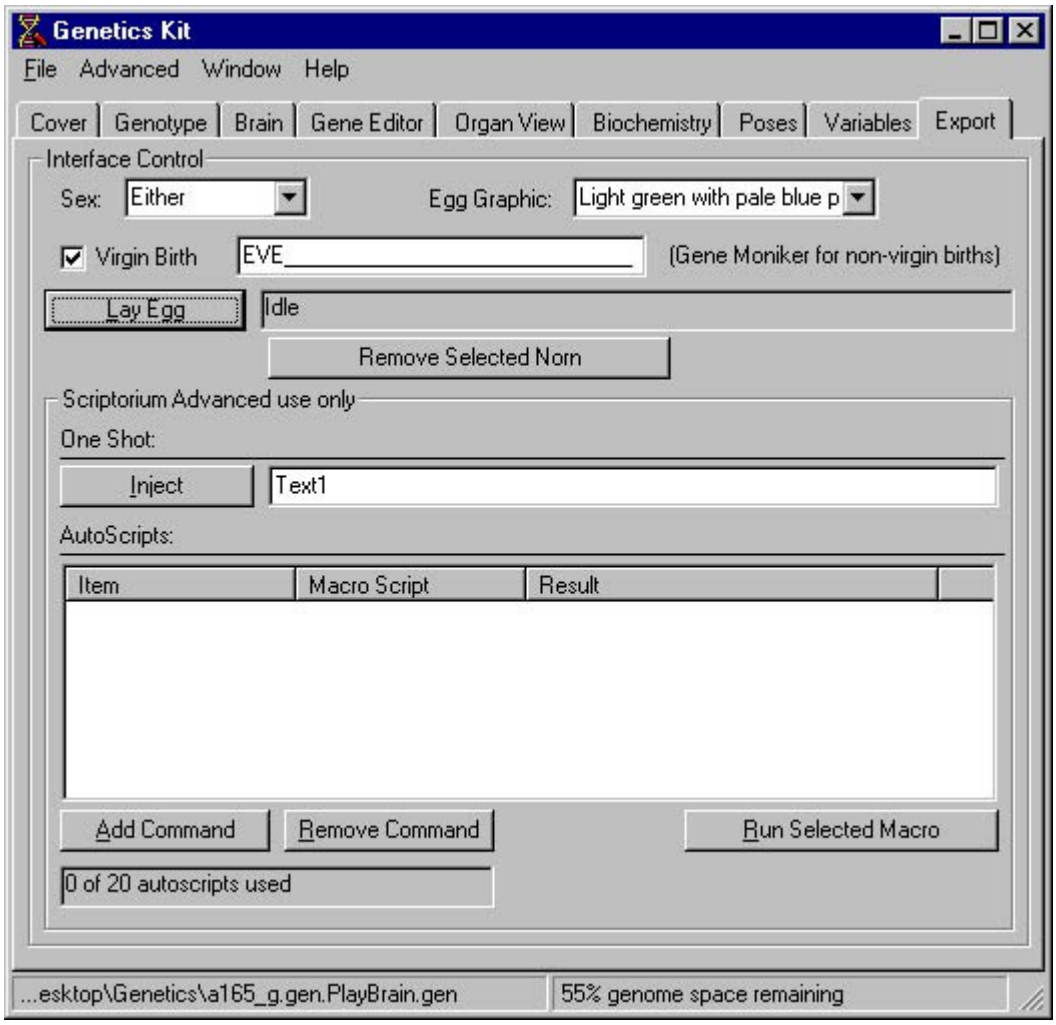
These menu items echo the button controls. **Save Changes** is only valid if changes have been made to the pose name list, and is functionally the same as the **Save Descriptions** option on the **Advanced** menu:

Saving the Variable Name List

The variable name list is not saved automatically. You must use the pop-up menu, or the "Advanced" menu. You will, however, be prompted on program exit if there are unsaved changes.

Export

Inject new eggs and scripts into Creatures.



The **Export** page interfaces the Genetics Kit to Creatures. You must have Creatures 3 installed **and running** in order to use the functionality on this page.

There are a number of advanced features present to work with macro scripts inside Creatures 3.

In its simplest mode, this page is used to inject new eggs into the Creatures world from the currently loaded genome. These eggs can then be hatched in the incubator. Click here for information on hatching eggs.

Interface Control **LAYS EGGS IN THE SPACE SHIP**

The drop down boxes allow you to choose which colour egg you wish, and what sex you would like it to be.

- **Egg with one parent:** Ensure the **Virgin birth** checkbox is checked. Clicking on the **Lay Egg** button will then generate an egg directly from the loaded genome.

- **Egg with two parents:** Un-check **Virgin birth** and enter the genetic moniker for the second parent in the text box:

Once options have been chosen, clicking on the **Lay Egg** button will lay an egg. This combines the two genomes to create a new offspring. This will **not work unless Creatures 3 is running**.

The **Remove Selected Norn** button (below) can be used to remove creatures from the game. This is permanent! A removed creature **cannot** be recovered:

Scriptorium **MACRO LANGUAGE INTERFACE**

Allows macros to be injected into the game, and results displayed. Up to 20 "autoscripts" can be used for commonly used macro commands. Several defaults are provided, and you can add your own.

This is for advanced users only. Click here for information on Creatures Developer Services. There are two sections, **One Shot** and **AutoScripts:**

- **One Shot.** Directly inject a macro into Creatures and display the result, if any. To use, type the macro into the text box and click on the **Inject** button:

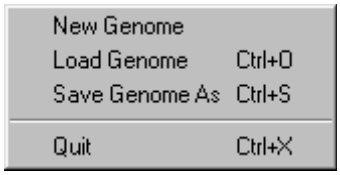
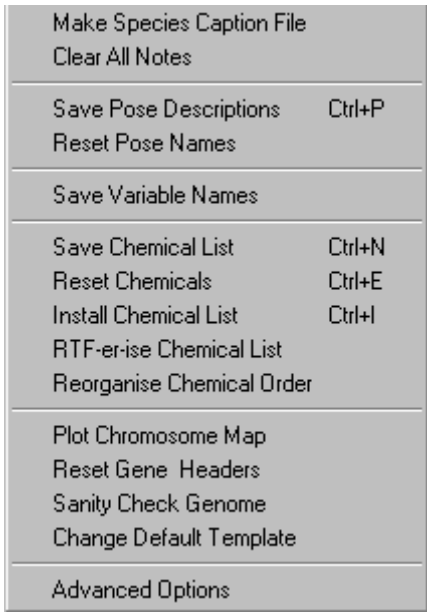
- **AutoScripts.** A customisable list of macro commands that can be easily injected into Creatures. To run an AutoScript, select it, and click on the **Run Selected Macro** button. You can also use the right mouse button to bring up a pop-up menu over the AutoScript list:

WARNING!

If you do not understand the Creatures macro language, it is best not to experiment using the macro language interface. **You could crash Creatures and lose valuable work.**

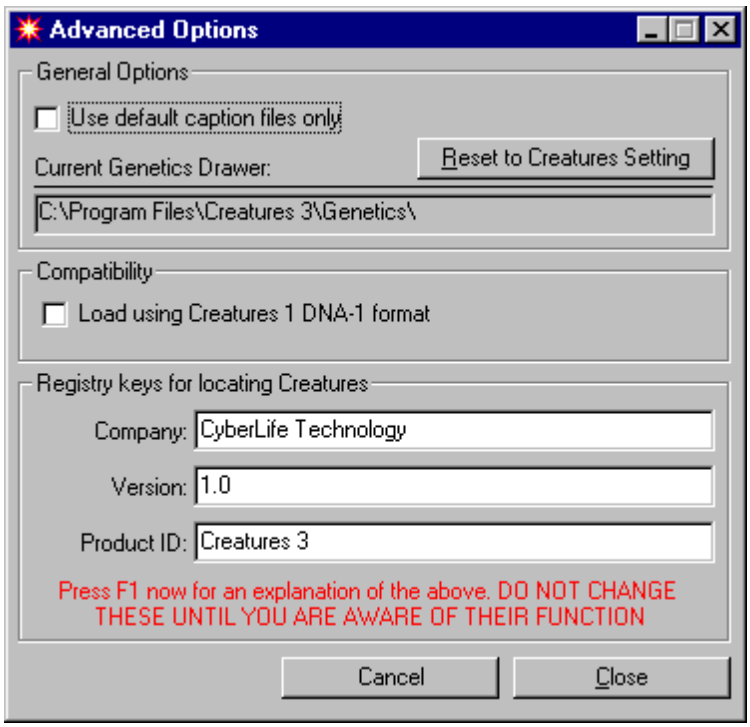
If you make changes to the AutoScripts, you will be prompted if you wish to save them when you exit the Genetics Kit.

Menu reference

1.	**File**		• Create a new genome from scratch. Discards currently loaded genome. • Load an existing genome. Discards currently loaded genome. • Save a genome to disk. • Quit the Genetics Kit.
2.	**Advanced**		• Sets the default caption file for a species. • Clear notes associated with genes. • Saves changes made to pose name list. • Resets to the default pose name list. • Save changes made to variables list. • Saves changes made to chemical list. • Resets to the default chemical list. • Installs the currently loaded chemical list into Creatures. Any new chemicals will now be seen from the Science Kit biochemistry monitor page. • Displays the chemical list in an RTF (Rich Text Format) display box. Copy/Paste can be used to copy this into another application. • Reorganises the chemical list. **Highly advanced option**. • Plots chromosome map. • Resets the mutability values to their default (128) for *every* gene. • Checks the genome for duplicate ID keys (this would indicate a fault) • Changes the template values that the Genetic Summary page uses to display mutations from template. • Shows advanced options dialog.
3.	**Window**		• Closes all gene windows that are currently open.
4.	**Help**		• Displays the contents of the on-line help. • Displays program information, credits and version/license details.

Advanced options

The Advanced Options dialog is available from the **Advanced** menu:



Use **Close** to close the dialog and save changes.

To Cancel, use the **X** button at the top right of the dialog.

General Options

Use default caption files only:

The Genetics Kit is capable of keeping different caption files for each genome it works with. It is also possible to force the default to be used in all cases. Check this box to use default caption files.

For a description of how the caption file system works, click here.

Default Genetics Folder:

Creatures remembers the last folder you used for loading or saving genomes automatically. The **Current Genetics Folder** shows what it is currently set to. You can reset it to the folder held in your registry for your existing Creatures set-up by clicking on the **Reset to Creatures Setting** button.

Compatibility

If this box is checked, the Genetics Kit will attempt to load a Creatures 1 genome file and convert it to Creatures 3 format. **Caution: Any converted genome will require work before it will function inside Creatures 3. Creatures 1 genomes are missing components such as organs.**

Registry Options

Sets the registry company and version used to find Creatures registry information.

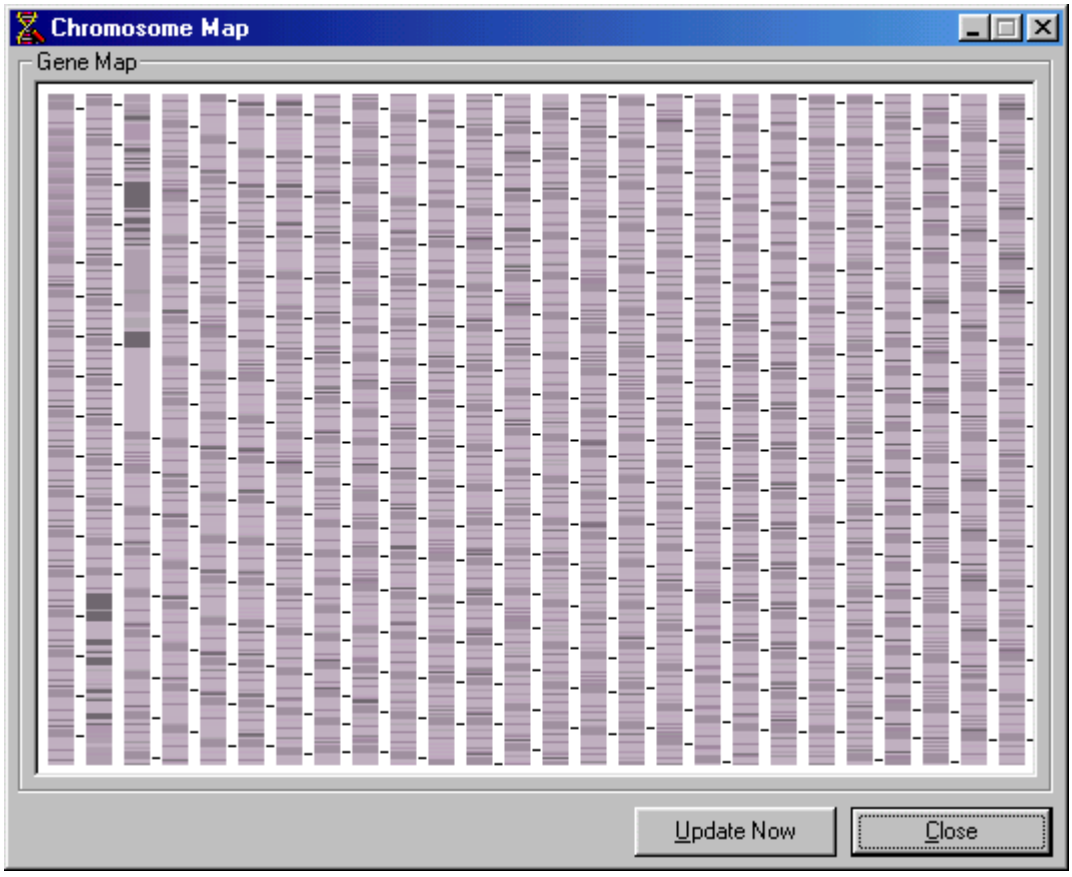
- **Company**. Company name used.
- **Version**. Creatures build folder number.
- **Product ID**. Product name.

PLEASE NOTE:

It is unlikely you will need to change these, and doing so could prevent the Genetics Kit from functioning correctly.

Plot Chromosome Map

Plot Chromosome Map plots a graphical representation of the currently loaded genome, and is available from the **Advanced** menu:



The Chromosome Map window can be kept open whilst using other features of the Genetics Kit.

Chromosome Window	Shows a chromosome map of the currently loaded genome. The black markers down the right hand side of each stripe indicate gene boundaries.
	Updates the chromosome map display. This may take several seconds on a slow PC. You can use this button to update the display after modifying the loaded genes.
	Close the Chromosome Map window.

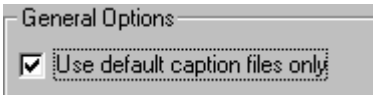
Basic procedures

There are a number of basic procedures that will help you with operation and understanding of the Genetics Kit. These are:

An Introduction to the terms and words used

Caption File

Creatures genetics are long sequences of numbers that are interpreted as construction details for biological structures. These numbers are not easily interpretable by human eyes, so the Genetics Kit provides a way of creating "Caption Files" that allow individual user-typed descriptions to be viewed along side individual genes. The Genetics Kit gives you the option to store a separate caption file for each genome, or use the default caption file for the current species (Norn, Grendel, etc.). To use default caption files, select **Advanced Options** from the **Advanced** menu and check the appropriate check-box:



As shipped, the Genetics Kit will attempt to use unique caption files wherever they exist, falling back to the default files if necessary.

Caption files are stored on disk with the ".GNO" extension. They are stored in the Genetics Kit application folder. Initial breeds provided in the game are stored in the Creatures 3 "Genetics/" folder. The files are named after the type that they are the genome for. Once a Creature is in the game, it has a unique moniker, just for that Creature. You can find the moniker from the last page of its agent help. The genetics files of living creatures are in the Genetics directory of your world's directory, underneath My Worlds. Unique caption files are named in the format "*moniker*.gno" where moniker is the genetic ID. The Attic directory in your world directory contains the genetics files for Creatures which died a while ago.

Digital DNA

Digital DNA describes the genetic system used in Creatures. It differs from real DNA, which is a biochemical construction, but achieves the same thing: a set of simple instructions that can be used to construct a complex biological system.

Genome

A complete set of Digital DNA genes to describe the construction of an entire creature. Genomes are stored as files on disk with the ".GEN" extension. They are kept in the Creatures Genetics folder. Initial breeds provided in the game are stored in the Creatures 3 "Genetics/" folder. The files are named after the type that they are the genome for. Once a Creature is in the game, it has a unique moniker, just for that Creature. You can find the moniker from the last page of its agent help in the game. The genetics files of living creatures are in the Genetics directory of your world's

directory, underneath My Worlds. Each creature (from the ones on the egg disk to the Grendels) has its own separate ".GEN" file. The Attic directory in your world directory contains the genetics files for Creatures which died a while ago.

Gene One single individual instruction. In the case of nature, a gene is made up of nucleotides, which in sets of three specify the amino acids that construct one protein. Many of these will be required to build one living cell.

In Creatures, there are 19 different gene types, in three classes. These are used to construct different biological systems ranging from chemical receptors to brain lobes. A typical Norn will have around 810 genes, whereas a human being has around 100,000.

Macro When the Creatures program is running, it is possible to issue it commands and instructions from outside the program. The same language used for this, is also used by the agents (Norns, plants, toys – in fact, every object in Creatures is an agent) inside Creatures to define their properties and behaviours. It is therefore possible to create new agents, and inject them into Creatures without Creatures having to know anything about the agents in advance. Macros can be issued from the **Export** page.

Moniker Genomes are identified with an alphanumeric code called the Genetic Moniker.

1. Select **Load Genome** from the **File** menu.
2. Find the file "Moniker.GEN".
3. Select and load that file.

The above procedure can be used to load the genome for any Norn you have or have previously had in Creatures 3

Genetics in nature and Creatures

The instructions for making living systems are encoded into their DNA (and in the case of most viruses, RNA). DNA stands for *d*eoxyribo*n*ucleic *a*cid (for RNA, drop the "deoxy" from the beginning) and is made up of chemical instructions for manufacturing proteins—the building blocks of living cells. A complete set of instructions for making one single protein is called a gene.

Collectively, the genetic instructions required to make an entire living system are called the *genotype*, and the resultant life form exhibits the *phenotype*.

Genes are joined together in a long string of DNA, punctuated by special markers. This is then wrapped into a giant super-helix called a *chromosome.* Chromosomes can contain many tens of thousands of genes.

Creatures contains a biological modelling system that borrows many of the metaphors and concepts from biology. Digital DNA (the system in Creatures) is a digital equivalent of biological DNA. The primary differences are:

	Human DNA	Creatures DNA
Construction	23 chromosomes, diploid (46 total)	Single haploid chromosome
Chromosomes	46 (23 pairs, one set from each parent)	1

Total Genes	100,000	810

More information is available on the Norn Genome, the Grendel Genome and the Ettin Genome in Creatures.

The Norn genome

A "Generation One" Norn (from an egg in the Hatchery) consists of approximately 810 genes. Unlike human beings, who carry two of each gene (one from the mother, and one from the father), a Norn carries only one of each gene. Some of these genes are specific to a certain sex, so in a male Norn, the female genes will be *carried*, but not actually *used.* The "Generation One" Norns have 17 female specific genes, and 9 male specific genes.

When Norns breed in the wild, the genomes from the mother and father are laid out next to each other, and genetic material from one parent is exchanged with material from the other. The points along the genome where the exchanges take place, and the number of genes exchanged are random and occasionally there will be "crossover errors" which could result in individual genes being lost or duplicated. This process generates two new genomes, one of which is male, and the other is female. During natural births, the choice of which of these to use is random, whilst a Genetics Kit birth leaves the choice to you, based on which gender you would like the new creature to be. The result of this is that a new Norn egg inherits a combination of genes from the father and mother together with some potential mutations and errors.

Norns have 19 different gene types, each containing varying amounts of genetic information. Genes are broken down into four basic categories:

1. **Brain Gene**. Definition of brain lobes, tracts, neural dynamics and dendrite properties.
2. **Biochemistry Genes**. Chemical receptors, emitters, neuro-emitters, reactions, half-life and initial concentrations.
3. **Creature Genes**. Stimulus, species, appearance, poses, gaits, facial expressions, instincts, pigments and pigment bleeds.
4. **Organ Genes**. Organs contain biochemistry components such as reactions, emitters and receptors.

The Genetics Kit allows all of these Genes to be viewed, and most can be edited. In addition, genes can also be either added to the genome, or removed entirely. Click here for a summary of the different gene types.

Grndl Grndl Grrrr

Grendel Digital DNA is similar to Norn D-DNA. Many of the genes and structures are identical, but Grendels are differentiated by their instincts, and stimuli. The initial Grendel genome used in Creatures is stored with a moniker starting with "g". A caption file to label the purpose of each gene is also kept for each.

The Ettin Genome

Ettin Digital DNA is similar to Norn D-DNA. Many of the genes and structures are identical, but Ettins are differentiated by instincts and stimuli. The initial Ettin genome used in Creatures is stored with a moniker starting with "e". A caption file to label the purpose of each gene is also kept for each.

Loading the genome of a specific creature

All operations inside the Genetics Kit require a valid genome to be present. As it is very difficult to create a genome from scratch, you'll probably wish to start from one of your existing Norns. The Digital DNA for every creature you have ever had (including Grendels and Ettins) is stored on your hard drive. Once a Creature is in the game, it has a unique moniker, just for that Creature. You can find the moniker from the last page of its agent help in the game itself. The genetics files of living creatures are in the Genetics directory of your world's directory, underneath My Worlds. The Attic directory in your world directory contains the genetics files for Creatures which died a while ago.

The monikers are made up as follows:

ggg-ffff-xxxxx-xxxxx-xxxxx-xxxxx.gen

ggg is the generation number. It is the higher of the generation numbers of the two parents plus one. E.g. The child of a gen 1 and gen 6 Norn is gen 7. The child of a gen2 and gen3 is gen4. ffff is the "friendly name" for the moniker - From the feel of the word, it should be pretty simple to see if the genome is Norn, Ettin or Grendel. The four sets of five characters are the moniker itself. This is a combination of several seeds, creating a unique string just for that Norn.

To load the genome of a specific creature:

1. Load the Genetics Kit and click on the "Load Genome" button. A file loading dialog will appear. Use the dialog to locate the ".GEN" file for the creature whose DNA you wish to load.
2. Click "Load".
3. That is it! You now have that creature's genome loaded into the Genetics Kit.

Considerations when saving Genomes

Genomes can be saved using the File Menu.

There is a restriction to the names you can use to save genomes under certain circumstances. To understand this issue, it is necessary to explain how Creatures accesses genomes: A macro command is used to instruct Creatures to create an egg or a creature from a named moniker. The Genetics Kit automatically does this for you when you create eggs from the **Export** page, so if you are doing this exclusively then there are no restrictions as to the filename you can pick.

However, for Creatures to be able to access your new genomes *independently* of the Genetics Kit, you must follow the following naming convention:

- The genome must have the extension ".gen" and be saved in the Creatures Genetics folder. This is the default when you save a genome.
- You should pick a unique identifier (moniker), starting with a tag for the type of creature you are making. Monikers for Norns should start with "norn.", monikers for ettins should start with "ettn." and monikers for grendels should start with "gren.". The three initial Norn types are civet, bengal and bruin so moniker names starting with "norn.civet", norn.bengal" and "norn.bruin" are reserved for these only.

If you save it in an alternative place or with an invalid file name, neither Creatures nor the Genetics Kit will be able to use that genome as a parent when eggs are created. This is because both Creatures and the "moniker of other parent" text box on the **Export** require a valid moniker.

Using the default D-DNA

The Digital DNA for the initial eggs provided in the Hatchery are stored in the Creatures 3 "Genetics/" folder. The files are named after the type that they are the genome for. For example, the moniker that starts with "norn.bengal" is the bengal tiger Norn.

Creating new eggs

New eggs can be created on the "Export" page of the Genetics Kit. Eggs can either be created as "virgin births", where only one genome is used to make the egg, or a second parent can be specified. **Creatures must be running to use this page!**

- **Single Parent Births**. Check the "Virgin Birth" box. Click on the "Lay an egg" button and the currently loaded genome will be used to create a new egg. You can choose which sex the egg will be with the option buttons.
- **Two Parent Births**. Un-check the "Virgin Birth" box and enter the genetic moniker for the second parent into the text box labeled "Gene Moniker". You can choose which sex you wish the egg to be, and by clicking on the "Lay an egg" button, a new egg will be injected into the world.

What if the incubator is not working in Creatures?

This is because you have too many Norns on board the Creatures 3 space ship. Remove some by exporting them. The incubator may take a few minutes to switch back on again.

Creating genetic "clones" of existing creatures

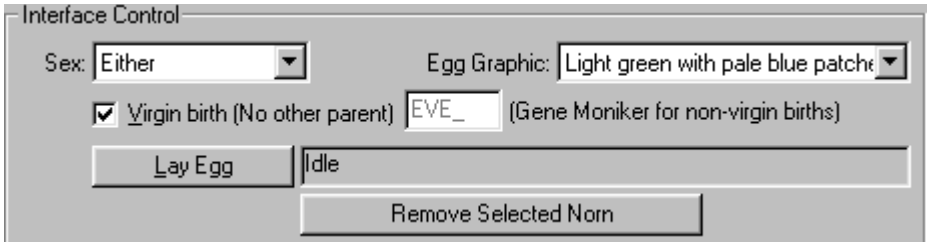
It is possible to create genetic clones of any Norn or other creature you have had.

Remember!

A genetic clone is not a copy of the phenotype. It has the *potential* to be identical to the original, but as it has not been subjected to identical experiences at identical times, it will not behave identically.

To make a clone of a creature:

1. Locate the genome of the creature you wish to clone and load it into the Genetics Kit (See Loading the genome of a specific creature.)
2. Click on the **Export** tab.
3. Ensure the **Virgin birth** check box is ticked.
4. Select the sex the clone should be.
5. Ensure Creatures is running, then click on the **Lay Egg** button:



You will now get an egg inside the space ship by the incubator. This egg will hatch naturally after around 4 minutes. You can speed up this process by putting the egg in the incubator.

Things to remember

What if the incubator is not working in Creatures? Why could this be?

This is because you have too many Norns on the Creatures 3 space ship. Remove some by exporting them. The incubator may take a few minutes to switch back on again. It is easy to tell if your incubator has shut down in this way, as the doors will be closed.

How to make a "phenotypic clone":

Export a Norn, duplicate the ".exp" file created, and import the two identical files. You'll now have two clones! **It is not recommended to have both your clones in the game at the same time.**

How to make eggs other than clones

The Genetics Kit allows you to create new eggs by "breeding" existing genomes. This can be useful for experimentation purposes.

Remember!

Breeding creatures in this way gets around natural selection and evolution, and is useful for developmental purposes only. The most faithful way to progress and develop your Norns is through natural births, where the skills and abilities of the Norns themselves take a part in deciding who breeds with who. Using unnatural methods of giving birth, it is possible to breed Norns that *may not be able to survive long enough to breed and will be "removed" by natural selection.*

To create an egg from D-DNA:

1. Locate the genome of one of the two parents you wish to use and load it into the Genetics Kit (See Loading the genome of a specific creature.)
2. Click on the **Export** tab.
3. Ensure the **Virgin birth** box is not checked. Enter the genetic moniker (a special character code, see An introduction to the terms and words used) of the second parent in the **Gene Moniker** text box to the right of the checkbox. For this to work, there must be a ".GEN" file in the Creatures/Genetics folder corresponding to this moniker.
4. Select the sex the new egg should be.
5. Ensure Creatures is running, then click on the **Lay Egg** button:

You will now get an egg inside the space ship by the incubator. This egg will hatch naturally after around 4 minutes. You can speed up this process by putting the egg in the incubator.

Deleting mistakes from Creatures 3

Genetic manipulation and experimentation tinkers with the very building blocks of life, accelerating the process of evolution, and compressing millions of years worth of mutations into an afternoon's work. Along the way you will create many imperfect creatures, unable to prosper in the Creatures world. In these cases it is often more humane to also accelerate the process of natural selection by removing them yourself.

There are many ways of removing creatures from the Creautres world that do not involve pain, the easiest of which is to simply export that creature using the **Creatures** menu inside Creatures 3.

However, the Genetics Kit does contain a quick way of eliminating objects and creatures from Creatures 3. Click on the **Export** tab. You can remove a Norn by running Creatures, selecting the Norn you wish to remove, and then clicking on the **Remove Selected Norn** button:

WARNING!

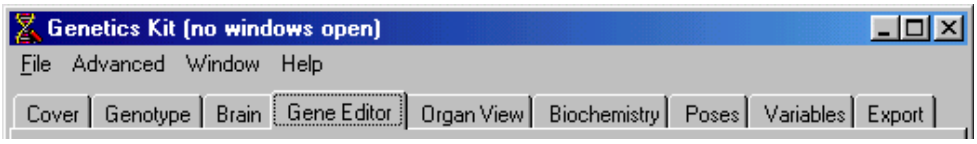
Any Norn that is removed in this way is **deleted permanently.**

The macro interface means that you have the option to create your own macro scripts that can remove Norns from the space ship (or any other agent, for that matter).

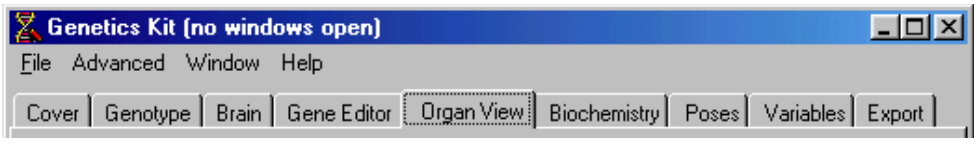
Genetic engineering

Genetic Engineering is a complex task, even in Creatures where the genetics are less complex than their biological parallels. It is beyond this help file to teach genetics to every reader, although we do recommend some good books. Two basic concepts are required before working with Creatures genes:

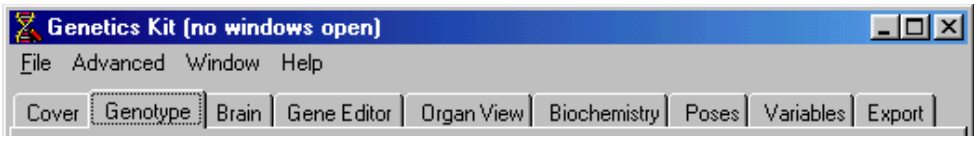
1. Gene editing, deleting and creating is done from the **Gene Editor** page:



2. Genes can be viewed *by organ* on the **Organ View** page. This shows just genes inside organs, i.e., Receptors, Emitters and Reactions:



3. At any time, a summary of the currently loaded genome can be seen on the **Genotype** page:



This section of help looks at the processes involved in:

- Editing existing genes:
- Creating new genes:
- Creature organs:
- Creature brain organs:
- Creature brain:
- Creating brain lobes:
- Creating brain tracts:
- Creating instincts:
- Creature chemicals:
- Creature poses:
- Creature facial expressions:

Editing existing genes

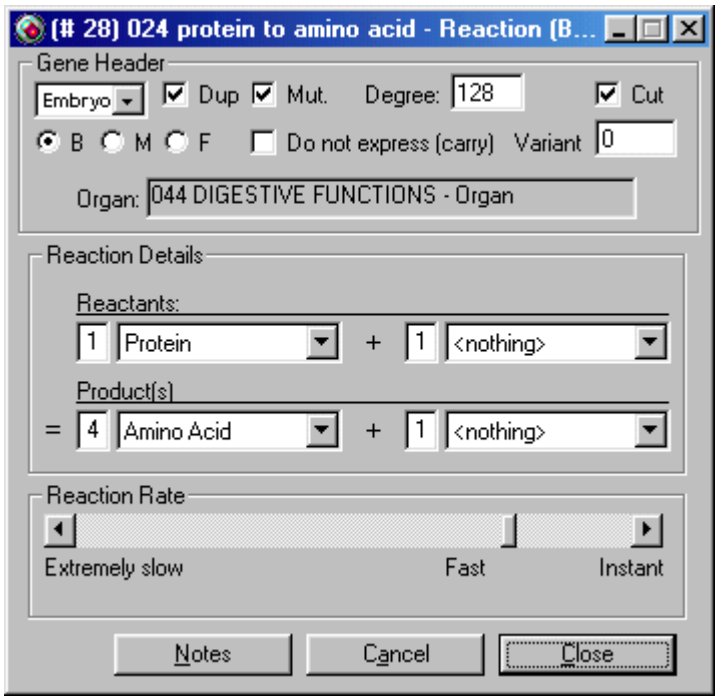
There are three different ways to edit a gene. All of them require you to select a gene from the **Gene Editor** first. Then, either:

Use the right mouse button to access the context sensitive menu.

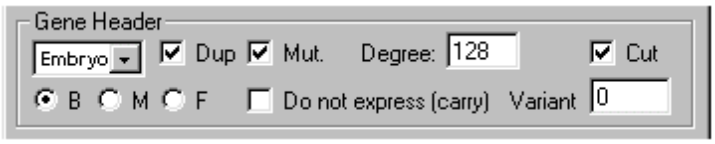
Or… Double click on the gene in the list.

Or… Click on the **Edit Gene** button

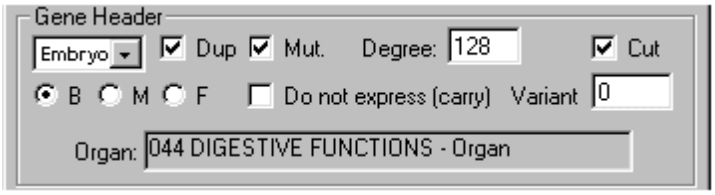
When a gene is selected for editing, a window will open. The appearance of this window depends on the gene type. For example, editing a Chemical Reaction gene opens a window like this:



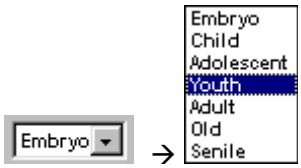
There are 19 different gene types. All gene windows share some common controls:



WITH THE EXCEPTION of reaction, emitter and receptor genes. These genes are grouped in Organs. To help you identify which organ a reaction, emitter or receptor is in the containing organ is displayed:



Broken down into their five categories, they are:



GENE SWITCH-ON

Genes can switch on at any one of seven different stages of life, from Embryo to Senile. The length of time between these stages of life depends on the decay rate of the **life** chemical, and the chemoreceptor genes that control the advancing of stages.

MUTATION CONTROLS

- **Dup.** Gene can be duplicated. If this checkbox is checked, this gene can be duplicated during crossover.
- **Mut.** Gene can be mutated. If this checkbox is checked, information in this gene can be changed during crossover (See note below). The degree of mutation is specified by default as 128. This corresponds roughly to the mutation probability in Creatures 1. By varying this number from 0 to 255 the gene can be made less or more likely to be mutated.
- **Cut.** Gene can be deleted. If this checkbox is checked, information in this gene can be deleted during crossover.

DO NOT EXPRESS

If checked, this gene is carried in the genome but will not be expressed (i.e., the gene is ignored but remains in the genome).

SEX

Genetics in Creatures are haploid. Every Creatures genome carries both female and male genes, and a number of genes that are the same regardless of sex. Only the appropriate set is ever expressed, so if you are a girl Norn, the boy ones will never switch on. You can specify here which sex (*M*ale, *F*emale or *B*oth sexes) this gene is.

VARIANT

Although this is not used in Creatures 3, it is possible to have several variants of Norn, such as exist in Creatures Adventures. In this case,

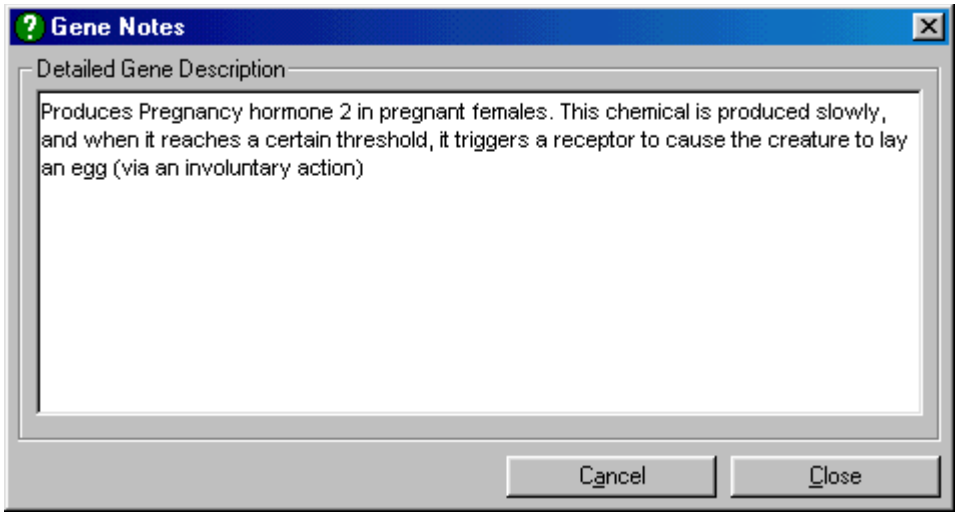
this flag dictates which variant the gene is expressed in.

NOTE

If a gene is marked with no mutation flags at all (Mut, Dup and Cut un-checked) it becomes a "compulsory gene" that will never be mutated in any way. This, whilst useful in some cases, can be easily over-used and gives natural selection nothing to work on, preventing evolution of Norns.

As well as a common header and a **Cancel** button, each gene also has a **Notes** button that allows you to enter a more detailed description of a gene. This is in addition to the gene name, and is saved in the caption file (.GNO files) along with gene names. To access the notes page for a gene, click on the appropriate button inside any gene window:

This opens the gene notes window. You can use copy and paste to insert text that includes basic formatting. Try pasting from Word, or WordPad for example, or simply type directly into the window. Here is the gene notes page for a progesterone emitter gene:



WARNING:

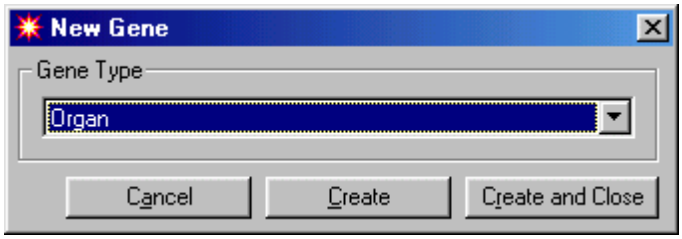
Using **Cancel** to abort a gene will **not** cancel any changes you have made to the detailed descriptions.

Creating new genes

To create a new gene, click on the **New Gene** button from the **Gene Editor** page:

If you are starting from a clean genome (i.e., no genes loaded), the Genetics Kit will ask you if you wish to create a species gene (the only compulsory gene). **Read the notes** before trying to create your own genome from scratch.

If you are adding new genes to a genome that contains at least one gene, the following window will be opened:



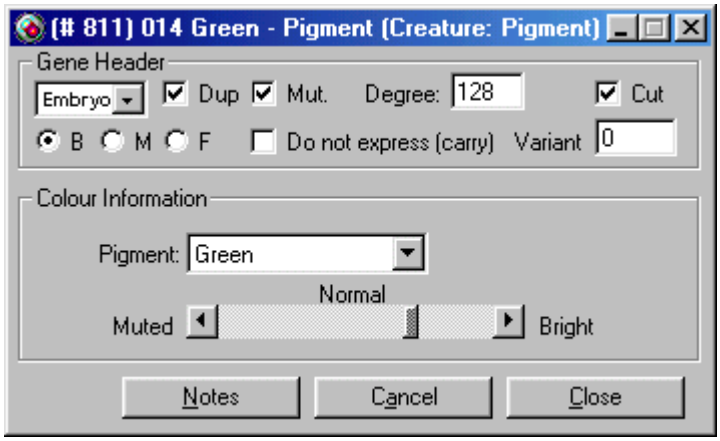
Clicking on the drop down box will reveal a complete list of gene types that you can create. These fall into four categories, Brain Genes, Creature Genes, Biochemistry Genes and Organ genes.

You can use the **Create** button to make new genes whilst leaving the new gene window open. This allows many genes to be added at once.

Example: Making a green Norn

As a demonstration of the Genetics Kit, here are the instructions to creating a green Norn:

- Load up any D-DNA file into the Genetics Kit
- Go to the **Gene Editor** page and click on the **Type** line to sort the list by type. Scroll down the list until you find the "Creature: Pigment" genes. There should be thirteen of these in a generation one creature
- Edit all of the "Green pigment" genes (See under the "description" column) and move the slider up to "bright" (the right hand side) in each case:



- Now edit all of the "Blue pigment" and "Red pigment" genes (four of each) and turn the slider right down to "muted" (the left-hand side) in each case.
- Click on the **Export** tab, check **Virgin Birth**, ensure Creatures is running and click on the **Lay Egg** button.
- Drop this egg in the incubator, and in a few seconds you'll have a very bright Kermit green Norn!

Notes on creating genomes from scratch

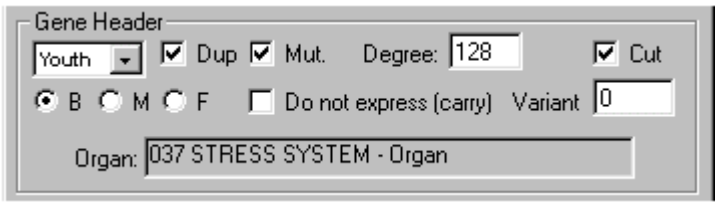
It is possible to use the Genetics Kit to create genomes from scratch. This is a highly complex process, and it is possible to build genetic structures that could cause Creatures to fail.

In almost all cases, it is desirable to load an existing genome and work from there until you are sure you have learned enough to consider building genomes from scratch.

Should Creatures crash as a result of loading a genome you have created, spend some time ensuring that the basic systems you would expect in a living system are present genetically. If you are sure that they are, and there are still problems, then we would like to hear from you.

Gene reference chart

Creatures has 19 separate gene types divided amongst four separate groups. These groups are: Brain Genes, Biochemistry Genes, Creature Genes and Organ Genes. All gene types share some basic header information:



- **Sex**. Norn D-DNA carries both male and female genes. Some genes can be active for one particular sex only (i.e., the reproductive system), and others are for both (such as the digestive system, immune system, etc.)
- **Mutability**. Most genes can be mutated, deleted or duplicated during the breeding process. Some critical genes may not be manipulated in some ways, specified in the mutability box. Those that can be mutated can be mutated to varying degrees.
- **Switch-on time**. This dictates which of the seven life stages switches on this gene. To be on at birth, it should be set to "Embryo".
- **Do not express**. A gene can be 'silent', or carried. This means that it does not contribute to the creature's phenotype at all, but is potentially available for future generations through mutation of the 'do not express' option.
- **Variant**. It is possible to have several Norn variants in Creatures games. This feature is not used in Creatures3, but is the basis for the different personalities of Creatures Adventures Norns.
- **Organ**. Biochemistry genes belong in organs. For biochemistry genes, the header indicates which organ the current gene belongs to. This information is not relevant to all genes.

The gene types and their descriptions are shown in the table below. Type and sub-type numbers are shown in parentheses after the name:

Gene Type	Gene Sub-Type	Gene Description
Brain Genes (0)	Lobe(0)	**Defines a brain lobe. (15 in generation 1 creature)** The Brain Lobe is the most complex gene type. Click hereBrainLobe for further information.
	Organ (1)	**The brain organ. (1 in generation 1 creature)** Only one of these is allowed per creature. This organ is similar to the body organs, but contains the brain lobes. When this organ's life force reaches zero the creature dies.
	Tract(2)	**Brain tracts (29 in generation 1 creature)** Tract genes specify the connections between lobes of the brain. These connections have some processing functions as they transfer data between the different parts of the brain.
Bio-chemistry Genes (1)	Receptor (0)	**Chemical receptor. (196 in generation 1 creature)** This binds to a named location (a locus) and sets the value stored in that locus according to the concentration of the chemical it monitors. Receptors are used throughout a creature's systems. For instance, the

locus may be the reaction rate of a reaction, in which case the receptor controls the rate of that reaction.

Emitter (1)

Chemical emitter. (43 in generation 1 creature)

Binds to a named location (locus) and emits an amount of a specified chemical according to the value of the locus to which it is attached.

NeuroEmitter (5)

NeuroEmitter (1 in generation 1 creature)

Similar to an emitter, in that it emits a specified amount of up to four chemicals. The NeuroEmitter is triggered by neurons in the brain which it attaches to.

Reaction (2)

Chemical reaction. (101 in generation 1 creature)

Specifies a chemical reaction and the amounts involved. Chemical reactions are in the form $_{I}A + _{J}B \Rightarrow _{K}C + _{L}D$, where A, B, C and D are chemical numbers and I, J, K and L are the concentrations involved. All reactions are allowed except nothing => something. The reaction rate can also be specified, the approximate half-life of which is shown in the status bar.

Half Lives (3)

Chemical Half-lives. (1 in generation 1 creature)

There is normally only one of these genes, and it specifies the approximate half-life (the time in which it takes for a chemical to decay to half its initial concentration) for each chemical.

Initial Concentration (4)

Chemical initial concentration. (25 in generation 1 creature)

This gene allows a fixed dose of a chemical to be present when the gene switches on. It is these genes that allow us to give newborn Norns energy (glucose and glycogen) and natural immunity (a low dose of antibodies).

Creature Genes (2)

Stimulus (0)

Stimulus. (57 in generation 1 creature)

Change the concentration of up to four chemicals when a given stimulus occurs. This allows a creature to feel pain when it bumps into a wall, for example.

Genus (1)

Species. (1 in generation 1 creature)

The only compulsory gene (although many others are required to make a viable life-form). This gene specifies the species of creature and the mother and father’s genetic moniker.

Appearance (2)

Graphic appearance ID. (5 in generation 1 creature)

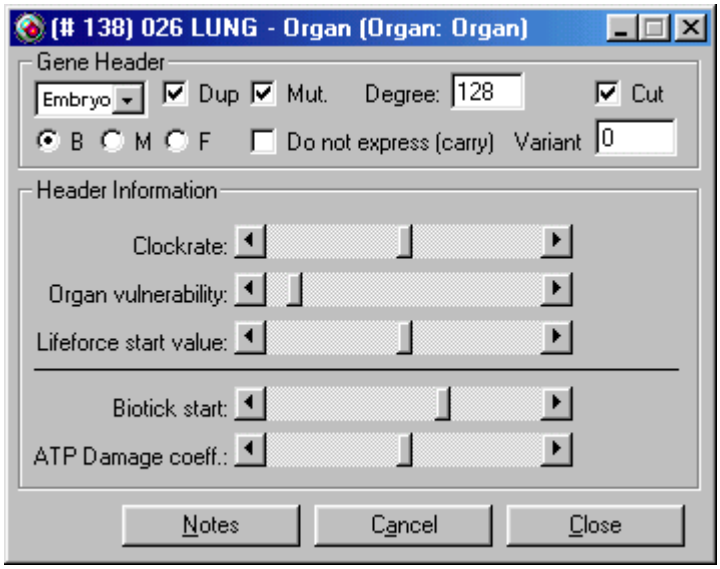
Describes which of the possible graphic sets are used to make up any given area of the body. Initially, five are specified: Head, arms, body, legs and tail.

	Facial Expression (8)	**Facial Expression. (7 in generation 1 creature)** Creatures have several facial expressions they can display; the facial expression genes select which will be used according to the levels of the drives specified within these genes.
	Pose (3)	**Creature Pose. (242 in generation 1 creature)** Describes the graphic location information for a Norn to get into any given "pose". There are four walking poses, for example, which are cycled in an animation specified with a "gait" gene (see below).
	Gait (4)	**Specify pose sequence. (14 in generation 1 creature)** Specifies the poses required to move through a given sequence. For example, there is a gait for normal walking. Different poses switch on at different times to replace these with "older looking" walking sequences as the creature ages.
	Instinct (5)	**Creature instinct. (30 in generation 1 creature)** Instincts encourage creatures to perform a certain action at a certain time. An example instinct is the one that helps creatures to avoid overcrowding. Instincts are "taught" to creatures whilst they sleep. Click here for a detailed explanation.
	Pigment (6)	**Pigmentation. (13 in generation 1 creature)** Refers to a colour and the concentration of that colour. Colours can be red, green or blue.
	Pigment bleed (7)	**Pigmentation modification. (12 in generation 1 creature)** Allows the colours of a newborn Norn to differ slightly from its parents, while still being based on inherited characteristics.
Organ Genes (3)	Organ (0)	**Organ. (21 in generation 1 creature)** Organs house the chemistry genes – reactions, receptors and emitters. They regulate the rate at which these chemical functions run.
TOTALS:	19 separate types	*811 genes total in generation 1 creature* Female specific genes: 17 Male specific genes: 9 In most cases, existing Norns use the sex specific genes for reproductive systems.

Organs: A summary of how they work

Organs were a new feature in Creatures2. Just like real-life organs, they contain biochemical functions, and can be damaged by disease, and repair themselves. In a generation one Norn there are 21 organs, although one of these is female-only. The more organs a Norn has, the more ATP it will use up.

Just like the other genes, the organ genes can be mutable, allowing Creatures to accumulate new organs for new functions. The gene appears like this:



The "Clockrate" determines how frequently the contained biochemistry will be updated. The further to the right the slider bar is, the more frequently the biochemistry will be updated. It is possible for a receptor to speed this up, or slow it down.

The "Organ vulnerability" sets how fast the Long Term Life Force moves towards the Short Term Lifeforce. The lower it is the more resistant the organ will be to damage (see below for a more complete description of this system).

The "Lifeforce start value" determines how sturdy the organ is at birth, and how much damage it can take before it dies.

The "Biotick start" is a way to co-ordinate the genesis of organs during development, so their functions switch on in the right order.

The "ATP damage coefficient" defines how dependent on ATP the organ is. ATP is the energy source for chemical reactions, receptors and emitters, and when it runs out the Creature becomes unconscious, and the organs start to degrade, being injured at a speed determined by their damage coefficient.

Organs allow biochemistry genes to be regulated in groups based on their common function. An organ will "contain" and regulate all the biochemistry genes following it in the genome, up until the next organ gene. The organ clockrate has a locus which receptors can attach to, and so it can be regulated according to a chemical level for instance. This allows reactions to be sped up or slowed down to maintain a constant chemical concentration, and deal with fluctuating conditions.

Organs can be in a healthy or damaged state, determined by their Short Term and Long Term Life Force values. Organs can take damage from diseases or physical injury, lowering their Short Term Life Force, and producing Injury chemical as a signal to the immune system. When Short Term and Long Term Life Forces are apart, they move towards each other at a certain rate. The rate at which Short Term Life Force moves is generally faster than Long Term Life Force, and is open to regulation through a locus. This allows for organs to heal, at a rate which can be influenced by the biochemistry.

If an organ’s Long Term Life Force falls to zero the organ is declared dead, and the biochemistry it

contains will never be updated again. In this way Creatures can lose some functions before others. For instance, it is possible for a Norn to catch a disease which kills their reproductive system, rendering the Norn infertile, but otherwise healthy. Once an organ has died there is no way to bring it back to life.

To increase the rate of healing, each organ has a locus called the 'Repair rate', which a receptor can attach to. The effect of this locus is to regulate the rate at which Short Term Life Force returns towards Long Term Life Force. In hatchery Norns this locus is regulated by prostaglandin, which is produced by the bones in response to Injury chemical.

Brain Organ Summary

There is one brain organ per creature, which contains a number of brain lobes, specified in the lobe genes. The organ gene is responsible for specifying the physical structure that holds the brain, and is the target of any injury to the brain.

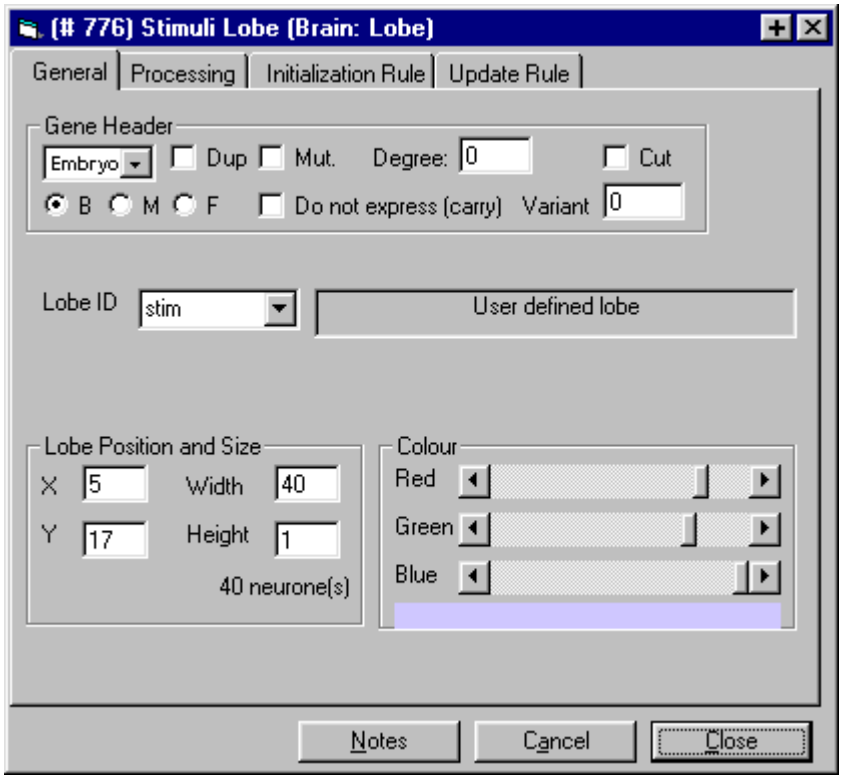
Brain Summary

In Creatures 3, the Brain Genes are divided into Lobes and Tracts. Lobes are collections of neurons with a common processing rule and in a similar way Tracts are collections of dendrites with a common source lobe, destination lobe and processing rule.

The processing rules are called SVRules. For both lobes and tracts, they have an Initialization and an Update component. The Initialization Rule is called on neurons and dendrites newly created (and also on dendrites that have just migrated). The Update Rule is called every 'tick' (about 4 times a second in Creatures) to calculate the new state of neurons, the new state of dendrites and also for dendrites to pass information to and from their source and destination neurons.

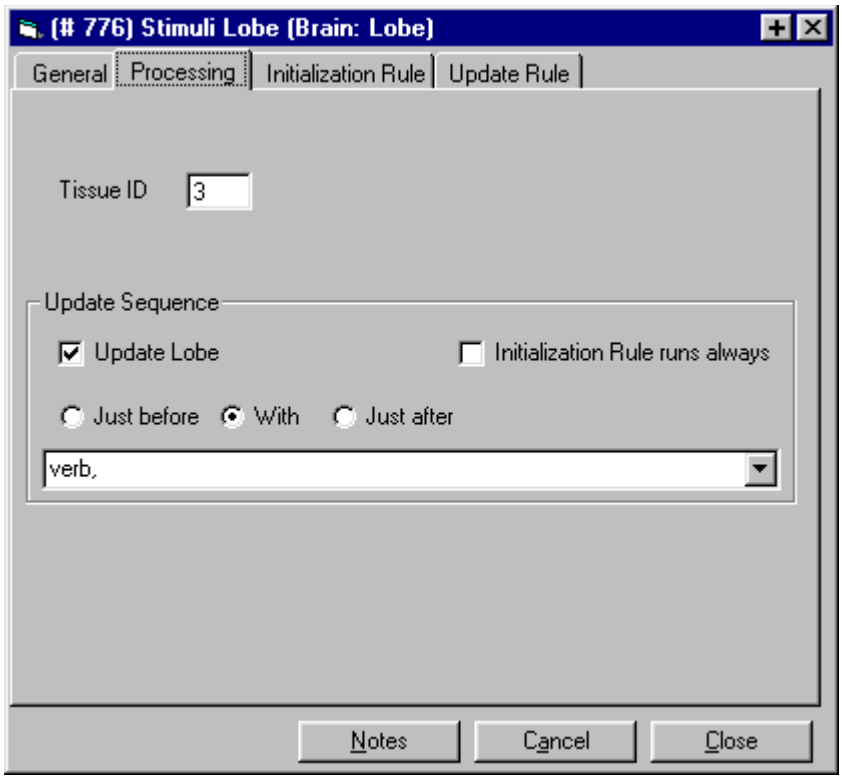
Lobes

General



Defines general properties for this brain lobe, and has the common mutation controls. The positioning and dimensions of the brain lobe can be specified here, also a colour for display in the Vat Kit. The Lobe ID is a four character word which uniquely identifies the lobe.

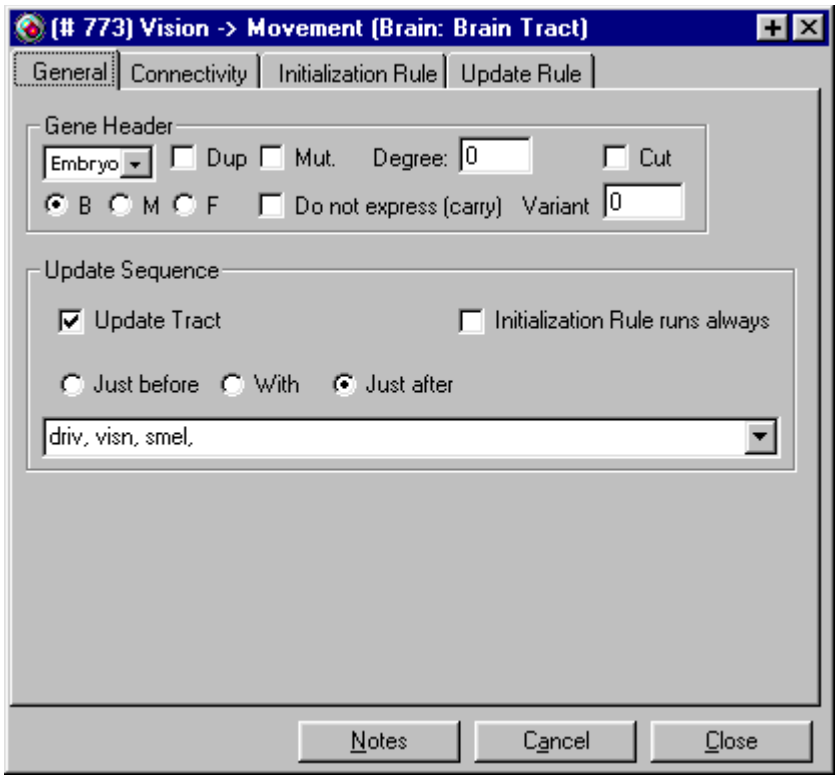
Processing



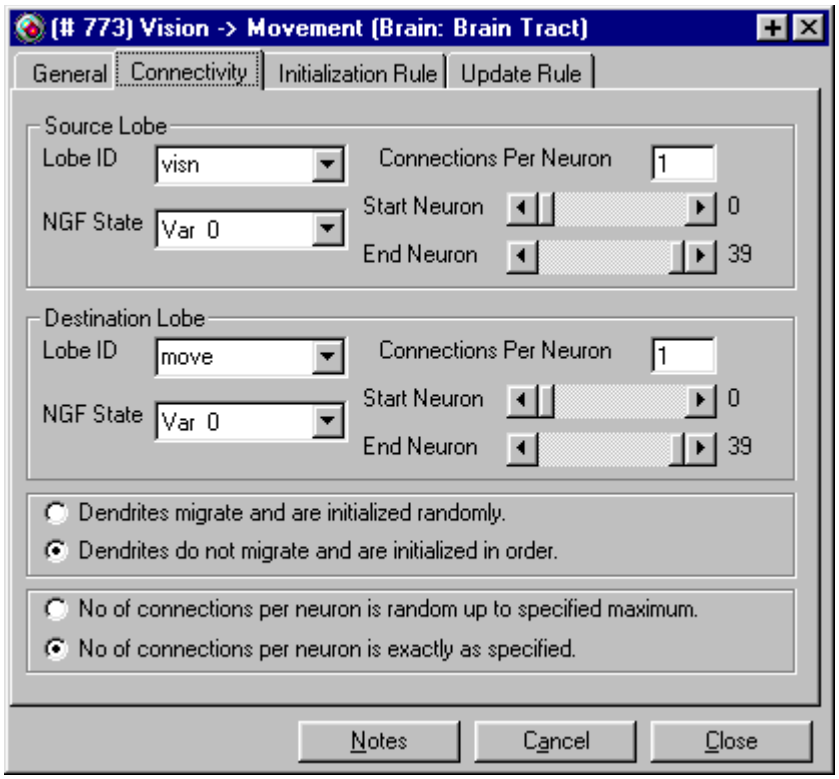
- **Initialization Rule runs always**. When ticked, this box specifies that the Initialization Rule is treated as another Update Rule, called every tick instead of when the neurons are first created.
- **Update Sequence**. These fields specify whether the lobe is updated at all, and if it is, where in the update sequence it should be processed. The update sequence is a giant list containing all lobes and tracts in the order they should be processed to ensure information flows properly through them.
- **Tissue ID**, when specified, allows biochemical receptors and emitters to bind to the neurons in this lobe.

Tracts

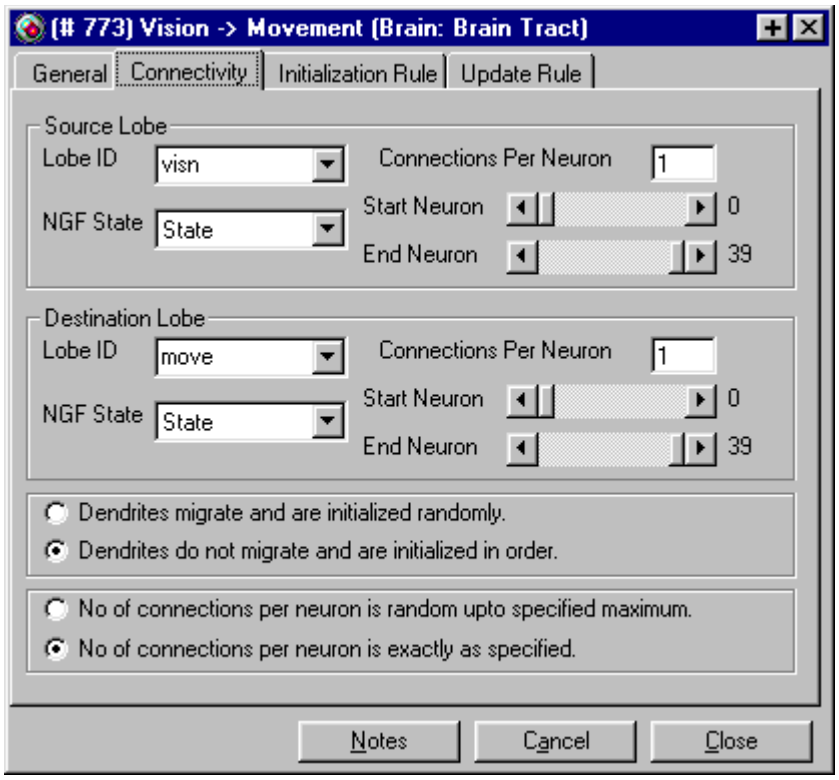
General



This page contains the common mutation controls and the Update Sequence information identical to its counterpart in the Lobe Gene. Note that the when the "Initialization Rule runs always" flag is set the Initialization Rule is no longer processed on newly migrated dendrites.



Connectivity



- **Source Lobe, Destination Lobe**. Specifies the source and destination lobes for the dendrite connections for these dendrites.
- **Start Neuron, End Neuron**. Dendrites can be told to attach themselves only to a sub-section of both their source and destination lobes. Dendrites will connect to neurons numbered from Start Neuron to End Neuron inclusive.
- **Connections Per Neuron**. This field serves to set the initial arrangement of dendrites. The two numbers (one for source, one for destination) work differently depending on whether the tract is migrating or non-migrating.

  For tracts which allow migration, a zero means unconstrained i.e. any amount of dendrites may connect to these neurons (note that the source and destination may not both be unconstrained). Any other number specifies (constrains) exactly how many dendrites you want to be connected to each neuron.

  For tracts whose dendrites do not migrate their dendrites are initialised in order starting from the beginning of each source and destination connection. The Connections Per Neuron refers to how many times the neurons should be connected up before moving on to the next neuron. The most often used setting is 1 for source, 1 for destination, which comes out as connecting the 1st neurons together, the 2nd, the 3rd and so on. A value of zero (never move on) is not allowed.

- **NGF States**. Dendrites in a tract migrate to make connections from multiple source neurons to a single destination neuron. The source neurons selected as those with the highest NGF (Neural Growth Factor) levels for their lobe. The destination neuron is the one with the highest NGF level for its lobe. NGF State in the tract gene determines which state variable to use to represent NGF for the source and destination neurons.
- **Dendrites migrate and are initialized randomly**. Sets this tract as having dendrites which can migrate each tick depending on their strength.
- **No of connections per neuron is random up to specified maximum**. Specifies that when the Connections Per Neuron field is used in initialising dendrites it is treated as a random value. This allows you to specify that (say) all source neurons should have a random number of dendrites on them from 1 to 3.

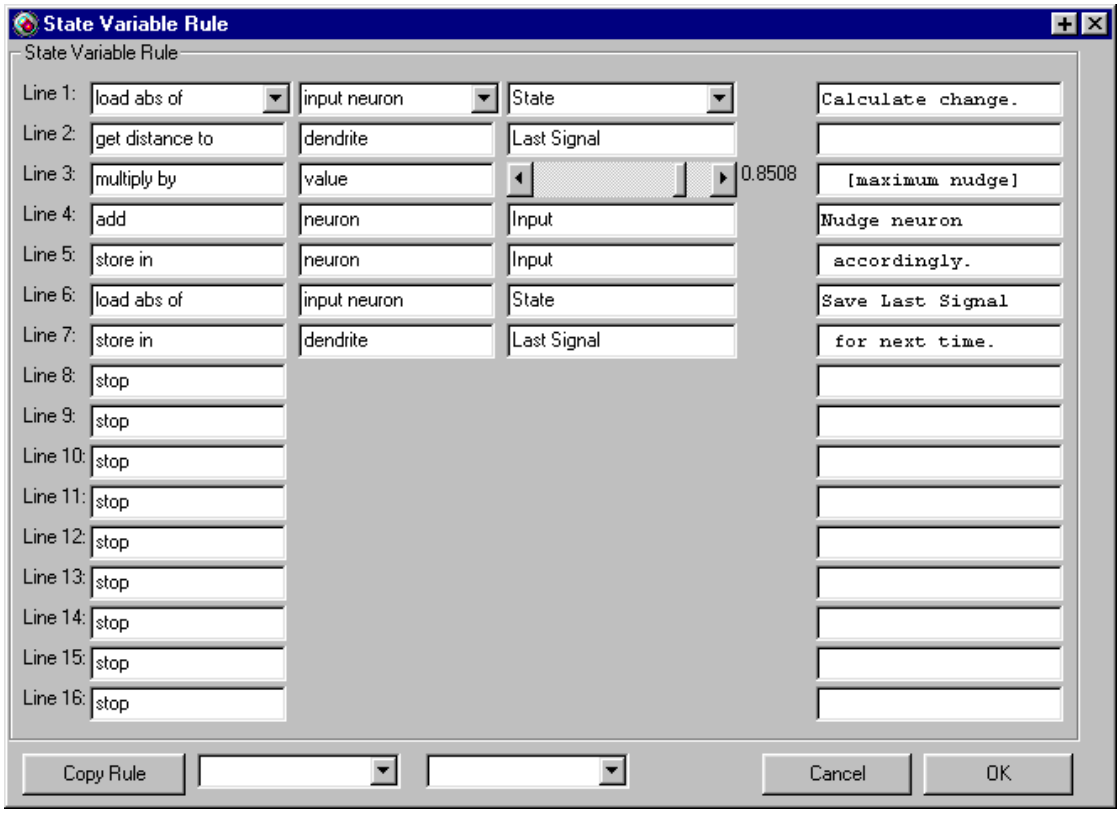
State Variable Rules

State Variable Rules (or SVRules) are genetically defined functions that are used throughout a brain lobe structure to control most aspects of synaptic and denritic behaviour, as well as to compute a neuron's state.

State Variable Rules are composed of interpreted opcodes and operands. Each SVRule expression is designed to be interpreted extremely fast (as each neuron's state needs to be calculated, as well as other synaptic behaviours such as the dendrite relaxation functions, for example), non-brittle and "fail-safe"—genetic mutations must never cause syntax errors.

SVRules can compute new state values in many ways. A considerable amount of the possible functions go well beyond the present needs of the brain model in Creatures, giving great scope for alternative brain structures.

SVRules for brain lobes are defined on the various pages of the brain lobe gene. When a State Variable Rule is edited, this window appears:



The SVRule can then be edited by using the drop-down boxes. The expression can consist of up to sixteen opcodes and operands. During processing, at each stage in the rule the interpreter keeps a particular value in mind, called the 'accumulator'. In input lobes (i.e. those that the game engine feeds information into), this value is initialised to be the input for each neuron.

To aid more complex modelling and processing, each neuron (and dendrite) actually has eight variables available for information storage. For neurons the main ones are Input, State and Output. For dendrites (on the learning tract) the main ones are Short Term Weight and Long Term Weight. You can find a full list (which you can also edit) under the Variables tab on the main Genetics Kit window.

The rule above is taken from the C3 Norn genome from the 'visn' to 'move' tract. Each dendrite fires its movement neuron according to how much its vision neuron has changed. In detail:

1. The accumulator is put equal to the (absolute value of) the source neuron state we're connected to.
2. The (absolute value of) the difference between this value and the dendrite's last signal is put into the accumulator.

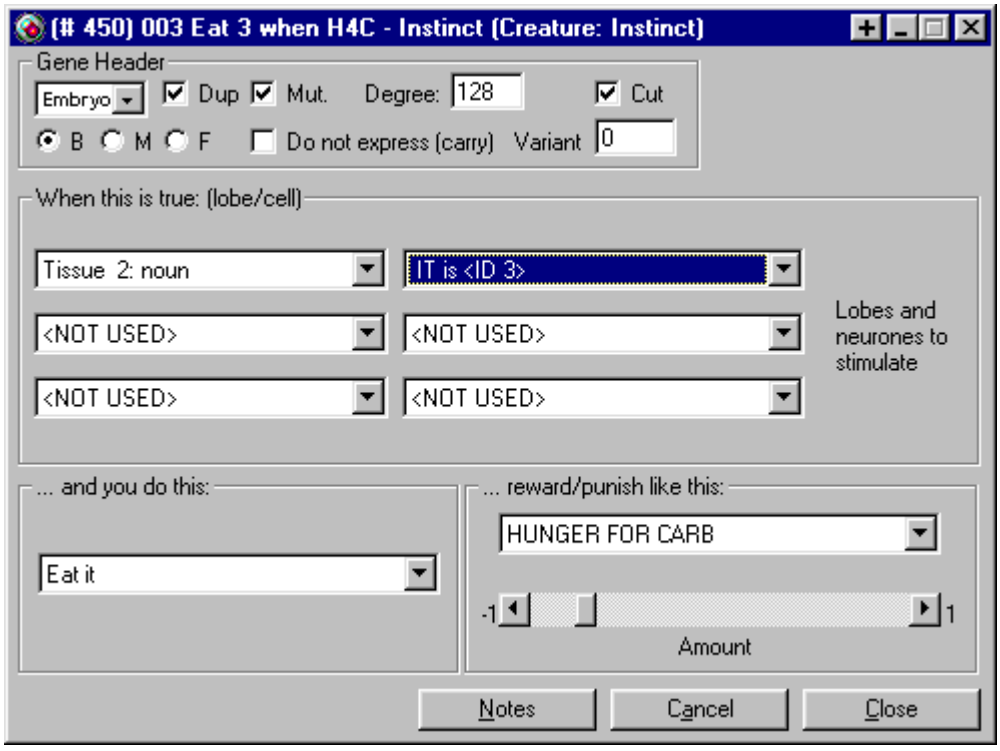
3. This value is attenuated by 0.8508.
4. It's added to...
5. ...and stored in the destination neuron's input.
6. The (absolute value of) the source neuron's state...
7. ...is stored as our last signal for next time.

Please note: If you press **Ok** on the SVRule window, and then **Cancel** on the gene window, any changes you made to the SVRules are **not cancelled!**

Instincts: A summary of how they work

Instincts allow creatures to be taught that doing a particular action given a certain situation is either bad or good for a particular drive, without the creature having to go through the experience itself. This allows important concepts to be "pre-taught" to Norns, Ettins and Grendels to affect their initial behaviour.

Instincts are used for many purposes. These include teaching Norns to retreat from other Norns when overcrowded, or to do something when bored and eat food when hungry. A typical instinct gene may look like this:



Instincts are processed when creatures sleep. **If a creature does not sleep, its instincts will not be learnt.**

During sleep, Creatures detaches the brain from any outside stimulation. The sensory inputs specified in the Instinct gene ("When this is true" frame, in the picture above) are then fed directly into the creature's brain. The action specified in the instinct gene is then encouraged to fire by means of an input to the "verb" lobe and then training impulses are sent through the response ("resp") lobe. This training causes dendrites from the drive lobe to the combination lobe to be strengthened and the weights increased according to the degree to which the drive rises or drops, as specified in the instinct gene.

The creature will then form neural connections that are likely to respond should the scenario specified in the instinct actually arise when the creature is awake. This allows scenarios to be presented to the creature's brain, in advance of them occurring in real life.

Many instincts switch on at different life stages. Instincts are used to influence and encourage mating behaviour, for example.

An instinct will not guarantee certain behaviour in a given situation, it can only influence and encourage, as it will integrate itself with the existing neural structure the creature has.

Creature chemicals: Summary

The biochemical modelling system inside Creatures supports 256 arbitrary chemicals, each of which can vary from being not present (a level of zero) to maximum concentration (a level of 1). To help keep track of these chemicals, each can be assigned with a name and description. These names are then used to select chemicals in the Biochemistry Set, and also here in the Genetics Kit.

Out of the possible chemicals, just over half are used in "generation one" creatures. Over several generations, it is possible for some of the other chemicals to come into use by mutation.

New chemical names can be assigned in the Genetics Kit using the Biochemistry Page, and then used for new chemical reaction genes. You can also edit their names and descriptions. Be careful when deleting chemicals, as you may lose the ability to see them in the Biochemistry Set if they were already in use.

New objects and agents can also make use of any new chemicals.

Complete chemical reference chart

Pyruvate	Product of aerobic respiration, an intermediate
Glucose	Derived from starch, and in a reversible reaction from glycogen. Used up by muscle action
Glycogen	Short-term energy reserve, produced in reversible reaction from glucose. Broken down to glucose to replenish supplies for muscle action.
Starch	Contained in some food, and converted to glucose to produce energy
Fatty Acid	A building block of fats and other chemicals
Cholesterol	A vital steroid
Triglyceride	An intermediate in adipose tissue synthesis
Adipose tissue	A high density energy store for creatures, analogous to fat.

Fat	Contained in some food, and converted to fatty acids in the body
Muscle tissue	Not just for strength, but also acts as a long-term amino acid store
Protein	Contained in some foods, and converted into amino acids by the body
Amino Acid	Building block of protein and muscles
Downatrophin	Emitted on downslopes
Upatrophin	Emitted on upslopes
Dissolved carbon dioxide	Waste product of the conversion of glucose to energy
Urea	Non-toxic product of carbon dioxide and ammonia reacting
Ammonia	Toxic product of reactions converting amino acid to pyruvate
Air	Breathable atmosphere
Oxygen	Useable portion of the air
Water	Vital fluid for life
Energy	Derived from pyruvate, and used to recreate ATP from ADP
ATP	High energy compound used to drive reactions
ADP	The depleted form of ATP, left over from used up ATP.
Arousal Potential	Signal of readiness to mate
Libido lowerer	Regulates sex drive during pregnancy and infertility
Opposite Sex Pheromone	Signal to enable recognition of the other sex

Oestrogen	Hormone controlling fertility cycle in females
Progesterone	Hormone regulating pregnancy in females
Testosterone	Hormone regulating fertility in males
Inhibin	Complements the effects of testosterone to regulate fertility
Heavy Metals	Sign of radiation poisoning, and contributes to high mutation rates
Cyanide	Poisonous. Quick acting, depletes energy
Belladonna	Produced by the Deadly Nightshade, and can cause heart attacks
Geddonase	Depletes any adipose stores that a creature has
Glycotoxin	Depletes reserves of glycogen, leading to an energy crisis
Sleep toxin	Makes a creature very sleepy. They may fall into a coma if not cured quickly
Fever toxin	Infected creatures run a high fever
Histamine A	Makes a creature sneeze constantly, and spreads disease
Histamine B	Makes a creature cough, and so spread disease
Alcohol	Ingested from rotting fruit; alters gait and mood. Creatures may suffer from hangovers after being cured…
ATP decoupler	Turns ATP into ADP and so quickly depletes all energy in a creature. Fatal if not cured quickly
Carbon monoxide	Prevents proper absorption of oxygen
Fear toxin	Makes an infected creature very very scared
Muscle toxin	Produces lactate in the muscles, and causes muscle burn

Antigens	Carried by bacteria and recognised by the immune system, causing antibody production.
Wounded	Chemical released when hit by another creature or fallen from a cliff. Can be fatal in large doses
Medicine one	Cure for ATP decoupler toxin
Anti-oxidant	Cure for carbon monoxide poisoning
Prostaglandin	Speeds recovery from injury
EDTA	Cure for heavy metal (radiation) poisoning
Sodium thiosulphate	Cure for cyanide poisoning
Arnica	Cure for glycotoxin poisoning
Vitamin E	Fat-soluble vitamin, keeps a creature fertile
Vitamin C	Water-soluble vitamin, used to boost production of antibodies to fight infection
Antihistamine	Helps to cure sneezing and coughing
Antibodies	The bodies natural defence against and cure for bacterial infection. Each corresponds to the bacterial antigen with the same number
Anabolic steroid	Regulates muscle growth
Pistle	Regulates urination
Insulin	Regulates storage or usage of glucose
Adrenaline	Chemical produced during ‘flight or fight’ response to danger
Grendel nitrate	Chemical that identifies a Grendel to its brain
Ettin nitrate	Chemical that identifies an Ettin to its brain

Protease	Enzyme that digests protein into amino acids
Life	Decays from full concentration at birth throughout life to zero at death. As the chemical decays, it changes the life stage of the creature via receptors
Injury	Chemical indicator that damage has been inflicted on a creature.
Stress	Chemical generated by high drive chemical levels, and builds up in the creature. High levels of stress can affect fertility and immunity
Drive backups	When a creature is scared or in pain, all other drives are 'stored' as backup chemicals which are invisible to the brain. The reactions that change drive chemicals to backup drive chemicals are driven by the presence of high levels of pain and fear
Drives	There are now three drive chemicals relating to hunger, each dealing with a different food group that the creatures can detect
Comfort drive	This drive is like a 'homesickness drive' and when high will prompt creatures to go back to their nests/lairs/dens…Used to help creatures navigate round the ship
CA Sound	Chemical that relates to levels and direction of sound in the CA (room) system. Used for navigation.
CA Light	This chemical gives the plants an idea of how much light they are getting in their current position
CA Heat	Plants use this as a measure of the heat in the air to help them grow. Creatures use it too.
CA Water	The levels of this chemical show how much water is around in the form of rain or snow
CA Nutrient	This chemical is used by the plants in each terrarium to give them an idea of the food available to them in the soil
CA Water	Levels of this chemical show how close any large body of water is - such as lakes or rivers

CA Protein	Levels of this chemical show how close any agent containing protein is.
CA Carbohydrate	This smell leads creatures towards foods containing carbohydrate
CA Fat	Creatures use this chemical to locate food containing fat
CA Flowers	The insects in each of the terraria use this smell to track down flowers to pollinate
CA Machinery	All machinery that is moveable emits this smell, and Ettins can use it for navigation
CA Norn smell	The smell of Norns, used for group cohesion and by Grendels…
CA Grendel smell	This smell warns Creatures of the approach of a Grendel
CA Ettin smell	This smell is emmitted by Ettins
CA Norn home smell	A smell that Norns recognise as ‘home’ and can navigate towards
CA Grendel home smell	In the same way, a Grendel can make its way home by following this smell
CA Ettin home smell	Ettins recognise that they are finally home when they can smell this chemical
Stress (high drive)	An intermediate stress chemical produced by the detection of high levels of drives. Converted slowly into stress
Disappointment	A brain chemical used when a creature tries an action that is not allowed, such as eating machinery. It discourages them from trying this action again
Up	Creatures use this 'drive' to navigate upwards, especially in lifts
Down	This is the opposite 'drive' and relates to navigating downwards
Exit	This 'drive' helps creatures exit through doors

Enter	This 'drive' helps creatures navigate into rooms through doors
Wait	This 'drive' makes a creature wait if it has called a lift
Reward	Used by the brain to reinforce 'good' actions to take
Punishment	Used by the brain to discourage 'bad' actions
Pre-REM	Brain chemical related to instinct processing
REM	Brain chemical related to instinct processing

Creature poses: Summary

Creatures supports a total of 256 different "poses" for creatures. These are numerical representations for the positions that creatures can get into in order to interact with their environment. Pose 77, for example, describes the body position for death. A total of 170 poses are used in first generation Norns. The Genetics Kit has a specific page for editing and viewing the pose names.

Adding a new pose name will not create a new pose. A new pose must be specified genetically. The pose naming system simply provides a method for assigning human-friendly tags to pose numbers.

For new poses to be valid, appropriate genes must also be created. The pose sequence requires each body part's position to be specified numerically, a task made much simpler by the Creatures Pose Editor.

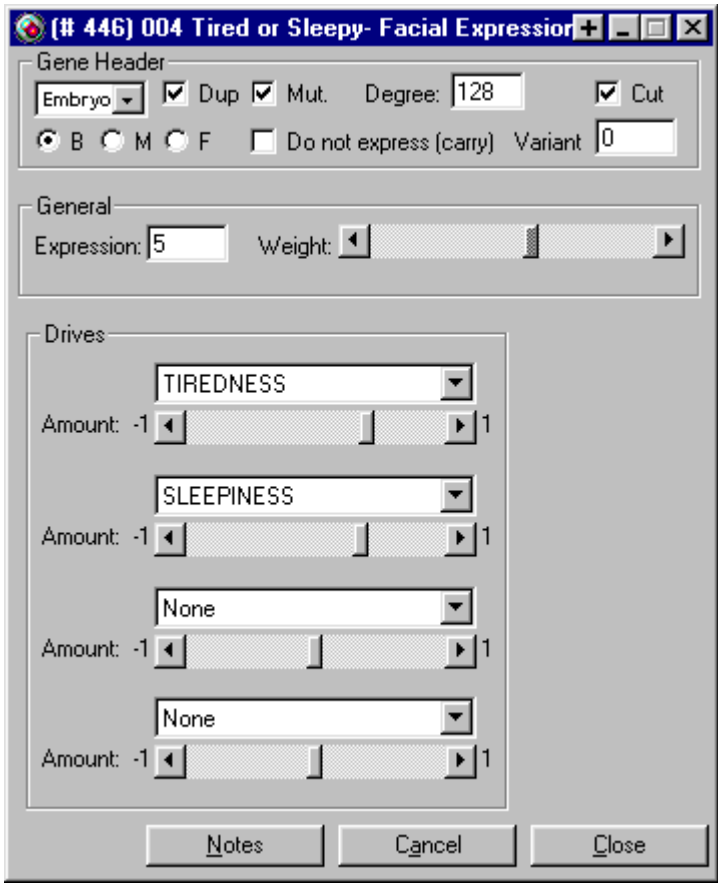
For poses then to be used by a creature, they have to either be incorporated in a gait, or used by a macro script that acts on the creature.

Facial Expressions

In Creatures 3 there are 6 facial expressions with IDs as follows:

Normal	0
Happy	1
Sad	2
Angry	3
Scared	4
Sleepy	5

Each facial expression gene votes for the expression it represents, sleepy etc, in the following way: Firstly, the overall strength of its vote is governed by its Weight under the General section. Secondly, facial expressions get points based on whether their drives mentioned in the form are high or low. In the picture below you will see that it represents expression 5 (sleepy), has a middling overall weight and drive weights of 0.3 on both Tiredness and Sleepines. So extra points are given to this expression (up to a maximum of 0.3 per drive) if the Norn is tired or sleepy. If the weights were –0.3 instead points would be awarded (again up to 0.3 per drive) depending on how *not* tired and sleepy the Norn is.



Genetics Kit – Help File

Version:	1.00 (28.2.99)
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