# Lesson Element

# Genetically Modified Organisms Dating Game - Game Cards

Red-border gene donor organism cards:

| Image on front | Information on back |
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| Phyllomedusa bicolor frog - Giant Leaf Frog | **Name** *Phyllomedusa bicolor* Giant Leaf Frog  **Key gene** *DRS B1*  **Properties of gene product** B1dermaseptin protein kills bacteria and fungi.  **GM use** To prevent blight and bacterial diseases in potato crops. |

| Image on front | Information on back |
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| Bos primigenius - Cow | **Name** *Bos primigenius* Cattle  **Key gene** *Cym*  **Properties of gene product** Chymosin is a protease enzyme that curdles milk.  **GM use** GM bacteria produce the enzyme which is purified and used to make cheese. Previously chymosin was extracted from the stomachs of calves so cheese made in this way was not acceptable to vegetarians. 80-90% of the cheese sold in Britain is made with GM bovine chymosin. |
| Bacillus thuringensis  Rod shaped bacterium representing agrobacterium sp C4 strain | **Name** *Bacillus thuringensis*  **Key gene** *Cry*  **Properties of gene product** Crystal protein kills caterpillars, maggots and beetles that eat the protein.  **GM use** To make crops such as maize, cotton and soya bean resistant to herbivorous insects.  **Name** *Agrobacterium sp* C4 strain  **Key gene** *C4 EPSPS*  **Properties of gene product** EPSP synthase performs a crucial metabolic step in plant chloroplasts. The bacterial version is undamaged by glyphosate.  **GM use** To make crops resistant to glyphosate so it can be used as a weed killer without harming the maize, cotton or soya bean crops. |
| Bacillus subtilis | **Name** *Bacillus subtilis*  **Key gene** *cspB*  **Properties of gene products** Cold shock protein B helps organisms metabolise normally during abiotic stress.  **GM use** To make maize grow more and produce a higher yield under drought conditions. |

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| Nephila clavipes - Golden Orb Weaver | **Name** *Nephila clavipes* Golden Orb Weaver  **Key gene** *MaSp*  **Properties of gene product** High-strength silk fibre for webs.  **GM use** Gene is switched on in mammary glands of GM goats to mass-produce the silk fibre for artificial tendons and ligaments and for bullet-proof vests and parachutes. |
| Hepatitis B virus  Aequorea Victoria - Jellyfish | **Name** Hepatitis B virus  **Key gene** *HBsAg*  **Properties of gene product** Surface antigen of virus stimulates an immune response in humans if injected or given orally.  **GM use** GM potatoes eaten raw in small quantities boost immunity to hepatitis B. Cheap way of delivering vaccines in developing world..  **Name** *Aequorea Victoria*  Jellyfish  **Key genes** *GFP*  **Properties of gene products** Green Fluorescent Protein glows under UV light.  **GM use** The gene is extensively used as a marker to reveal which organisms have taken up a foreign gene and in which tissues the gene is switched on. Spin-offs include Glo-FishTM and NeonMice sold as pets in the USA. |
| Homo sapiens - Human | **Name** *Homo sapiens* Human  **Key genes** Mutated version of *BRCA1* and activated *Ras* oncogene.  **Properties of gene products** Cause cancer. The products of the normal versions of the genes repair DNA mutations and suppress tumours.  **GM use Creating cancer research models**. GM mice engineered to carry the mutant alleles are used to study cancer and treatments for cancer. |

| Image on front | Information on back |
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| Homo sapiens - Human | **Name** *Homo sapiens* Human  **Key genes** Normal alleles coding for insulin, lactoferrin, Factor IX, anti-thrombin III and glucosidase.  **Properties of gene products** Insulin controls blood glucose concentration. Lactoferrin is an antimicrobial found in colostrum and milk. Factor IX helps blood clot. Anti-thrombin III stops blood clotting. Glucosidase in lysosome function  **GM use Pharmaceutical drugs** Insulin from GM bacteria treats diabetics. Lactoferrin in GM rice treats diarrhoea in children. Factor IX from GM sheep’s milk treats people with haemophilia B. Anti-thrombin III from GM goats’ milk is used as an anti-coagulant in surgical procedures. Glucosidase from GM carrot cells in culture treats people with Gaucher’s disease. |
| Homo sapiens - Human | **Name** *Homo sapiens* Human  **Key genes** *CFTR RPE65*  **Properties of gene products** *CFTR* protein allows normal mucus production in lungs and gut. *RPE65* protein is needed in rods and cones for normal vision.  **GM use** *Gene therapy*Normal *CFTR* allele is introduced into lung epithelial cells of cystic fibrosis patients. *RPE65* inserted into retinal cells of blind patients with Leber’s Congenital Amaurosis restored sight. |
| Androctonus australis hector - Scorpion | Name Androctonus australis hector Scorpion  Key genes AaHIT1  Properties of gene products Toxic to insects but not harmful to mammals.  GM use To kill insects on GM cotton crops. |

Blue-border recipient organism cards:

| **Image on front** | **Information on back** |
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| Zea mays - Maize or Sweetcorn | **Name** *Zea mays* Maize or Sweetcorn  **Suitability as a GM recipient** Major food source for animals and humans and as a source of starch and sugars for processed food. Many insects attack the crop however, its yield falls in drought conditions and the crop must be kept free of weeds. |
| Gossypium hirsutum - Cotton | **Name** *Gossypium hirsutum* Cotton  **Suitability as a GM recipient** Important crop for textile fibres but many insect pests attack it and the crop must be kept free of weeds. |
| Glycine max - Soya bean | **Name** *Glycine max* Soya bean  **Suitability as a GM recipient** Major food source for animals and for humans as a source of protein in processed food. Many insects attack the crop however and the crop must be kept free of weeds. |
| Solanum tuberosum - Potato | **Name** *Solanum tuberosum* Potato  **Suitability as a GM recipient** Major carbohydrate food source in Europe and America. Potatoes are easy to grow and can give high yields but suffer from many diseases such as blight, which lower yields. They can be engineered to make vaccines but these must be grown under cover to prevent gene flow to other potatoes and to stop antigenic potatoes accidentally entering the human food chain. |
| Daucus carota - Carrot | **Name** *Daucus carota* Carrot  **Suitability as a GM recipient** Field-grown crops generally have been found to be unsafe to use as vehicles for production of pharmaceutical drugs but carrot cells grown in culture in bioreactors are a new ‘expression platform’ for human proteins that can be used as medical drugs. |
| Oryza sativa - Rice | **Name** *Oryza sativa* Rice  **Suitability as a GM recipient** Major food source in Asia and a suitable vehicle for therapies like treating children with diarrhoea (rice enhanced with human lactoferrin) and preventing vitamin A deficiency (genes from maize or daffodil and a soil bacterium). |
| Capra aegagrus hircus - Goat | **Name** *Capra aegagrus hircus* Goat  **Suitability as a GM recipient** Female goats produce plenty of milk. A gene is linked to a promoter to switch the gene on in the mammary glands, so that the protein product appears in the milk. So-called ‘spider-goats’ produce silk in their milk for medical and military applications. Other GM goats produce a drug, human anti-thrombin III, used as an anticoagulant in surgery. |
| Ovis aries - Sheep | **Name** *Ovis aries* Sheep  **Suitability as a GM recipient** Female sheep produce plenty of milk. A gene for a pharmaceutical protein is linked to a promoter to switch the gene on in the mammary glands, so that the protein appears in the milk. Sheep have been used to make factor IX to treat sufferers of haemophilia B. |
| Mus musculus - Mouse | **Name** *Mus musculus* Mouse  **Suitability as a GM recipient** It is a genetic model organism with a well-known, fully-sequenced genome. As a mammal its genome is very similar to that of humans. Mice are small so are cheap to feed and house. Many GM techniques applicable to humans or farm mammals are first tried on mice. Fluorescent GM NeonMice are sold as pets in the USA. |
| Homo sapiens - Human | **Name** *Homo sapiens* Human  **Suitability as a GM recipient** People suffering from genetic diseases caused by two recessive non-functional alleles can be treated with gene therapy. The dominant functional allele is inserted into affected somatic cells. Trials have included treatment of cystic fibrosis and Leber’s congenital amaurosis. The limitation on treating a human with another human allele is whether the cells that need the foreign DNA are accessible (eg lung epithelium) and stable (not replaced every few days). |
| Rerio danio - Zebrafish | **Name** *Rerio danio* Zebrafish  **Suitability as a GM recipient** It is a genetic model organism with a well-known, fully-sequenced genome. It is a useful simple vertebrate for research. GM zebrafish expressing genes for fluorescent proteins are on sale in the pet trade in the USA marketed as Glo-FishTM. |
| Escherichia coli | **Name** *Escherichia coli*  **Suitability as a GM recipient** GM bacteria divide rapidly in a fermenter to produce proteins like human insulin, and bovine chymosin for cheese-making.  *E.coli* is a genetic model organism with a well-known, fully-sequenced genome. Its plasmids are widely used as vectors. However some strains of *E.coli* are pathogenic and the GM process may involve inserting antibiotic resistance genes into the bacteria. |