Chapter 1

Breeding and Genetics

All In the Family

Rabbit Skill: Choosing a breeding program

Life Skill: Decision making

Success Indicator: Uses decision making skills to develop and adopt a sound breeding program.

Science Standard: Biological evolution

Stop and think: a key to successful rabbit production is identifying and using a sound breeding program. Whether you have commercial or show rabbits, you will want to decide which breeding program will work best. A breeding program involves choosing bucks and does for mating based on their pedigree and performance records. In this activity you will learn the differences between breeding programs, such as inbreeding and line crossing, so that you can develop your own breeding program.

Hop to it!

After studying pedigrees and interviewing reputable rabbit breeders, describe a breeding program (inbreeding, linebreeding, outcrossing or crossbreeding) that best fits your type of breeding stock.

Type of breeding program _____

Description _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

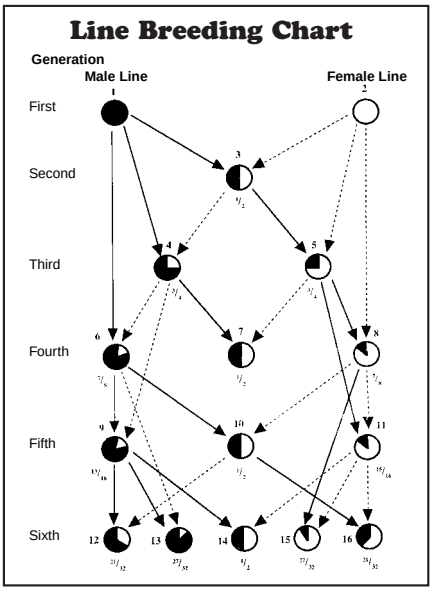
Line Breeding Example

The breeding chart illustrated may be used to carry out a linebreeding program. The circles represent the offspring, a solid line leading from a circle represents the male and a dotted line represents the female. Number 3 is a result of mating 1 and 2 and contains half of the genetic makeup of the sire and dam.

Number 4 is a result of mating No. 1 and No. 3. Number 4 now contains 75% of the genetic makeup of the male and only 25% of the genetic makeup of the female.

Mating No. 3 male to No. 2 will produce No. 5. Number 5 has 75% of the original dam's genetic makeup and only 25% of the genetic makeup of the original sire.

Mating of No. 4 male with a No. 5 female results in No. 7. Number 7 has 50% of the original sire's genetic makeup and 50% of the original dam's genetic makeup.



Using the linebreeding chart, figure out the genetic makeup of the offspring if:

Number 7 is mated to No. 11

_____% Dam's genetic makeup

Number 9 is mated to No. 11

_____% Sire's genetic makeup

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Rabbit Rap

Share What You Did

What breeding program did you choose? Why?

Process What's Important

How do the various programs differ? Tell what is important about deciding on a breeding program.

Generalize to Your Life

What economic impact will your rabbit breeding program have on your personal life?

Apply What You Learned

How does comparison shopping save you money?

Rabbit Facts

Breeding Programs

	Pros	Cons
Inbreeding	like gene pairs eliminates tissue rejection eliminates heredity difference	depression decreased litter size increased susceptibility to disease
Outcrossing	maximum genetic diversity vigorous offspring large litters	poor lab use
Linebreeding	similar gene pairs	decreased level of negative traits as inbreeding
Crossbreeding	produces new breed/variety hybrid vigor	unacceptable for show

Did you know

Generally, an inbred rabbit breeds better than it looks whereas an outcrossed rabbit looks better than it breeds.

Bounding Ahead

1. Visit a reputable rabbit breeder to discuss breeding programs. Carefully study several rabbit pedigrees. Report your findings to your helper.

Acknowledgments: Adapted with permission from Kansas 4-H Rabbit Notebook by Steven Lukefahr.

What's Inside?

If you are a good judge of rabbits you probably have a very good idea what the skeleton of a rabbit looks like. When you examine a rabbit do you know when you touch the ribs, sternum and spine? How about the femur, tibia and ulna? In this activity you'll have an opportunity to learn the names and location of 20 bones in the rabbit's skeleton.

Rabbit Skill: Identify bones of a rabbit's skeleton.

Life Skill: Learning to learn

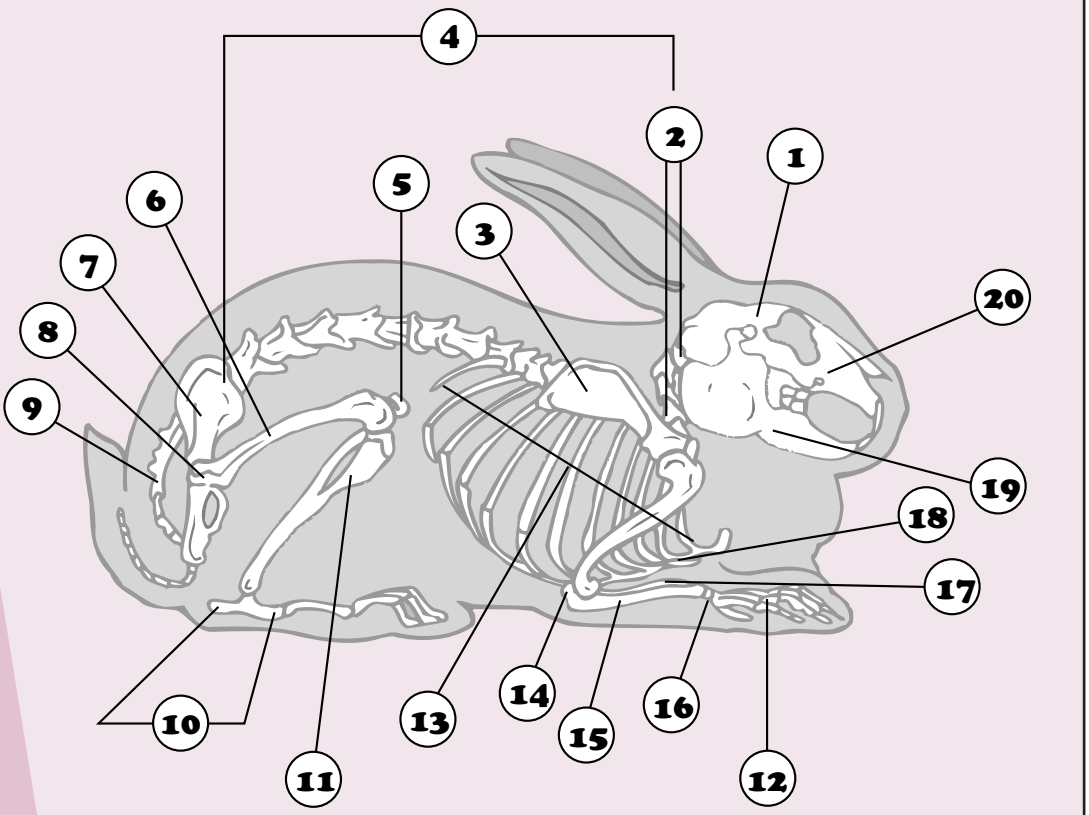
Success Indicator: Identifies 20 parts of a rabbit's skeleton.

Science Standard: Form and function

Photo:
of youth with a pointer, pointing to a part

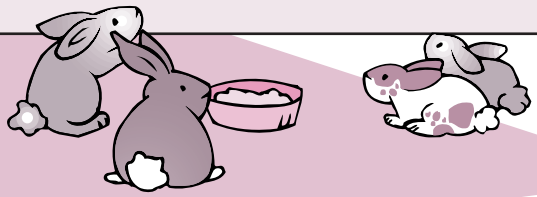
Hop to it!

Match the number of each bone to its name. Then when you meet with your helper explain the importance of each bone in relation to both judging and rabbit meat cuts.



Bone Bank

_____ caudal vertebrae
_____ cervical vertebrae
_____ elbow
_____ femur
_____ hip joint
_____ mandible
_____ maxilla
_____ metatarsus
_____ patella
_____ pelvis
_____ phalanges
_____ radius
_____ ribs
_____ scapula
_____ skull
_____ spine
_____ sternum
_____ tarsus
_____ tibia
_____ ulna



Did you know

You can check the bone size of a rabbit by feeling the front leg.

Rabbit Rap

Share What You Did

What new bones did you discover? How did you learn the names and locations?

Process What's Important

What bones relate to what parts of a rabbit that are consumed?

Generalize to Your Life

Why is knowing where to find answers sometimes more important than knowing the answers?

Apply What You Learned

How can knowing the skeletal structure of a rabbit help you select better rabbits? What learning strategies do you prefer? Why?

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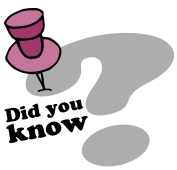

Rabbits raised as pets can be spayed or neutered, as dogs and cats are, to prevent unwanted offspring.

Acknowledgments: Adapted from The New Rabbit Handbook

Rabbit Facts

Skeleton Mounting Hints

Materials. Glue, knife, paint brush, 2' #30 aluminum wire, 3' #22 wire, 16" stainless steel wire 1/16" diameter, 21" piece 3/16 diameter stainless steel rod, toothbrush, chlorine bleach, 7" x 12" x 1" hardwood for base, small drill.

Step 1. After euthenizing the rabbit remove the skin and all viscera (internal organs). Then carefully cut the meat off so as not to harm any of the bones.

Step 2. Fold the skeleton and tie with a string to make a small compact mass of intact skeleton.

Step 3. Boil the carcass for two hours and simmer for an additional four hours. Then cool, remove any remaining flesh and scrub the bones clean with a tooth brush. String the bones in the neck and tail with wire to keep them in order.

Step 4. Dry at room temperature or bake at 200 degree F for an hour. Then bleach for 24 hours in solution of one cup of chlorine bleach in four quarts of water.

Step 5. Bend the rod to support the bones. Push heavy wire inside the neural canal of the fused vertebrae of the back. Put the first thoracic vertebrae in place and then put the cervical (neck) vertebrae on the wire in their normal positions and glue together.

Step 6. Drill small holes and wire the femurs of the legs into the sockets of the pelvic girdle. Wire or glue the bones of the legs together.

Step 7. Based on the length of the legs cut the rod so the skeleton is supported in an upright position and anchor the rod to the base board. Glue the digits against the wood base.

Step 8. Glue and wire the lower mandible to the skull. A cemented thread can be used to hold the hypnoid apparatus and the ocular rings.

Step 9. Retouch the many joints with quick-drying cement then spray the skeleton with clear plastic for preservation or brush it with a thin coat of varnish.

Bounding Ahead

1. Use the bones of a rabbit to construct your very own rabbit skeleton. See Rabbit Facts for tips on how to do this.

Determining Pregnancy

Is she or isn't she? Only about 70% of does conceive on the first mating. If you are able to palpate a doe to see if she is pregnant you will be able to rebreed her much sooner than if you wait a full month to see if she kindles. In this activity you'll practice your palpation technique and demonstrate it to others.

Rabbit Skill: Determining pregnancy
Life Skill: Learning to learn
Success Indicator: Demonstrates how to palpate a doe.
Science Standard: Biological evolution

Hop to it!

Practice your palpation technique on several rabbits and then demonstrate how to do this skill to a group. Check Rabbit Facts for hints. Often working with someone who is experienced will help you acquire the "feel" necessary. Palpation can be frustrating if you don't understand the anatomy of the female reproductive system. A drawing is shown. You may also want to use the model rabbit made from the 4HCCS Rabbit Pattern to practice and use for your presentation. See if you can feel the embryos (marbles).

Tape a picture here of you palpating a rabbit.

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Extra! Extra!

Model Rabbit Pattern

The model rabbit made from this pattern provides an excellent training aid for use by 4-H project leaders, extension educators, vocational instructors and classroom teachers. You'll also enjoy using the model to give demonstrations at club meetings and fairs. The use of Velcroed tails and legs, plus realistic teeth, ear canker, interchangeable sex organs and application as a puppet contribute to its versatility.

When a person who is new to the rabbit industry is first learning management skills, the model rabbit offers a practical way to more fully control the learning environment while still providing enough realism to contribute to the learning outcome desired. Often injury to both animal and individual can be avoided by first practicing on the model before using the live animal.

Some of the management practices which 4-H members have demonstrated using the model made from this pattern include the following:

- Identifying breeds
- Identifying parts
- Determining finish
- Judging conformation
- Identifying types of fur
- Recognizing breed standards
- Determining pregnancy
- Recognizing the normal rabbit
- Determining sex
- Identifying rabbit disqualifications
- Handling
- Trimming nails
- Fitting
- Showing
- Tattooing

Rabbit Rap

Share What You Did

How did you palpate a doe?

Process What's Important

What special care does a pregnant doe require? Why should you palpate a doe to determine pregnancy?

Generalize to Your Life

How did preparing for a presentation help you learn the technique?

Apply What You Learned

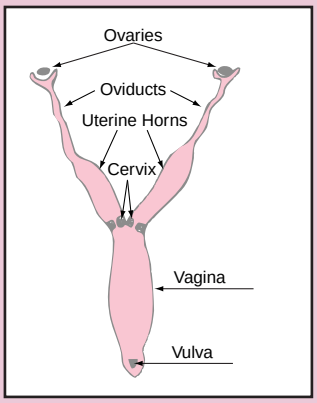
If you had 50 does and by palpating were able to tell that 10 were not pregnant at 15 days after each mating, over a year's time how many days of non productivity would you save? Explain to your helper how you arrived at your answer.

Acknowledgments: Adapted from Kansas 4-H Rabbit Curriculum Notebook.

Rabbit Facts

The Female Rabbit Reproductive Tract

The reproductive tract in female rabbits consists of the vagina, body of the uterus, cervix (2), horns (2) of the uterus, oviducts (2) and **ovaries** (2). The ovaries are located beside the midline and attached to the back of the abdominal cavity in masses of ovarian fat. This attachment is just behind the kidneys on each side of the body. The ovaries are about the size of a small bean.



The function of the ovary is to produce the eggs (ova) that are capable of being fertilized by the male sperm. The ovaries are connected to the horns of the **uterus** via small tubes, the **oviducts**. The function of the oviducts is to transport the eggs to the uterine horns.

The uterus is "Y"-shaped and is attached on the end of the oviducts. The length of the **uterine horns** are determined by heredity and will control the size of the litter. The uterine horns and body of the uterus are where the **sperm** and **egg** unite and where the **feti** will develop to maturity.

The **cervix** divides the uterus from the **vagina** and provides a barrier through its secretions that prevent organisms from entering the uterus and disrupting the pregnancy. The vagina extends from the cervix to the vulva and is the receptacle used for receiving the sperm.

Palpation Techniques

1. Position: You and the doe should be relaxed and comfortable. The posterior abdominal area of the doe should rest in the palm of your hands.
2. Palpation Site: The area to be explored is behind the last rib and in front of the pelvis. Early in the gestation period (9–13 days) the feti will lie mostly posterior and high in the abdominal cavity.
3. Restraint: When you and the doe are in position, gently lift your hand to come into contact with the posterior abdominal muscles just in front of the hind legs and pelvis. The thumb should be on one side of the abdominal cavity and the four fingers on the opposite side. The doe should be in a "stretched out" position with you raising her rear quarters until just the tips of her rear feet are touching the table. Wait for the doe to relax in this position. Use your other hand to restrain the doe by holding her head gently.
4. Hand Movement: When the abdominal muscles are relaxed, feel for internal structures between the thumb and fingers (held tight together) starting at the most posterior area of the abdominal cavity. Never use more pressure than it would take to rupture a grape. Move the hand to explore the entire abdominal cavity. Feel for a very round, firm, marble-shaped object in the early stages of pregnancy. After 15 days the feti will start to elongate. Once a fetus is located discontinue the evaluation.

When first starting it is easiest to palpate the does at about 14 days into the gestation period. The marble-sized feti are easiest to feel and are the most difficult to damage at this time. You may find it advisable to withhold feed for 24 hours before palpation.

Bounding Ahead

1. Conduct a clinic or skillathon station on palpating a rabbit. Involve the audience rather than telling or showing.

X's and Y's

After you have some experience breeding and raising rabbits, it's time to think about improving your rabbit herd. Learning about different breeding programs and genetics will give you helpful information for improving your herd.

For more information about breeding programs and the advantages and disadvantages of each system, see *A Progressive Program for Raising Better Rabbits and Cavies* published by the A.R.B.A., or talk to an established breeder.

Rabbit Skill: Learning the importance of genetics in rabbit breeding

Life Skill: Learning to learn

Success Indicator: Completes a genetic problem.

Science Standard: Molecular basis of heredity

Hop to it!

With your helper, work through the following genetic problem. Answers are included in the Answer Key in the Helper's Guide.

1. Using the information and example in Rabbit Facts diagram what the offspring would be if a doe carrying a dominant (B) and a recessive gene (b) for bucktooth is mated with a buck containing two recessive genes for bucktooth (bb).

Doe

_____ _____

Buck

_____

_____

Offspring normal? _____

Offspring bucktoothed _____

2. Coat color in rabbits involves the interaction of many genes. All recognized breeds and varieties of rabbits can be classified into one of the following: Agout (A), Tan (at), Self (a) according to their genotype. What is the phenotype of the rabbits when the genotype is:

Aa _____ ata _____

aa _____ atat _____

Aat _____ AA _____

3. In rabbits the gene for spotted pattern (S) is dominant over the gene for self-colored (s). The gene for short hair (F) is dominant over the gene for long hair (f) (Angora).

Show what the possibilities are for the offspring if a pure breeding, spotted, patterned short-hair rabbit is mated to a self-colored Angora rabbit.

	ssff	ssff
SSFF		
SSFF		

Genotype _____

Phenotype _____

Did you know

The act of mating stimulates the doe to ovulate or shed her eggs so fertilization with the sperm from the buck can occur. A rabbit is an induced ovulator.

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Rabbit Rap

Share What You Did

What did you learn by doing the genetic problems? Where did you find additional resources about genetics?

Process What's Important

Why is it important to know the genotype that produces each phenotype?

Generalize to Your Life

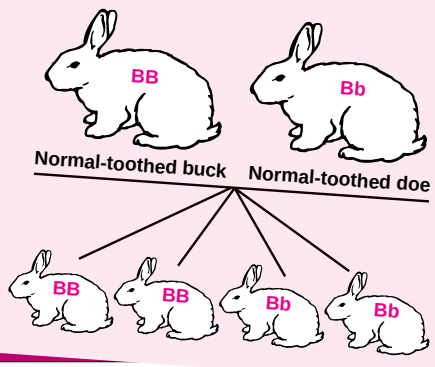
What are advantages of working with a knowledgeable person who helps you learn?

Apply What You Learned

How can you use this genetic knowledge to improve you own herd?

Dominant and Recessive Genes

Certain genes may hide the effect of other genes. These genes are called "**dominant**." The hidden gene is referred to as "**recessive**." Recessive genes are important in rabbit breeding. Defects such as buckteeth are due to recessive genes. (See diagram.) It is important to know how to identify those rabbits carrying recessive genes. An excellent discussion of the recessive gene problem appears in the A.R.B.A's *Official Guide to Raising Better Rabbits.*



Rabbit Facts

Rabbit Genetics

Each rabbit develops from a single cell, the fertilized egg. This single cell divides to form two cells, then these divide to four, then eight and so on. In the first divisions, mother and daughter cells are identical; later daughter cells are produced which change to form tissues and organs which make up the rabbit's body. The genetic materials of these cells is composed of many small units referred to as genes. **Genes** are located on thread-like bodies called **chromosomes**.

Chromosomes occur in pairs and their numbers vary from one species of animal to another. Genes also occur in pairs. Genes are passed from parent to offspring in sex cells known as gametes. Female gametes are called **ova** or eggs, and male gametes are known as **spermatozoa** or sperm.

Meiosis

An important step in the formation of gametes is a random separation of the paired chromosomes to form new cells having only one chromosome of each pair. This process is called **meiosis**. At fertilization, the female and male gametes unite and the pair of chromosomes is restored. Thus, the number of chromosomes in the offspring remain constant from generation to generation. One pair of chromosomes (referred to as X and Y) determine the sex of the rabbit. If X and Y chromosomes are paired at fertilization, a male is produced; if two X chromosomes are paired a female is produced. The female can transmit only X chromosomes to her offspring, but a male can contribute either an X or Y chromosome.

Genotype and Phenotype

Characteristics of rabbits may be controlled by one or many genes. Traits such as coat color are controlled by one or two pairs of genes. Growth rate, litter size, and milking ability are controlled by several or possibly many pairs of genes. **Genotype** refers to the make-up or combination of genes that control a particular characteristic. The response visibly observed from the genotype is called the **phenotype**; for example, color, size, etc.

Two genes control color in rabbits: a for albinism (absence of color) and A for full color (actual color depends on other genes). Since genes appear in pairs, combinations possible are AA, Aa or aa. When either AA or aa occur the genes are said to be homozygous. When Aa occurs the genes are said to be heterozygous. The dominant gene is "A" and the recessive gene is "a".

Bounding Ahead

1. With your adult helper, conduct a real-life rabbit breeding experiment. Analyze and report the results in a science fair exhibit or demonstration.