

AMERICAN ANGUS ASSOCIATION[®]

DEVELOPMENTAL DUPLICATION (DD)

FACT SHEET

ANGUS
THE BUSINESS BREED

The following fact sheet was developed to respond to questions commonly asked by American Angus Association members. Additional information may be found online at www.angus.org.

What is Developmental Duplication (DD)?

DD is an abnormality that has been long-observed in Angus cattle, but was previously thought to be caused by conjoined twins or other anomalies during fetal development. This abnormality was recently found to be a simply inherited recessive genetic condition passed through certain lines of Angus cattle. Animals affected with this condition can sometimes be born with an extra limb or part of an extra limb (a condition referred to as polymelia).

What does simply inherited mean?

Simply inherited means that one pair of genes determines an animal's phenotype for a trait of interest.

What does recessive mean?

In general, an animal must inherit the recessive form of a gene from both parents for a recessive phenotype to be expressed. We would call this type of animal homozygous recessive. The only way to have an affected calf is to breed carrier or affected parents.

Do I need to test all of my animals?

No. The majority of registered Angus animals are not potential carriers for DD or other currently recognized genetic conditions. Only those who are potential carriers should be considered for testing.

How do I know if an animal is a potential carrier?

An animal will be classified as a potential carrier if an ancestor is a known carrier or known to be affected. You can learn about the potential carrier status of your animals in several ways. On the registration papers, potential carrier animals will be designated with the "DDP" notation (where "P" stands for potential carrier) under their registration numbers. Language regarding the genetic status of registered animals, including definitions, is listed on the reverse side of all printed registrations or through a link on electronic versions. A convenient Potential Carrier Report is also available through AAA Login (see reverse).

How do I know for sure if my animal is a carrier?

If an animal is designated DDP, the only way to know for certain whether it is free or a carrier is to have it genetically tested. Testing for all genetic conditions is available through Angus Genetics Inc. (AGI). Preferred sample type is blood on a proper blood card (available through [AAA Login](#)). Blood submitted using any other form is not acceptable. Other possible sample types are: hair root samples, tissue samples from ears and semen samples. A video on www.angus.org explaining how to collect the sample can be found [here](#).

What do the test results mean?

Possibilities for DD test results are DDF (the animal carries 0 copies of the recessive gene), DDC (the animal carries 1 copy of the recessive gene), or DDA (the animal carries 2 copies of the recessive gene). If the animal is DDF you can breed it with no fear of ever having an affected calf. If the animal is DDC or DDA, you'll need to adopt a management strategy to avoid affected offspring and to deal with potential carriers entering your breeding herd.

What does a DD carrier (DDC) look like?

A DD carrier looks normal; there is nothing in the way an animal looks (its phenotype) that indicates that the animal is a carrier of the DD mutation.

My animal tested DDA, but doesn't have any extra limbs. Is the test wrong?

Unlike some of the other simple recessive traits, not all animals who are homozygous recessive (DDA) will express the condition. This is a concept known as incomplete penetrance. Research is ongoing to discover why that may be the case. However, simple inheritance rules still apply. Animals who are DDA will pass on the recessive allele to every one of their offspring, regardless of the animals to which they are bred.

If a cow has a DD-affected calf, what does that mean?

If a cow has a DD calf, and if it is the cow's natural calf, it means that the cow is a carrier of the DD mutation and the sire of the calf is also a DD carrier.

If a recipient cow has a DD-affected calf, what does that mean?

If a recipient cow has a DD calf, it means only that both the donor cow and the sire of the calf are carriers of the DD mutation. It doesn't tell you anything about the DD carrier status of the recipient cow.

If a bull sires a DD-affected calf, what does that mean?

If a bull sires a DD calf, it means that the bull is a carrier of the DD mutation and that the dam of the calf is also a DD carrier.

I have never had a DD-affected calf. Does that mean my cows are non-carriers?

Not necessarily.

What is the risk of having a DDA calf if I breed a DD carrier cow to a DD carrier bull?

Every time you breed a carrier to a carrier, there is:

- A 25% risk of having a DDA genotype that may or may not be expressed visibly in the calf because of incomplete penetrance;
- A 50% risk of having a DDC calf (otherwise normal-appearing calf that carries the DD mutation); and
- A 25% chance of having a DDF calf (normal-appearing, non-carrier calf).

If I breed a DD-carrier cow to a DD-carrier bull and have three live calves, will the fourth calf be affected with DD?

The risk is the same every time you breed a carrier to a carrier. There is always a 25% risk of having a DDA calf (some of which may express polymelia), a 50% risk of having a carrier calf and a 25% chance of having a non-carrier calf.

If I breed a DD-carrier cow to a non-carrier bull, what is the chance of having a DD-affected calf?

Zero. You will never have a DD calf if you breed a carrier cow to a non-carrier bull (excluding the possibility of a spontaneous mutation).

If I breed a DD-carrier cow to a non-carrier bull, what is the risk of having a carrier calf?

Every time you breed a carrier cow to a non-carrier bull there is:

- A 50% risk of having a DDC calf (normal-appearing; carries the DD mutation); and
- A 50% chance you will have a non-carrier calf (DDF).
- Visit angus.org or AAA Login for "Understanding Developmental Duplication," a [video](#) that further explains DD and inheritance.

How do I manage any confirmed non-carrier females in my herd?

If the females are non-carriers and they are bred to non-carrier bulls, they will never produce affected DD calves or carriers. These non-carrier females can be used throughout your breeding program with no risk of propagating the DD mutation.

How do I manage the DDC and DDA females in my herd?

In order to avoid having affected calves, breed them to bulls that are not carriers. This can include bulls that do not have carrier ancestors or those confirmed DDF by genetic testing.

What is the AAA registration policy regarding DD?

Policy adopted by the American Angus Association Board of Directors does not require the testing of potential carriers of DD as a precondition of continued or prospective registration. The policy instead assumes members will follow sound breeding decisions and make strategic use of DNA testing in dealing with this genetic condition. DDF, DDP, DDC and DDA animals are currently eligible for registration. Leading geneticists in the bovine academic community have increasingly observed that all breeds have hundreds of mutations in their genome and that an association's approach to genetic conditions should be adapted to reflect the likelihood that the discovery of such conditions will continue in the future and at a pace accelerated by new scientific tools. Refer to the *Breeder's Reference Guide*, available at www.angus.org, to read the complete policy.

	One or both parents test DDC or if animal is DDP.
Heifers	No test required.
Bulls	No test required.
E.T. Calves	No test required.
Steers	No test required.
A.I. Sires that are confirmed carriers	No restrictions.
Definitions	DDC - DD Carrier, has been tested and carries the DD mutation. DDF - DD Free, has been tested and does not carry the DD mutation. DDA - DD Affected, has been tested and is homozygous with DD. DDP - DD Potential Carrier, animal that traces to one or more confirmed tested carrier or affected animals in its pedigree that have no intervening ancestors that have been tested free of DD.

Two Testing Options

1. Submit Samples through American Angus Association/AGI

Use [AAA Login](#) to order test. Samples are submitted to the American Angus Association and archived for future testing requests. Login at www.angusonline.org and use menu option: Order--Testing for AM/NH/CA/DD/D2/M1.



2. Additional Authorized Lab for Developmental Duplication (DD) Testing

Below is the lab currently authorized for DD testing by the American Angus Association. Consult the lab web site for information on DNA preferred sample types, sample submission forms, pricing information and complete instructions on how and where to submit samples for testing. In choosing a lab, members of the Association are urged to read and carefully consider any language on a given lab's submission form (for the DD test) or on its accompanying "Terms and Conditions" that relates to any lab's alternative use of the DNA samples being submitted.

The following labs are authorized for DD:

Zoetis

333 Portage Road, Bdg. 300
Kalamazoo, MI 49007-9970
877-233-3362
Fax: 269-833-4711
<http://www.zoetis.com>

GeneSeek

4665 Innovation Dr. Suite 120
Lincoln NE 68521
402-435-0665
Fax: 402-435-0664
www.geneseek.com

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DD potential carrier report & potential carrier management tool

AAA Login users can access interactive tools to generate a report of owned animals and their Developmental Duplication (DD) status based on the DD test results received to date. From the AAA Login menu, go to the "interactive" section and click on "Potential Carrier Report AM/NH/CA/DD/M1/D2" or "Potential Carrier Management Tool (PCMT)." The PCMT can identify those animals in your herd that have the most descendants in your herd and would be the most logical animal to start a testing scheme should you decide to test for a particular genetic condition. If you are not a current AAA Login user, you can sign up to create an online profile at www.angusonline.org.