

GCCF Breeding Policy

**Guidelines for Healthy
Breeding**



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GCCF Breeding Policy – Guidelines for Healthy Breeding

1 Summary Statement

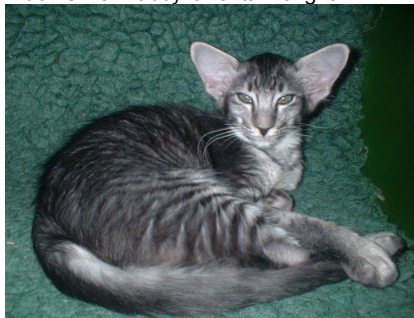
1.1 The GCCF operates a genetic based register. It is therefore fundamental to the spirit and ethos of the organisation that it should seek in every way to safeguard the genetic health and integrity of all breeds recognised for inclusion on that register. The General Breeding Policy outlined below offers advice and guidance for the dedicated and ethical breeder to (1) develop and progress any pedigree breed whether for show or companion purposes; (2) improve the quality of phenotype (appearance) of any given breed, through a robust process of selective breeding, towards the ideal described in the breed standard; and (3) maintain a robust, healthy and viable breeding population of any given breed through consideration of the genetic outcome of any breeding programme.

1.2 To be successful in this endeavour such work must be undertaken in a planned, considered and structured way, within a framework of reasonable limits and through a carefully managed breeding system. This policy seeks to avoid extremes of physical type and minimise the extent of inbreeding that may lead to deleterious consequences for a cat's health and affect its ability to live a natural healthy life.

1.3 Selective breeding by definition aims to increase homogeneity (similarity) and reduce random variation within a given breed gene-pool. In doing so it increases the chance that undesirable, and even harmful, genetic anomalies will begin to express themselves. It is vital that breeders pay particular regard to such a risk and monitor each successive generation for evidence of such anomalies. Recent advances in science and technology mean breeders can now increasingly take advantage of rapid developments in genetic testing and in the understanding of the cat genome, and to test for a range of specific genes and DNA markers. Following a practice of genetic testing wherever possible will increase confidence in the health of any potential offspring, offering benefits for both the breeder and new owner by reducing any necessity for unfortunate and costly veterinary interventions.

Careful selective breeding has ensured health and vitality whilst maintaining the distinctive type of these very different breeds:

Black Silver Tabby Oriental Longhair



Chocolate Tortie Burmese



Tabby & White Persian

2 General Breeding Policy

2.1 This policy applies to all breeds recognised by the GCCF and is intended to provide guidelines to ensure healthy breeding practice.

2.2 The GCCF is committed to the breeding of healthy pedigree cats of whatever registered breed, type or conformation. Our policy is to recognise only breeds that are able to live a healthy, contented and “normal” life – able to jump, climb and pursue normal cat behaviour, physically able to mate unaided and to give birth normally, without relying on major medical intervention (unless exceptional and unforeseen complications occur), and without genetic anomalies that impair the cat’s ability to live and behave in accordance with a cat’s nature (see Health Comes First – www.gccfcats.org/health.html See link to DEFRA Cat Welfare Policy – www.defra.gov.uk/wildlife-pets/pets/cruelty/documents/cop-cats.pdf). The GCCF will not recognise breeds that do not meet these basic criteria.

2.3 There are several breeds with deleterious physical anomalies which are not recognised by the GCCF and which it would not want to encourage people to breed. While cats with structural anomalies may appear cute there are no positive welfare benefits for the cat conferred by any of them. Some may be purely cosmetic, but for others there is substantial evidence that the mutation limits the natural lifestyle of affected cats and may cause pain and chronic ill health when the cat is older, shortening its life span. Doubling or trebling such anomalies for the appeal of novelty or oddity is likely to increase greatly the risk of a deleterious impact. For this reason the GCCF will not consider granting recognition to any new breed based upon a harmful genetic mutation and/or where the resultant structural anomaly is the key feature upon which the breed is based, this specifically includes shortened limbs (eg. Munchkin), shortened or bent tails (eg. Pixie Bobs), polydactyl feet (such as Pixie Bobs, Clipper cats), bent or deformed ears (eg. osteochondrodysplasia as in the Scottish Fold), hairlessness, or any miniaturised breed (see GCCF Rules, Section 1).



Semi longhaired Munchkin and Spotted Tabby Pixie Bob, two breeds not recognised by GCCF



Polydactyl foot

2.4 However, there are a few cat breeds, which it is claimed, are based on naturally occurring physical morphologies which have no detrimental impact on the cat's life. In future any application for recognition of a breed based on such natural morphologies will need to provide clear evidence that this mutation does not have a harmful effect or limit the cat's natural behaviour. Although the GCCF acknowledges that for historic reasons a very small number of breeds with similar features have been permitted for registration with the GCCF in the past, this is now not considered to be a sensible or sustainable policy to follow for the future recognition of new breeds.

2.5 In addition, some breeds have been developed from out-crossing to wild cat species with sufficient genetic similarity to generate viable, fertile offspring. Whilst acknowledging it has conferred recognition on one of these breeds (the Bengal) the GCCF strongly discourages any future out-crossing of domestic pedigree or non-pedigree cats to any wild cat species for the purpose of creating a new pedigree breed and will not recognise any breed(s) resulting from any such further matings/outcrosses.



The two Brown Spotted Bengal cats shown here are many generations down from the original out-cross to the wild species. Back crosses have never been allowed and selection has bred successive generations with a good domestic temperament.



3 Breeding Practices for Maintenance of Genetic Health

3.1 Breeds recognised for registration by GCCF cover the full range of body types, coat types and lengths, colours and patterns, but in each case the GCCF standard of points for each recognised breed discourages the breeding of extreme “type” that may lead to physical anomalies which then may become endemic in the breed.



Blue Selkirk Rex – a strong cobby breed with a dense curly coat and a cute expression



An elegant breed of moderate type, this Usual Somali shows to perfection the beauty of the pedigree cat

3.2 The GCCF requires each Breed Advisory Committee (BAC) to have in place a clear registration policy for each breed, in addition every BAC is required to produce, publish and promote an accepted breeding policy for its constituent breed(s). All breeding policies will be reviewed by the Genetics Committee, to ensure they are comprehensive and consistent with this General Breeding Policy. Copies of all breeding policies will be kept for reference purposes at the GCCF Office alongside current registration policies. It is also expected that the Genetic Register will be used for entire breeding cats of any given breed for the purpose of assisting future development of that breed.

3.3 The GCCF Genetic Register will exist to be used by breeders as part of a managed breeding system to eliminate any known genetic anomalies and to prevent the spread of such anomalies to other breeds of cat via permitted out-crosses. The Genetic Register is used to register either untested cats or a proven carrier of a genetic disease or anomaly. Cats on this register may be used by breeders in the process of eliminating that disease, but it is strongly recommended that novice owners should purchase breeding cats that are on the active register or pet cats on the non-active register.

3.4 In each case the breeding policy will describe the best breeding practice to be followed to safeguard the integrity, character, distinctive type and genetic health of the breed concerned. The registration and breeding policies will between them outline and describe any genetic anomalies known to exist in that breed, how these will be managed, and wherever possible, eventually eliminated. This includes the genetic (and other) tests required for registration, along with the status of cats known to be affected with defects (i.e. Reference Register, Non-active Register, and Genetic Register). The overall aim is to breed exclusively from cats that are healthy and without detrimental anomalies, and, within the context of ensuring a continued and sufficiently wide and varied gene-pool from which breeding cats may be selected in order to maintain the breed as a distinct recognised breed of cat.

3.5 What constitutes “sufficiently wide and variable gene pool” has been defined by more than one study and accepted wisdom can be summarised for guidance purposes as meaning that a breed needs to have a minimum of 50 to 60 unrelated individual cats as foundation cats or outcrosses in its gene pool. A recent RSPCA study (on their website) states 60 as a minimum for dogs, a similar number is also sensible for cats. There are quite a few breeds that do meet this criteria, but many that do not; (for example, the Singapura was shown by the Lipinski study to be the most inbred of all cat breeds with less than 10 unrelated cats forming the basis of the breed, it is followed by the Burmese). There are suitable outcross options for all breeds, even if this means replicating the origins of the breed and sourcing new foundation individuals. Genetic registers can now be used to facilitate the screening for colour and pattern genes which are undesirable to certain breeds, as well as for genetic diseases. Thus outcrossing could take place to cats of the correct colour and pattern only, without having to limit the breeding programme, because the offspring of outcrosses would remain on the genetic register until the correct genotype was achieved.



The LaPerm registration policy allows out-crosses to several breeds of similar type in order to maintain sufficient genetic variation to continue to develop this relatively new breed.



Singapura – breeders are selecting carefully to ensure the long-term genetic health of this attractive breed.

3.6 The GCCF actively promotes genetic and other relevant testing, and offers advice and guidance to breeders, clubs and BACs on best breeding practice. However, BACs and breeders should individually research available testing services, although the Genetics Committee is pleased to offer information and advice. The links below provide a range of sites offering DNA and other tests and give details of the procedures to be followed, along with prices, etc. In some cases the laboratory may require samples to be taken by a veterinary surgeon and may also require the tested cat to be micro-chipped subsequent to testing (see links to labs below for full information). UC Davis and Langford are both part of a university and income from testing supports further research into cat diseases; AHT (Animal Health Trust) is a UK based vet charity; the remaining three are commercial organisations.

<http://www.vgl.ucdavis.edu/services/cat/>

http://www.aht.org.uk/genetics_tests.html#feline

<http://www.catgenes.org/dna-tests.html>

<http://www.animalsdna.com/feline/>

<http://www.laboklin.co.uk/laboklin/GeneticDiseases.jsp?catID=CatsGD>

http://www.langfordvets.co.uk/laboratory_owners.htm

3.7 The GCCF strongly encourages people in all breeds to co-operate in the active genetic management of their breed(s). A suggested way to progress this work is via the establishment of preferred breeder schemes run through the BACs and breed clubs and perhaps aided and ratified by

the FAB. The Genetics Committee offers support to breeders with the interpretation of genetic test results or with screening and testing in general, as a means of encouraging breeders to test more frequently and for a greater range of genes so as to build a better genetic profile of both individual cats and breeders' lines. Perhaps breeders could even consider quoting the inbreeding coefficients on their pedigrees to show that they are complying with GCCF Breeding Policy regulations. This may also be a desirable factor for future pet owners in selection of a pedigree cat as a potential companion.



Red Spotted Oriental showing lovely colour and type



Handsome well balanced Black& White Cornish Rex showing excellent dense regular waves.

4 Breeding Systems

4.1 The general recommended systematic approach breeders should adopt in breeding any (GCCF) pedigree breed of cat is outlined in this section. An agreed breeding system is an integral part of the Breeding Policy for any specific breed. In order to ensure the maintenance of good breed type as defined in any breed's Standard of Points, while allowing scope to further improve aspects of type, coat, pattern and colour to meet the ideal described in that Standard, all breeders need to have a clear, defined, and well understood **breeding system**. This means the development and management of a breeding programme in which certain cats are affirmatively selected to be bred to others for predetermined reasons. Equally important, it means that breeders should allow no matings

unless they have given careful consideration to the outcome and any future consequences for the breed. In particular four key rules must be followed:

- **Health must be the overriding consideration in any breeding programme.**
- **The good (positive) and bad (negative) features of the individual cats should be assessed and weighed against each other before any mating. This includes the risk of passing on genetic faults/anomalies.**
- **When planning a breeding programme, breeders must realise that doubling of the good traits in a cat may also result in doubling any defects; the breeding of cats with similar faults should be avoided at all costs otherwise there is a danger of fixation (i.e. creating a characteristic which cannot subsequently be eliminated).**
- **Breeders must make themselves aware of the nature of the characteristics they wish to promote or avoid, whether these are due to a dominant gene (which will always be expressed when present) or a recessive gene (only expressed in the homozygous state i.e. where the cat inherits the gene from both parents).**

4.2 The prime motive is to perpetuate the breed concerned as distinct and recognisable and to improve the quality of the breed as measured against the Standard (with consequent success on the show bench). However it must be noted that not all good show cats reproduce themselves and some cats which do not conform well to the GCCF SOP can produce kittens of extremely good type. So allowing breeding from show-quality/superior cats only, does not always necessarily work out the way one would expect. Some emphasis on intelligent and well thought out breeding with a good breeding plan is better than the random mating of two “superior” cats. The skill in breeding lies in the **choice of the individual cats** to be used and **what the results are likely to be should these cats be mated with each other** – these two acts should be given individual attention and considered as completely separate, although interconnected.



The distinctive head-type of the breeds above shows the breeder's skill. Clockwise from the top: Usual Abyssinian, Seal Bi-colour Ragdoll, Tipped British Short Hair, Havana, Chocolate Silver Spotted Tabby Asian, Brown Tabby & White Exotic.

Selection

4.3 The phenotype (appearance) of the individual cat is made up of a large number of genetic characteristics of varying expression. The ideal cat is one in which the expression of each of these characteristics is just right in the eyes of the breeder – this means that an intermediate expression will be required for some characteristics, but a more extreme expression required for others. This expression is controlled by selective breeding. However, selection by itself is not very efficient in eliminating heterozygous genotypes (the producers of variation and diversity) – it is one of the tools available, but has its limitations in terms of creating and maintaining distinctive breed characteristics and type.

Beautifully balanced Red Self Persian



Asian Brown Ticked Tabby showing excellent type



Inbreeding

4.4 Inbreeding is an inclusive term covering many different breeding combinations and degrees of relationship – including the more distant, less intense; the latter is sometimes referred to as “line-breeding”. In-breeding is consistently more efficient in eliminating heterozygous (varying and diverse) genotypes and increasing homozygous (same) genotypes, thereby ensuring a greater likelihood that kittens will closely resemble their parents, which is the essence of any breed of pedigree cat. Used here the term

does not mean close, purposeful, inbreeding of closely related cats (brother/sister, father daughter), but rather the moderate form that results from the mating of not too distantly related (but not directly related) cats (first cousins, half brother/half sister, second cousins, etc). Some inbreeding is essential to stabilise conformation around a definite type and to maintain the integrity and distinct physical and genetic characteristics of any breed.

4.5 In-breeding is the act of mating individuals of various close degrees of kinship which, if continued, produces ever increasing homogeneity in the offspring.

4.6 It is important to monitor the percentage intensity of inbreeding for any mating, because of the risk of introducing or expressing detrimental factors or anomalies. A computer programme such as "Breeder's Assistant" (*see under List of References) or similar, will automatically calculate the percentage of inbreeding for any planned mating. A degree of inbreeding between 1% and 25% over a pedigree of at least eight generations should be regarded as perfectly acceptable; above 25% breeders should be sure that they have researched the pedigrees and ancestors of both prospective parents very carefully and that they are confident that both lines have been sufficiently tested for there to be minimal risk of defective genetic traits. It is highly inadvisable to breed two cats with resulting inbreeding coefficients of 50% in the offspring, no matter how well the parental lines may have been tested for genetic anomalies. (In devising recommended in-breeding coefficients the GCCF Genetics Committee has referred to the guidance provided in Chapter 6 (Breeding Practices) and Chapter 7 (Inbreeding) of **Robinson's Genetics for cat Breeders and Veterinarians" along with other sources of suggested inbreeding ratios).

4.7 The following quote from Professor Bateson's report into dog breeding provides sound advice to novice breeders: *"Avoid very close inbreeding. Grand-daughter mated to grand-father is too close in my view. A good rule of thumb is that if the pedigrees of the potential mates include more than two (common) grandparents, avoid that mating."*

4.8 If breeders can access details of a cat's ancestors going back less than eight generations, they should work to lower maximum percentages of inbreeding depending on the number of generations used in the calculation, (eg. 1 – 20% where only six generations are used; 1 - 17% for five generations). In **normal** circumstances and considering ancestors to at

least the eighth generation, it would generally not be considered sound, acceptable practice to mate cats where the resulting degree of inbreeding would exceed 40% (and the absolute maximum cut-off is 50% as stated above), where less than eight generations a lower percentage should be used (e.g. not more than 35% in the case of six generation pedigrees; not more than 33% for five generations). Breeders should use this consideration as a key part of the decision making process when considering any mating, and remember: **“The more intense the inbreeding, the more careful must be the selection”. “Loss of innate genetic variability and thus potential viability must not be too great”.**

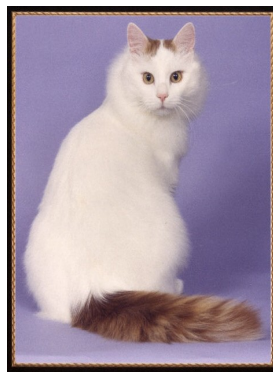
The genetic health and excellent type of all these breeds depends on careful selection and the intelligent use of limited inbreeding.



Ticked Tabby British Short Hair



Black Smoke Devon Rex



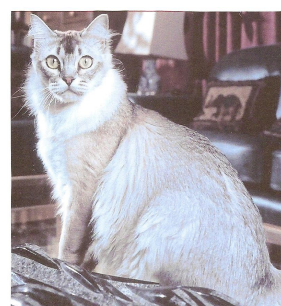
Turkish Van



Brown Tabby & White Maine Coon



Silver Egyptian Mau



Brown Shaded Silver Tiffanie

Anomalies

4.9 The problem of genetic anomalies is something of which all breeders should be aware – this is not to suggest that these are common but cats must be expected to have a quota of defects just as are found with other animals. (See the GCCF list of withholding faults and list of known genetic disorders given below).

4.10 It is recognised that breeders may want to test for any genetic anomalies in their own lines and that the mating of very closely related cats through a restricted mating programme is the simplest way to do this, unless a DNA test is available (a list of restricted matings is given below). **However, the GCCF requires any kittens bred from these matings to be placed on the non-active register in order to prevent the inheritance of any detrimental genetic traits by subsequent generations, unless there is a specific purpose which has been advised by veterinary or genetic counselling and is supported by the relevant BAC and/or approved by Executive Committee:**

i) Mother to son

ii) Father to daughter

iii) Full siblings

4.11 In essence the overall approach should be one of balance and moderation in the degree of in-breeding coupled with consistent selective breeding with a clear objective in mind – i.e. the improvement of a key aspect and/or the elimination of weak traits or defective genes.

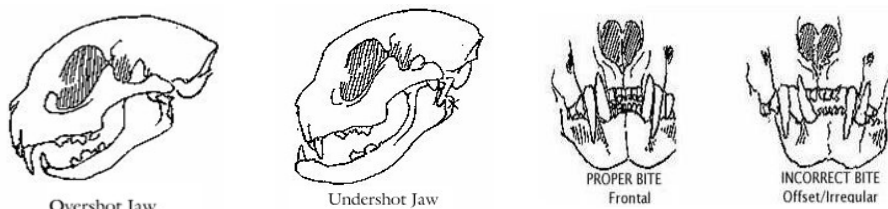
To summarise:

4.12 Breeding systems and practices need to operate to ensure the gene pool contains enough variation to give scope to continue improving the breed and avoid the danger of either fixing type too quickly (before the ideal of the standard is reached), or allowing deleterious genes to be expressed and fixed in the breed. Breeders need to use selective inbreeding to gain sufficient homogeneity to fix recognisable breed type and all key aspects that determine individual variety within a breed (i.e. colour, pattern, coat-length), but maintaining sufficient variation to both enable improvement and retain health and vigour (and avoiding fixation of defective genes or unwanted traits to ensure health and the elimination of anomalies). In addition, while it is recognised that breeders may not wish to entrust their valuable breeding lines to individuals who may not operate humane and qualitatively intelligent breeding practice the GCCF would strongly

recommend that breeders do not place excessive numbers of healthy good quality cats on the non-active register because they wish to operate commercially restrictive practices. This could have serious future consequences in reducing the viable, active gene-pool of a breed to an unacceptably low level and potentially promote undesirable inbreeding practices.

4.13 The golden rule is that health is paramount and must be constantly and consistently monitored. Any evidence of weakness or the emergence of lack of vigour must be dealt with immediately through modification of the breeding system/programme. No cat with evidence of obvious health problems or lack of vigour should be used for breeding. If a cat produces offspring with health problems the reasons for this should be investigated. Such cats should be removed from the breeding programme if evidence suggests a genetic basis for the problem.

4.14 For sufficient genetic diversity to be maintained breeders will occasionally need to outcross and bring in new foundation cats (see para 3.5 above). It is worth noting here too the views expressed by Dr Leslie Lyons: that to keep a gene pool healthy it is best not to breed too often from the same generation (perhaps for five or six years) before moving on to breed from the next generation, in order to maximise genetic diversity and maintain vitality.



Misaligned bites – a fault that can become more exaggerated over generations if carefully considered breeding programmes are not followed.

NB**For further reading on cat genetics and breeding practices refer to: "Robinson's Genetics for Cat Breeders & Veterinarians" Edited by Vella, Shelton, McGonagle & Stanglein, published by Butterworth & Heinemann Press.

Independent Inquiry into Dog Breeding

4.14 Reference is made here to the Bateson Report ([link to report](#)), produced as a result of the Independent Inquiry into Dog Breeding commissioned by the Kennel Club and Dogs Trust and supported by DEFRA, in response to widely expressed concerns as a result of the BBC documentary “Pedigree Dogs Exposed”. The ten month inquiry by Professor Sir Patrick Bateson FRS concluded that dog-breeding raises a number of serious concerns about the welfare of dogs. Key recommendations include:

- The creation of an independent non-statutory Council to develop breeding strategies which address issues of inherited disease, extreme conformation and inbreeding.
- Changes in the law including requirements for the compulsory micro-chipping of all puppies and a duty of care on all breeders
- The need for a robust Accredited Breeder Scheme setting out the requirements with regard to pre-mating genetic and other health tests.
- New regulations to replace the now out-dated breeding and sales of dogs’ legislation
- A new publicity and education campaign delivered by all key dog and welfare organisations working together to encourage a major improvement in how the public go about buying dogs.

4.15 Many elements of the Report, including issues of inbreeding, the pursuit of extreme conformation, genetic health and genetic testing resonate strongly with pedigree cat breeding and the report specifically mentions this on page 44:

“While this report addresses the specific problems that have arisen in dog breeding, many of the same issues arise with other sentient animals such as cats. Obsession with the purity of the breed and drives towards extremes of conformation crop up again and again in animal breeding. I hope some of the lessons that have been learned and continue to be learned from dog breeding will be taken to heart by those concerned with other species.”

4.16 The GCCF is determined to do everything in its power to ensure cat-breeding does not leave itself open to the level of criticism targeted at dog breeding, and the accompanying risk ultimately of imposed regulatory controls. The Policy above plays a key role in this endeavour and the Executive and Genetics Committees commend it to all breeders.

5 Role of the Genetics Committee

5.1 The GCCF Genetics Committee exists to monitor, guide and advise Breed Advisory Committees, Clubs and individual breeders on the best breeding systems and practices (see Terms of Reference for the Genetics Committee – [link](#)); and to develop and promote best practice in the management and elimination of detrimental genes from any pedigree breed by a combination of testing and selective breeding.

5.2 Below is a list of the better known genetic disorders affecting cats. A full list with extensive descriptions of causes, symptoms and management, including testing where available can be accessed via the FAB web-link at the end of this article.

6 List of well known genetic anomalies with brief description:

6.1 GCCF cannot compel any breeder to use genetic testing or screening but it strongly recommends all with conditions known to exist in their own breed(s) to use tests if available to reduce the risk of selling kittens whose health is compromised.

6.2 In future not to do so may count against a breeder in any action in the small claims court, invalidate insurance and/or be used as evidence in the GCCF disciplinary process.

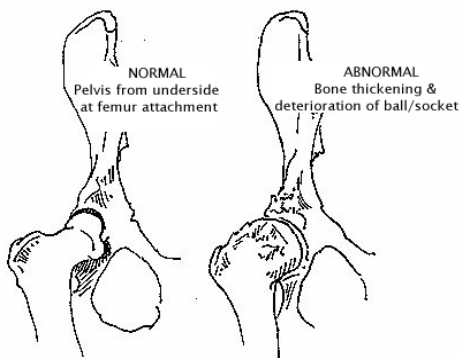
Brachycephalia/Brachycephalic Feline Noses – a malformation of the skull resulting in significant flattening of the face, the higher the degree of brachycephalia, the more the facial bones and upper canine teeth are displaced dorsally (i.e. the more pronounced the dorsorotation). Dorsorotation leads to abnormal dislocation of the ventral nasal concha and to almost horizontally rotated upper canine teeth, and thus a steeply oriented nasolacrimal drainage system (NDS). In severe brachycephalia

the NDS is forced to pass below the canine tooth and the drainage function seems to be inefficient.

Feline Hip Dysplasia (FHD) – Hip dysplasia is a deformity of the joint of the hips, which in plain terms, results in a displacement in the hip joint such that the ball of the femur no longer properly fits into the socket. A breakdown of the joint, and subsequent abnormality of the bones, will occur over time, resulting in arthritis and leading to severe pain in use of the joint (i.e., walking, running) which will only continue to get worse over time. Hip dysplasia in cats was until recently unheard of, but recent research indicates that felines of all breeds are capable of developing feline hip dysplasia and those cats who have larger bones are more prone to this disease. This is because in larger cats the bones may not be as cushioned as they could be by muscles and other sinuous tissues, which leads to a greater likelihood of dislocation of the hip joint. The disorder is genetic and can be avoided through well managed breeding programmes.



FHD is best diagnosed with the use of an x-ray of the hip joint. This can be done by a vet, and then sent to the Orthopaedic Foundation of Animals who maintains the Hip Dysplasia Registry, specifically designed to analyze the x-rays of cats suspected to have FHD. These specialists can tell definitively if FHD is present in one or both hip joints as the deformity is clearly visible on X-ray examination (see examples above)



Signs of the disorder would be apparent in their daily lives, however, as the condition is very painful and will impair a cat's ability to walk. This will then lead to limping, difficulties walking, and what appears to be a general sense of laziness in the cat (an avoidance of exercise or play).

There is no available treatment to completely repair the deformity of FHD. In the most severe cases, surgery may be necessary to fuse prosthetics into the joint. Other less radical options will include anti-inflammatory medicines and pain reduction medicines. For cats that are overweight, reducing the weight problem with food adjustments may be the first step. Also removing unnecessary exercise, such as extra jumping, is also helpful. Additionally, there is evidence that liquid glucosamine supplements have helped to correct some of the limping, lameness, and lack of exercising problems associated with hip dysplasia in their pets.

Feline Infectious Peritonitis (FIP) – This is not an inherited disease, however, a genetic predisposition to the development of FIP was identified by Drs. Foley and Pedersen in 1996. They examined pedigree and health data from 10 generations of cats in several pure-bred catteries and found that the inheritance of susceptibility to FIP could be very high (about 50%) At present the advice from veterinary scientists is not to repeat matings that have produced FIP succumbing kittens.

It is likely a polygenetic trait rather than a simple dominant or recessive mode of inheritance. Inbreeding, by itself, is not a risk factor. Selecting for overall disease resistance is a helpful tool for breeders. The likely defect in immunity to FIP is in cell-mediated immunity. Therefore cats that are susceptible to FIP are also likely susceptible to some other infections as well, especially fungal and viral infections. This finding gives breeders the ability to achieve success in reducing the risk of FIP by using pedigree analysis to select breeding cats from family backgrounds that have strong resistance to FIP and other infectious diseases. See link: <http://www.cfa.org/articles/health/FIP.html>

There are studies taking place at UC Davis into the genetic aspects of FIP and breeders' participation is requested if they lose a cat or kitten to this disease. For details of this see: <http://www.sockfip.org/fip-studies.html>. For more information and advice on this disease see: www.fabcats.org

Flat-chest syndrome – there is good evidence that this is caused by a simple recessive gene, but may also have a more complex genetic cause. The disorder results in kittens with compressed flattened rib-cage that has difficulty in breathing. It can be fatal in a proportion of cases depending on the degree of severity. No test is available.

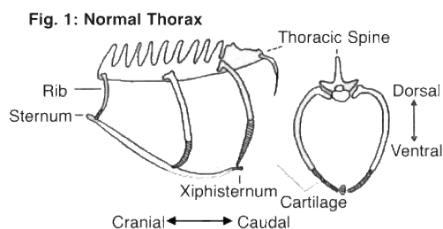


Fig. 2: Pectus Excavatum

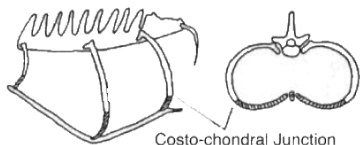
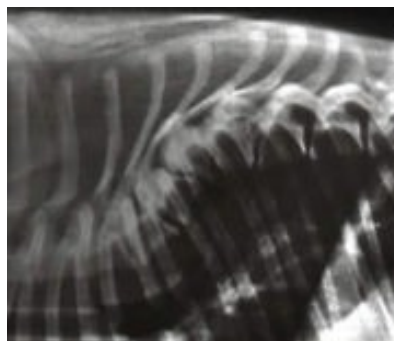


Fig. 3: Flat Chest



X-ray of flat-chest syndrome in a cat

GM1 & GM2 gangliosidosis – GMI is an autosomal recessive lysosomal storage disease. The condition is due to a lack of the enzyme acid β -galactosidase which leads to a build up of GM1 ganglioside within cells, particularly of the nervous system. Symptoms include ataxia (uncoordinated walking), and dysmetric (high-stepping walking) with the

presence of a tremor and rapid sideways movement of the eyes. GM2 is also an autosomal recessively inherited lysosomal storage disease. In the cat, the condition has been identified as being due to a lack of hexosaminidase A and B. As with GM1 the clinical signs are seen at an early stage (1 to 3 months). PCR tests have been developed which can detect the various forms of gangliosidosis.



Photo Robert Fox

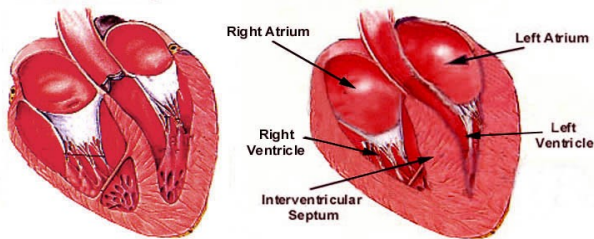


Photo Robert Fox

DNA screening for GM1 & 2 was offered to Korats in 1998. This was the first ever genetic testing opportunity for cats. All GCCF Korat breeders took advantage of the opportunity, mostly through a scheme offered by KBAC guided by Dr Kim Willoughby. The registration policy was written so that negative, positive, and any untested Korats could be registered, but there was a clear distinction between them. It has served as a model for other breeds that have tested for other diseases subsequently.
<http://www.gccfcats.org/regpol.html>

Hypertrophic cardiomyopathy (HCM) Restrictive cardiomyopathy (RCM) - Both of these conditions are characterised by impaired relaxation of the heart muscle. In HCM inward thickening of the heart muscle results in a reduction in chamber volume thereby reducing the volume of blood that the heart can pump with each contraction. In RCM fibrosis (scarring) of the heart muscle results in a chamber that can no longer expand in the normal way. Although the underlying disease process is important (because it affects the choice of drugs that can be used to treat the cat) the presentation of disease is similar. Most commonly cats will present in heart failure, but thromboembolic (blocking of a blood vessel by a blood clot) disease can also be responsible for the cat's clinical signs.

Hypertrophic Cardiomyopathy



Normal Heart

Hypertrophied Heart

HCM in humans, in the majority of cases, is an inherited genetic disorder, with over 130 genetic mutations already identified. It is now believed that the majority of HCM in cats is genetic. Recently, genetic mutations have been identified in both the Maine Coon and Ragdoll breeds of cat, and there is ongoing work looking for further mutations in the Norwegian Forest Cat and Sphynx. Within the Maine Coon breed, approximately one third of tested cats are positive for the mutation. The mutation identified in the Ragdoll is located within the same gene as the Maine Coon mutation; however this mutation is different to that identified in Maine Coons. Work at Bristol Vet School on tests on 600 Ragdolls has found a 30% positivity rate.

Genetic testing of affected cats can be useful in identifying which cats carry the mutation. Whilst a positive test result means that the cat is genetically predisposed to HCM, unfortunately a negative test only means that the cat does not have that one particular mutation. It does not mean that the cat being tested doesn't have or will develop HCM. The Feline Advisory Bureau, together with the Veterinary Cardiovascular Society (VCS) has set up a scheme to detect the presence or absence of hypertrophic cardiomyopathy (HCM) through scanning. This is of particular importance for certain breeds i.e. Bengal, Norwegian Forest, Siberian, Selkirk Rex and Sphynx.

Hypokalaemic Polymyopathy – a disorder which severely reduces potassium retention in the cat causing severe muscle weakness characterised by the collapse of limbs and hanging of head; believed to be a simple recessive gene. In severe cases it can contribute to an early death. A blood sampling study is underway; however no general test is as yet available.

Muscular Dystrophy – a genetically inherited disease that affects predominantly male cats as it is an X-linked autosomal recessive condition. In this disease the muscles are deficient in a protein called dystrophin, which makes them very weak. This disease is very similar to “Duchenne” muscular dystrophy in humans. There is no test or cure.

Neonatal Isoerythrolysis (Blood Type Incompatibility) – potentially life-threatening disorder that affects kittens of blood type A that are born to queens of blood type B. If kittens are allowed to suckle maternal colostrums in the first 18-24 hours of life they may absorb significant amounts of maternal anti-A antibodies, which causes haemolysis (destruction) of the kitten's red blood cells. The condition can be prevented by planned breeding, if the blood types of queen and stud are known; blood type B is recessive, blood group A is dominant (blood group AB is distinct from either and inherited separately). DNA testing from buccal swabs is available from UC Davis and other testing clinics.

Orofacial Pain Syndrome – the clinical signs are characterised by exaggerated licking and chewing movements, and pawing at the mouth. In the episodic version the distress usually occurs after eating, lasting between 5 minutes and 2 hours. In kittens the problem resolves when teething is complete, but may reoccur when the cat is adult. The cause is unknown, but the condition shows similarities to trigeminal neuralgia in humans. Many of the affected cats have been closely related, but the mode of inheritance has not been determined.

Osteochondrodysplasia – Scottish fold osteochondrodysplasia is a hereditary disease affecting bone growth as well as formation of articular cartilage. It is inherited as a simple autosomal dominant trait (the defected allele is designated Fd). Cats both heterozygous and homozygous for the Fd allele can suffer from clinical disease. It leads to progressive skeletal deformities at the distal parts of the legs and the tail. Lesions are evident radiographically in kittens aged 7 weeks. The metaphyses of metatarsal and metacarpal bones are distorted with widened physes. After the age of 6 months, exostoses on the plantar surface of metaphyses bones and progressive ankylosing arthropathy are evident. Similar, but less marked changes are evident in the phalanges. This results in an abnormal shape of these bones and shortening of the distal limbs. Joint lesions progress until the cats are unable to walk. The current treatment of affected cats, including glycosaminoglycans and NSAIDS, is unsatisfactory because the disease is relentlessly progressive and in severe cases it doesn't reduce lameness and accompanying pain.

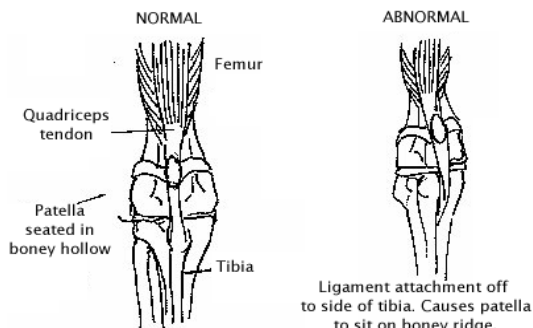


Malformation of joints in cat's foot caused by dominant gene mutation



Scottish Fold showing typical folded ears

Patellar Luxation – is thought to occur when an oversized patella (knee cap) is associated with an abnormally shallow groove at the end of the femur (the main bone of the upper part of the hind leg). The result is that when an affected cat straightens its back leg the patella is able to slip over the inner bony ridge (condyle) at the end of the femur and lie on the inside of the knee joint. In bad cases the patella is permanently displaced, while in milder cases it may slip in and out as the cat flexes or extends its knee joint. This may not cause a problem until the cat gets older when the constant wear and tear leads to arthritic change. The mechanism of inheritance is probably polygenic and directly associated with pelvic and hind limb conformation. It may be unilateral or bilateral and is frequently associated with hip dysplasia. It probably occurs in all breeds and non-pedigree cats; anecdotal reports indicate that it may be more prevalent in the Bengal and Devon Rex. Surgical correction is necessary in severe cases.



Polycystic Kidney Disease (PKD) – a deleterious gene mutation which causes enlarged kidneys composed of dilated cystic channels, resulting in early kidney failure and death. Genetic tests are available.



A normal kidney



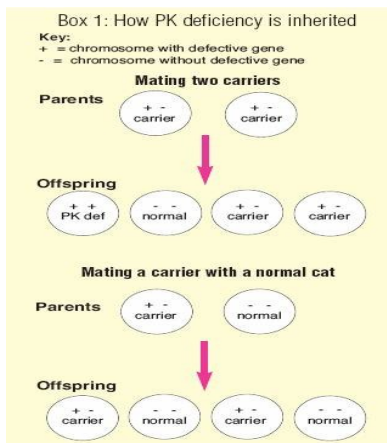
PKD in six week old kitten



PKD in adult cat

Progressive Retinal Atrophy (PRA) – an inherited ophthalmic condition leading ultimately to irreversible blindness. The underlying cause is dysplasia and/or degeneration of the rod and cone photoreceptors. There are two forms: autosomal dominant retinal dystrophy (Rhy) and rod-cone degeneration. No definitive genetic tests are yet available for either form. DNA tests for the affected loci are available with UC Davis & Laboklin, however, there is some emerging evidence of cats that have tested positive but not exhibited any symptoms by the expected age (5 years+); UC Davis are currently undertaking a review and further investigation.

Pyruvate Kinase Deficiency (PKDef) – an inherited disease the main consequence of which is development of anaemia caused by a lack of Pyruvate Kinase (PK) in the red blood cells.

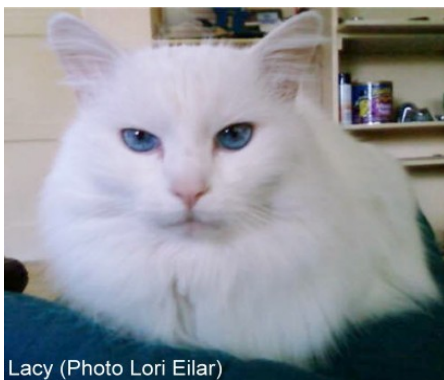


PK is necessary for red blood cells to produce the energy to survive. In severe cases a rapid anaemia can be life-threatening. The disease is inherited as an autosomal recessive trait. A reliable test is available that can distinguish clear, affected and carrier status

White cats and deafness – caused by progressive degeneration of the auditory apparatus of the inner ear and may affect one ear (unilateral) or both (bilateral). The gene responsible is the dominant gene W with complete penetrance for white coat colour. However, although the white gene is dominant, not all white cats are deaf, although the chances increase if one or both eyes are blue, without the influence of the Siamese gene. This deafness is not simply inherited and studies are ongoing at UC Davis. Those working with white cats should take care to breed from hearing parents until more is known. The BAER test is available to detect deafness. There is some anecdotal evidence that this may affect bi-coloured cats with a large amount of white (high-white).



BAER testing of a Foreign White



Lacy (Photo Lori Eilar)

Blue-eyed white cats have a higher incidence of deafness

FAB has a full and extensive list of feline disorders and genetic diseases, each includes a full description of symptoms and causes where known. Not all have a test, but where there is one it is stated. Please use link: <http://www.fabcats.org/breeders/index.php>



Genetics Committee, January 2010



Governing Council of the Cat Fancy

List of References:

Animal Welfare Act 2006

(www.opsi.gov.uk/acts/acts2006/ukpga_20060045_en.pdf)

Defra Policy for Welfare of Cats (www.defra.gov.uk/wildlife-pets/pets/cruelty/documentscop-cats.pdf)

Feline Advisory Bureau (www.fabcats.org)

“Independent Inquiry into Dog Breeding” – Sir Patrick Bateson FRS
(www.dogbreedinginquiry.com/)

“Robinson’s Genetics for Cat Breeders & Veterinarians” Edited by Valla, Shelton, McGonagle & Stanglein, published by Butterworth & Heinemann Press.

UC Davis, Davis, CA 95616-8744 (<http://www.vgl.ucdavis.edu/services/cat/>)

University of Bristol, Diagnostic Laboratory, Langford, N Somerset, BS40 5DU. (http://www.langfordvets.co.uk/labratory_owners.htm)

*Breeders Assistant – the breeding coefficients quoted in the General Breeding Policy above can be measured using Breeders Assistant by selecting the “optimisation” setting as follows:

1. Select Configure > Preferences (Ctrl+E)
2. Click on the Inbreeding tab
3. Enter the following settings –

No. Of generations to include = 10	Precision for computing inbreeding = 1
	Working Buffer size = 4
4. Click OK



Glossary of Terms:

Allele – Mutant form(s) of the normal gene on one strand of a chromosome usually paired with a gene on the complementary autosomal strand. Many alternative alleles can occur at one site.

Anomaly- Anything which is contrary to the general rule. An organ or structure which is abnormal with reference to form, structure, position; a malformation

Autosomal recessive disorders – The ill effects caused when an organism inherits two deleterious copies of a gene.

Chromosome – Strands of DNA which are bearers of genes.

Coefficient of relationship – The level of genetic similarity between two individuals

Coefficient of inbreeding – The probability that at a given locus an individual receives two alleles that are identical by descent, .i.e. inherited from a common ancestor.

Conformation – The look or physical type of a cat, usually when measured against the breed standard

DNA (Deoxyribonucleic acid) – The main constituent of chromosomes and the molecular carrier of hereditary information

Dominant gene – The allele whose expression completely over-rides that of another at the same locus

Effective population size – The number of breeding individuals in an idealized population that would show the same amount of inbreeding as the population under consideration

Genotype - The hereditary information of the organism carried on strands of DNA

Heterozygous – An organism is heterozygous when two different versions of the gene occupy the same locus on complementary chromosomes.

Homozygous – An organism is homozygous for a pair of alleles when the same version of the gene occupies the same locus on complementary chromosomes.

Inbreeding – Breeding between close relatives

Line breeding – A form of inbreeding intended to concentrate the genes of a certain individual, usually by repeated backcrosses.

Locus – The precise location of a gene on the chromosome

Morphology – Science of form, branch of science which deals with the form or structure of animals

Morph - variant form in a polymorphic population

Pedigree cat – a pure bred cat whose line of descent is recorded over a number of generations

Phenotype – Any observable characteristic or trait of an organism: such as its shape, appearance or behaviour. Phenotypes result from the expression of an organism's genes (genotype) as well as the influence of environmental factors and interactions between the two.

Polygenes – Genes with small but cumulative effects on the expression of a character

Recessive gene – Allele whose expression is over-ridden by another at the same locus

Selective breeding – Artificial choice of certain individuals in preference to others so as to favour certain desirable traits, or combination of traits.



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