A3D Rat Anatomy LESSON 1.1

DESIGN AND BUILD A RAT CHARACTER FOR YOUR STORY

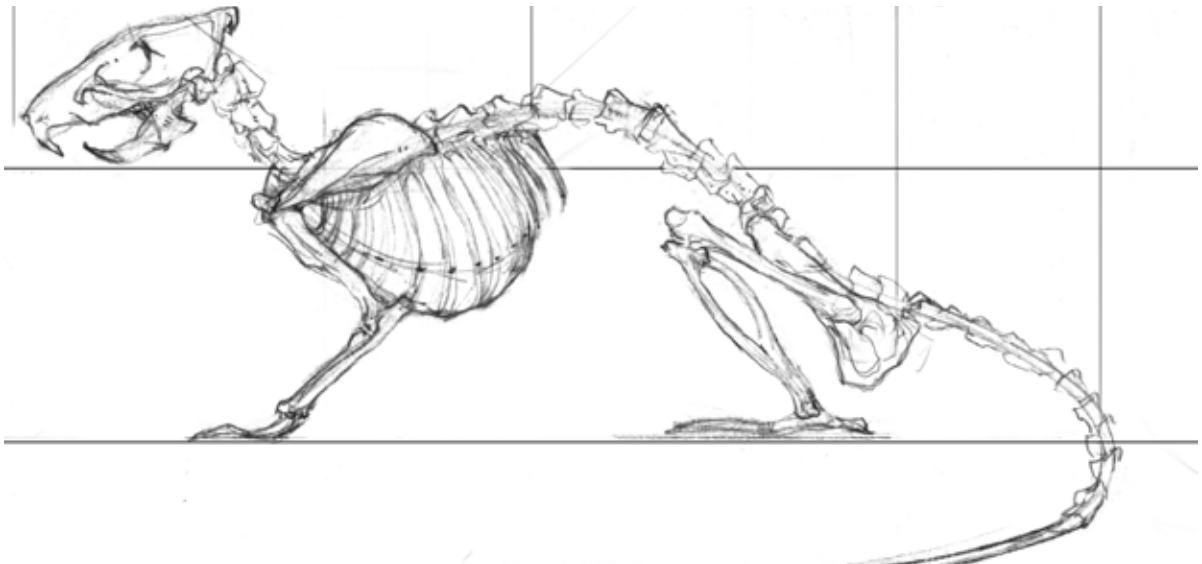
BASIC RAT CREATION

In this lesson, you will build a rat. A rare opportunity for anyone, but especially a privilege when you think about the fact that it will move and act like a human, serve as your alter-ego, amuse you and your friends, never make a mess unless you find messes entertaining, and be utterly maintenance-free once it is built. But before that rich reward, you will do a lot of work to earn it.

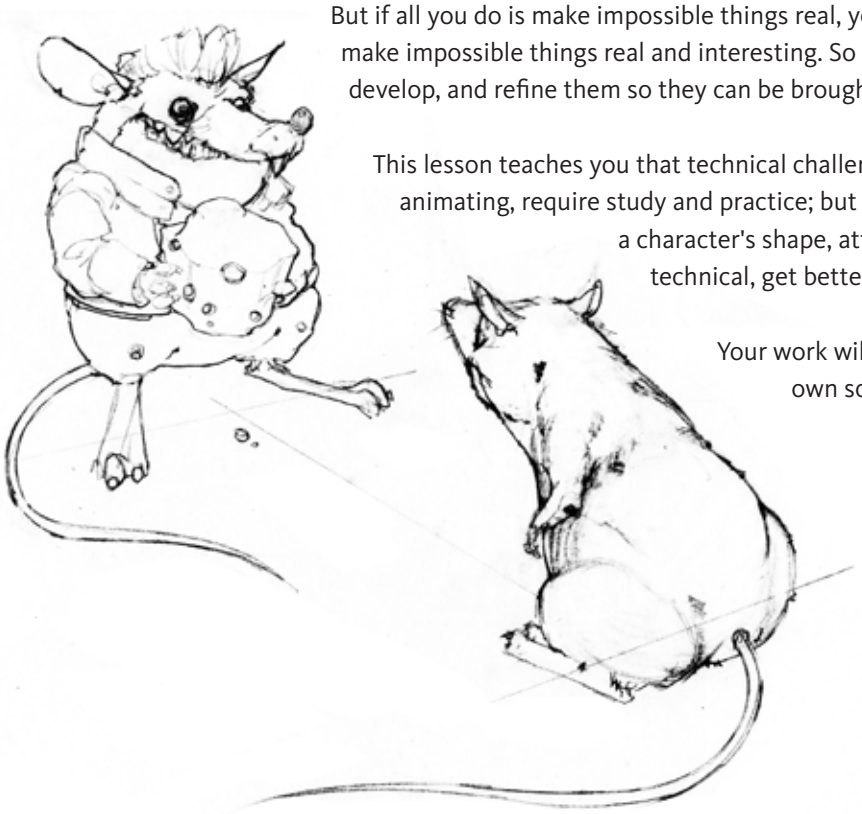
This lesson will enable you to:

- Understand rat anatomy to the extent that you will know more about rats than most exterminators.
- Understand human anatomy so that you will know how rats are similar to humans, how humans are similar to rats, and yet still be able to tell the difference.
- Know what happens when rats decide to act like humans, walk around on their hind legs, and use instruments reserved for higher mammals.
- Make this character entertaining—not a mere animated rat, but a rat who could be your friend, bodyguard, coach, offspring, or family member.
- Prepare this rat to be modeled and animated, and understand the challenges of designing a character when you work with professionals.

To make an animated rat look real, it helps to know rat anatomy. To make an animated rat look anthropomorphic (like a human), it helps to know human anatomy. In this les-son, you combine human and rat anatomy like genetic engineers, but safely and with less controversy, and for a noble cause—to entertain your audience.



Some characters come to life when real actors portray them, but fall flat when they are animated. Some characters come alive only when they are animated; in fact, the word animate means "bring to life." It would be impossible to exaggerate a wild-eyed rat who can build a roller coaster if you were limited to using real rats or real actors. 3D animation enables you to make impossible things real.



But if all you do is make impossible things real, you may bore your audience. You want to make impossible things real and interesting. So you will study how artists come up with ideas, develop, and refine them so they can be brought to life with animation.

This lesson teaches you that technical challenges such as modeling, texturing, and animating, require study and practice; but so do creative challenges such as designing a character's shape, attitudes, and posture. Both skills, creative and technical, get better with knowledge and use.

Your work will include exercises to help you work out your own solutions.

The reward: a rat.

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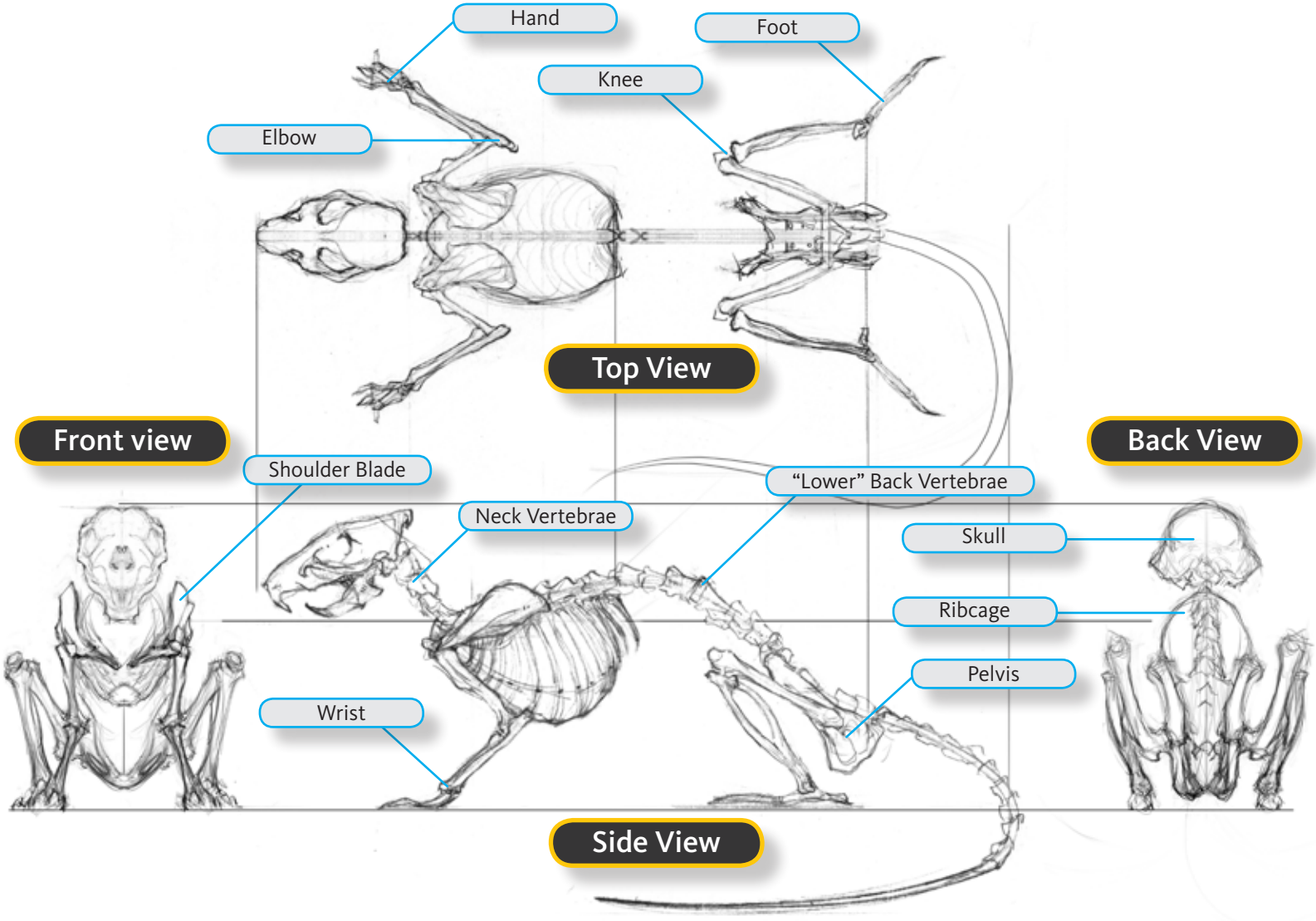
THE ANATOMICAL RAT

What do you need to know about rats to model a rat? You might think that you only need to know the surface, but the surface comes last. The skeleton is the foundation under the surface. Artists do not need to know every bump on every bone, but they care about the major bones, and not just from one angle. You can tell how long a leg is from the side, but you cannot tell how wide it is. You need a top or front view. But from a front view, you cannot tell the length of a rat's snout.

This is why artists and modelers use multiple views, sometimes called draft or construction views. Every measurement can be seen, compared, and built accurately. There is no guesswork regarding where things are in their height, width, or depth.

Here is a simple layout of a rat skeleton. Look over the names and see if any of them sound familiar. You will find that rats have almost all the same bones as humans, and with the same names.



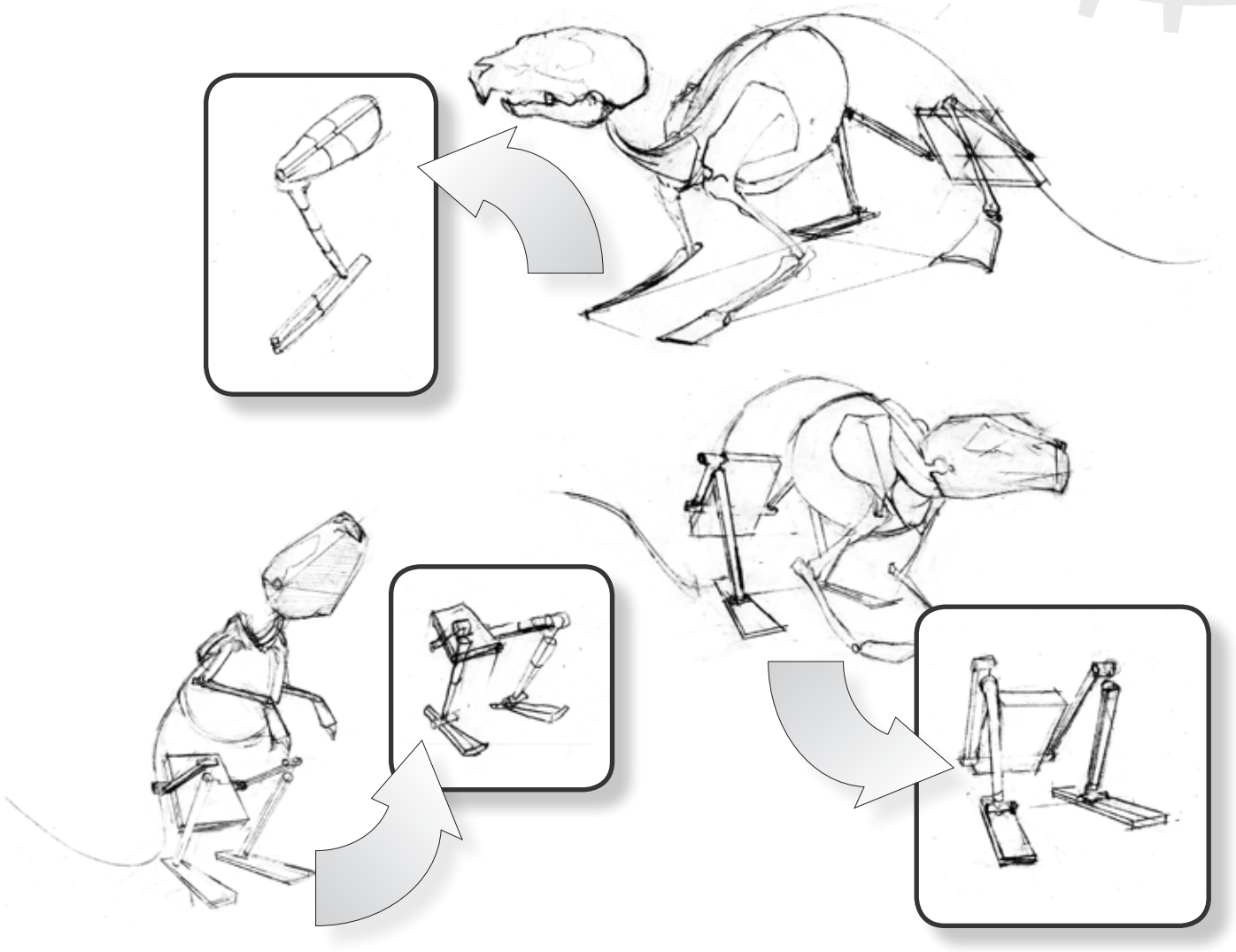
A3D Rat Anatomy LESSON 1.3

RAT PROPORTIONS

Proportions are measurements: how long, short, wide, narrow, big, or small something is compared to something else. Proportions begin with bones because bones do not stretch or change size when they move—they stay as consistent as rock. But they are under the skin, so you do not need to attend to all the little gnarls as much as to the big measurements.

Since bones determine the size of an animal, you consider how they relate to a character. If they are long like sticks, or short like stumps, they set the internal measurements of a character.

These simplified bones are based on a real rat. You cannot see how the rat will look until it is fully fleshed, but you know that it will not be much bigger, and cannot be any smaller, than its skeleton.

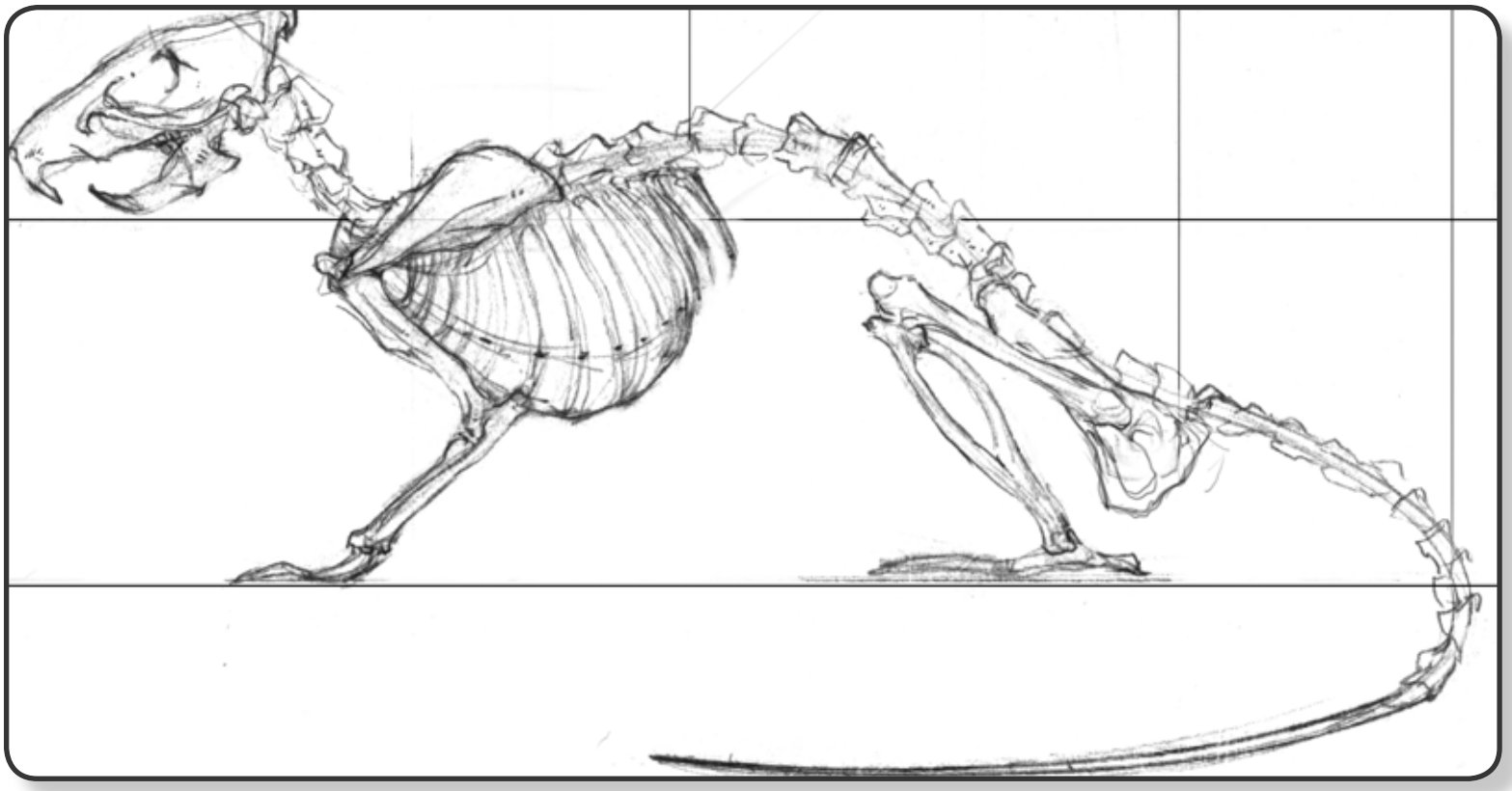


EXERCISE:

DRAW SOME BONES

Try drawing an assembled animal skeleton from a side, top, front, and back view. It is easier when you arrange the drawings with vertical and horizontal transfer lines to "line up" the measurements, as in these examples.

Keep it simple! The bumps are not that important, but proportions are important. When you feel daring, try drawing a 3/4 view. When you feel very daring, try drawing a 3/4 view while looking only at the draft views. It is not easy, but your computer does it constantly. If you cannot do it, at least when you are finished trying you will have new respect for your computer.



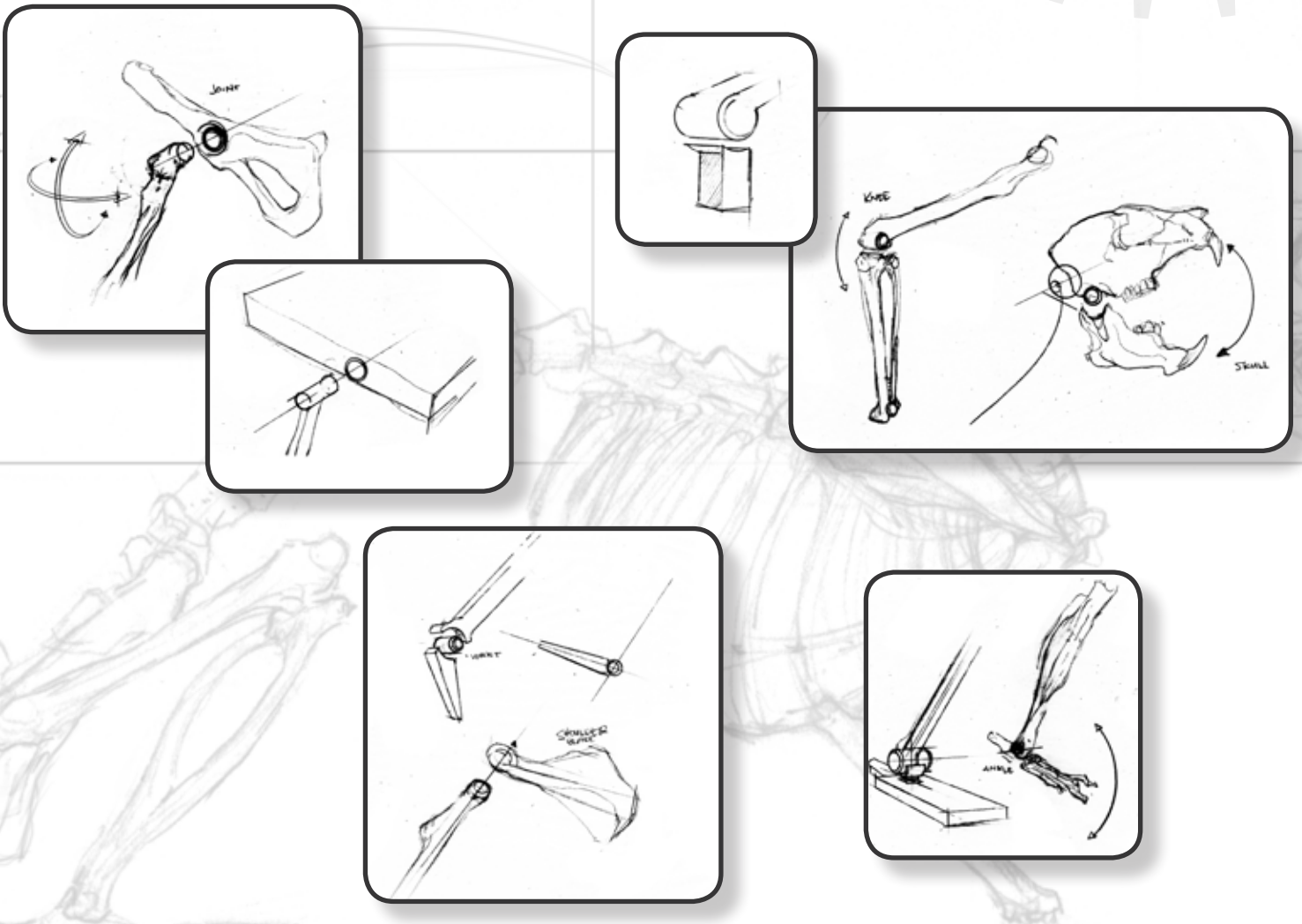
A3D Rat Anatomy LESSON 1.4

BONE JOINTS

Bones do not change shape, but they change position. Some bones move on a fixed axis, like a door hinge. Others move more freely, like a joystick. Some, like the shoulder blade (scapula) even "float" around the rib cage. Artists care about how bones move because every change of position affects the shape of the animal.

An octopus has no bones, so it can morph into all sorts of shapes. A rat has bones, so it cannot change shape so radically, but it still has a great range of flexibility compared to a rat model molded out of hard plastic. When a living rat curls up to sleep, or stretches to reach up high, its body changes shape but its bones stay firm.

Movement happens at the joints, where bones "join together." Modelers, riggers, and animators study these links within real animals so that their animated characters appear more anatomically authentic.

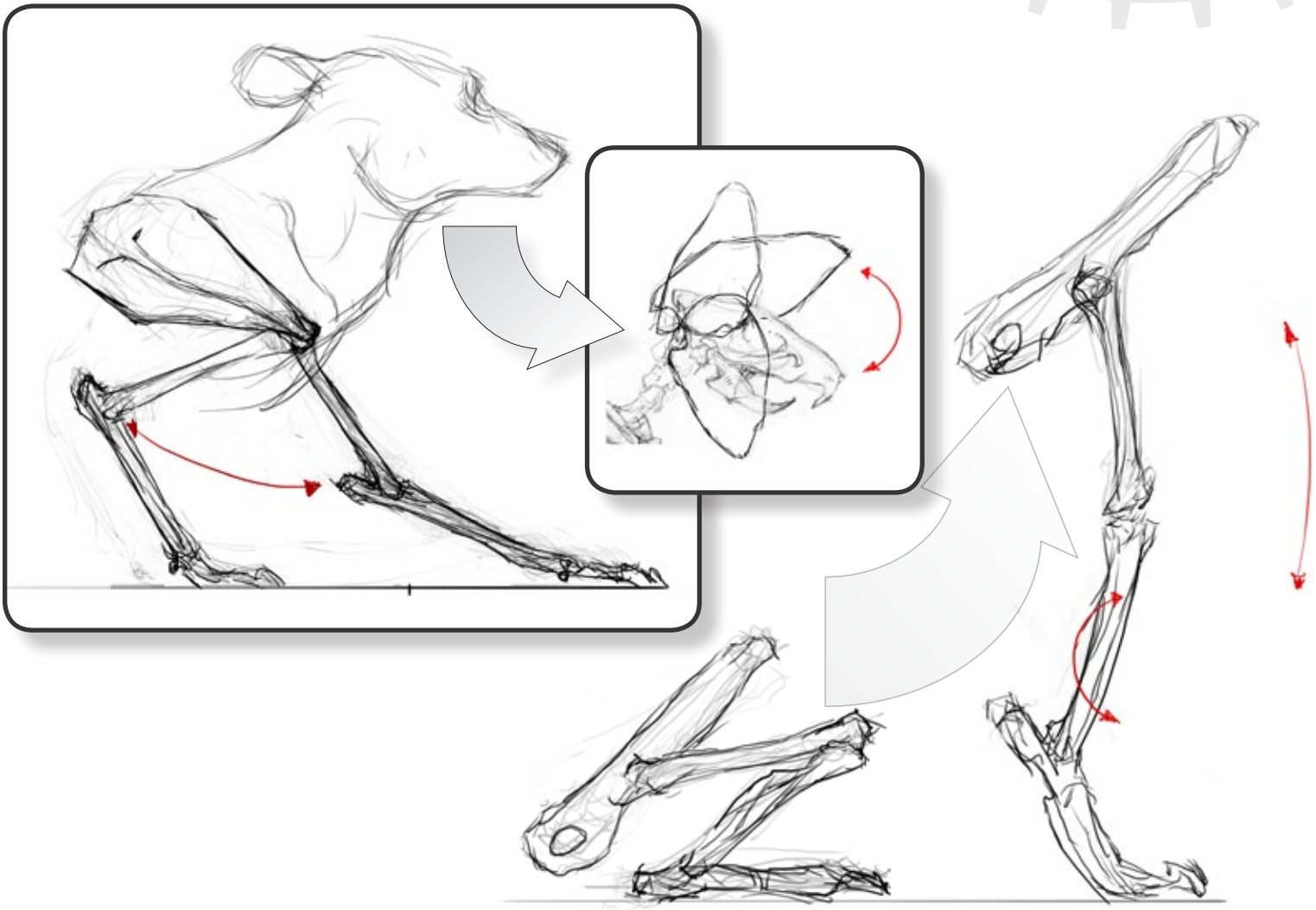


A3D Rat Anatomy LESSON 1.5

BONES: RANGE OF MOTION

Bones have limits. Just as you can only open a door so far, you can only straighten your arm or leg so far. These limits of position are the "range of motion," and they are not the same for every animal. Horses have forelegs that are locked on one axis; they do not "spin" like ours do. Rats can twist their arms, though not as much as apes or humans, who can use screwdrivers.

Later in the lesson, you learn exaggeration of movement because animators love to exaggerate, but right now you are studying real rats. And yet, if you have ever seen a real rat scurry away for its life, or clean its face at warp speed, or reach tremblingly for food, you know that a real rat is a character worth observing. Movements reveal attitudes and emotions. You study how a rat moves so that when you create your own characters, you understand the mechanics of the character's movement.



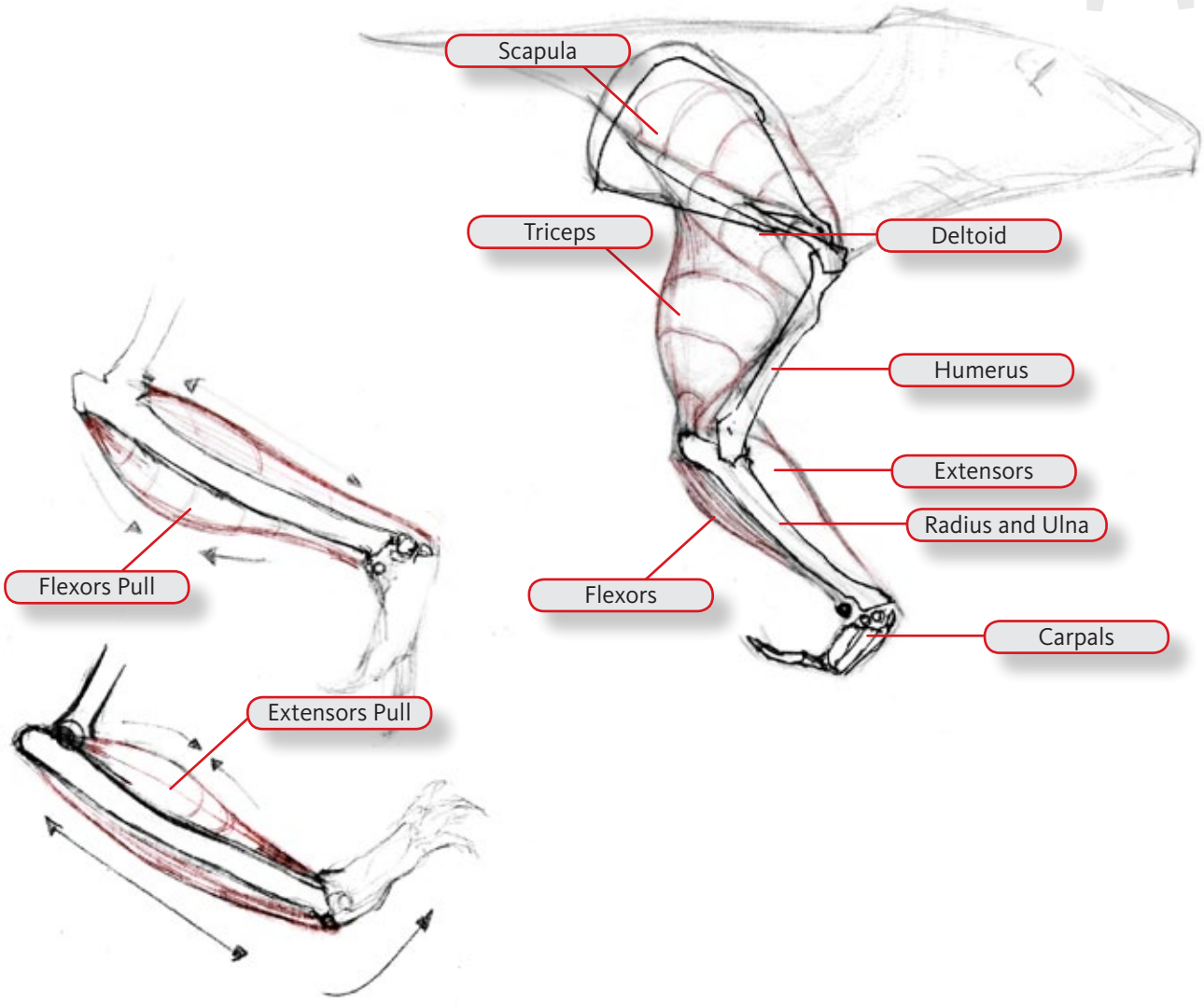
A3D Rat Anatomy LESSON 1.6

MUSCLES: HOW THEY WORK

Bones cannot move on their own strength; they need muscles to pull them.

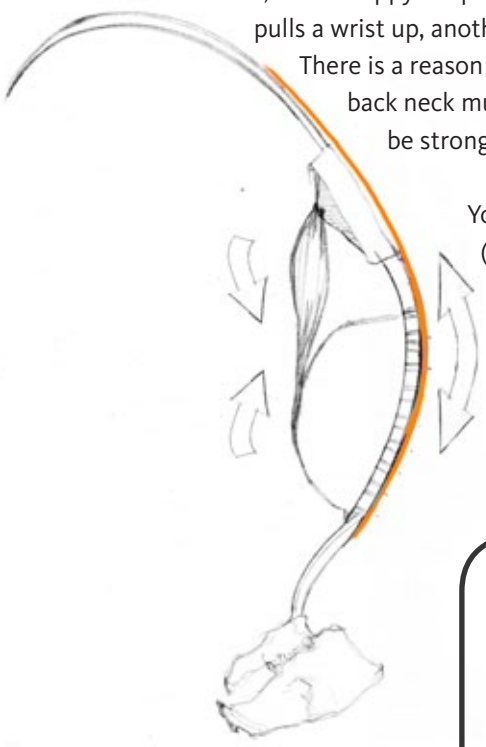
Muscles are like rubber bands. They can pull, but they cannot push. One difference between muscles and rubber bands is that when muscles pull into extreme tension, they "bunch up" and appear to get bigger.

Most muscles do not connect directly to bones; they have tendons to help them grip the bone. Tendons are usually smaller, stronger, and less flexible than muscles; they are the final cords that pull on a bone. Clench your fist and look at the palm-side of your wrist; those "wires" that pop out are tendons. You have them in your wrist. You have them in your feet. You have them all over. So do rats.



A3D Rat Anatomy LESSON 1.7

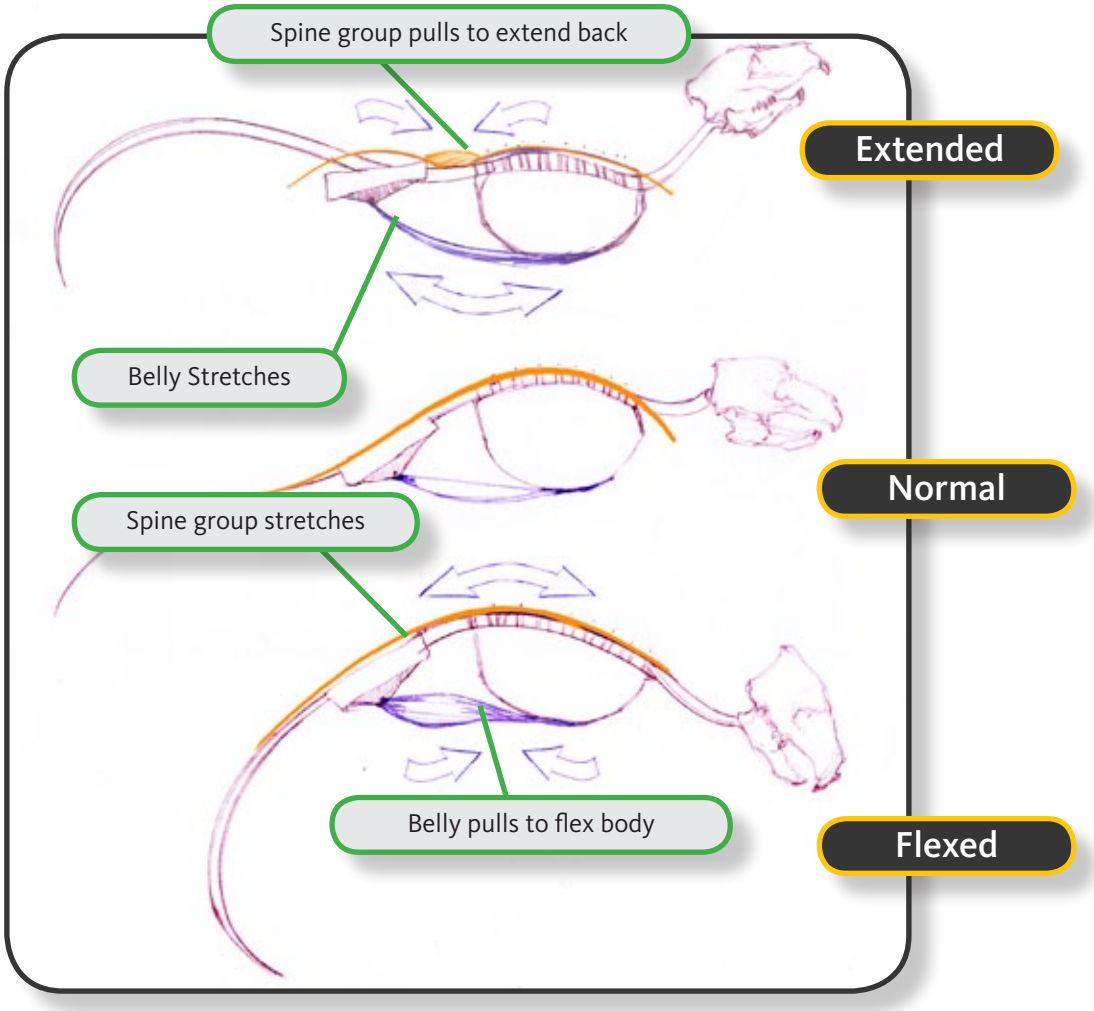
MUSCLE PAIRS



Muscles, like unhappy couples, work against each other. One muscle bends the body, another straightens it. One pulls a wrist up, another pulls it down. One strong group lifts the head, another weak group pulls it down. There is a reason the throat muscles are weaker than the back neck muscles: if a rat simply relaxes its back neck muscles, gravity does most of the work to drop the head. The back neck muscles must be stronger because they work against gravity.

You learn muscles more easily when you study them in pairs. The front-thigh muscles (quadriceps) straighten the leg by pulling the lower-leg bones forward. The back-thigh muscles (hamstrings) bend the leg by pulling the lower–leg bones back.

Muscles are arranged in pairs. Even if you do not know their names, you can figure out their functions by imagining how they would pull a bone into opposite positions.



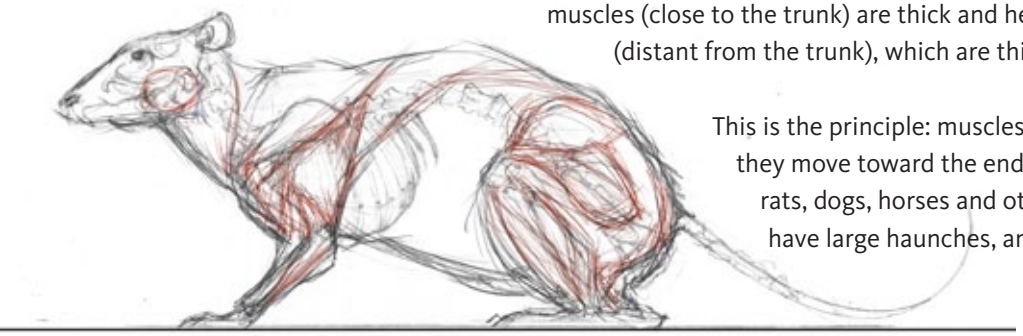
A3D Rat Anatomy LESSON 1.8

MUSCLE BULK

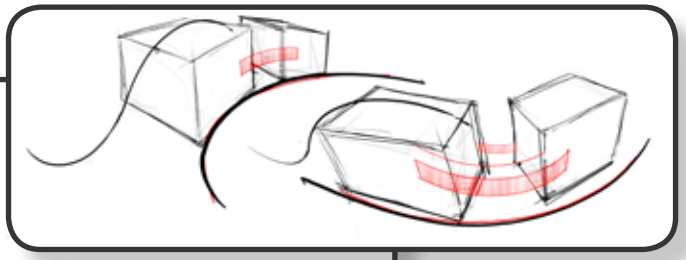
Muscles have an anchor, called an origin, and an insertion, called, well, an insertion.

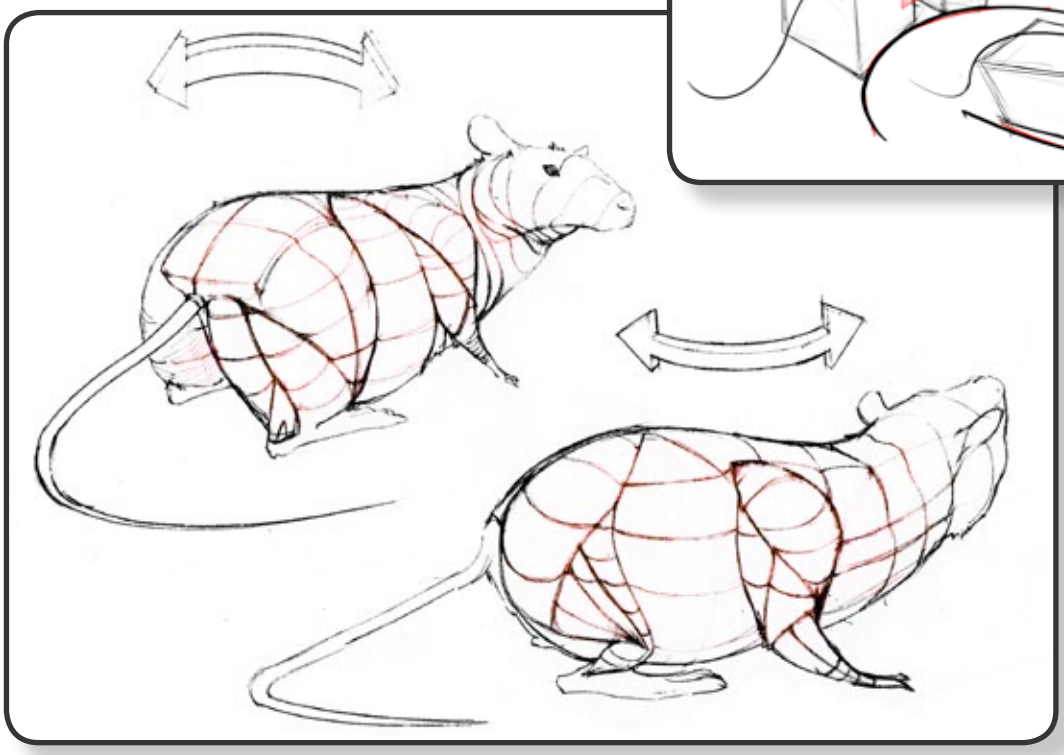
Usually, the origin is close to the center of the body, and the insertion is further away from the center of the body. Hind leg muscles anchor near the hips, and insert further down into the legs and feet.

This is important for artists because the muscles close to the trunk have to move heavier loads, like entire legs and arms. The muscles further down move lighter loads, like toes and fingers. That means the proximal muscles (close to the trunk) are thick and heavy compared to the distal muscles (distant from the trunk), which are thinner and lighter.



This is the principle: muscles are thick near the torso, and thin as they move toward the ends of the limbs. Now you know why rats, dogs, horses and other animals you love are so likely to have large haunches, and possibly delicate toes.





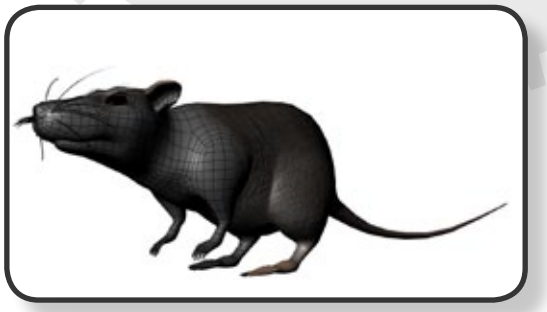
A3D Rat Anatomy LESSON 1.9

ANATOMY AFFECTS MODELING

The shape of an animal comes from the assembly of anatomical parts. You have seen a glimpse of how bones and muscles affect the shape of a rat. Fat and fur make a difference, too. Bellies need plenty of room to house soft parts of a digestive system. Throats may have comparatively weak muscles, but they are not thin because they also contain a windpipe and esophagus.

Eventually, you decide on a final shape: that the hindquarters are a certain width, the shoulders another width, the belly a certain thickness, the head a certain depth, and so on. You make these decisions with authority when you know why the hindquarters are so wide and the belly is so thick.

This is why you study anatomy, and why you relate it to multiple views.



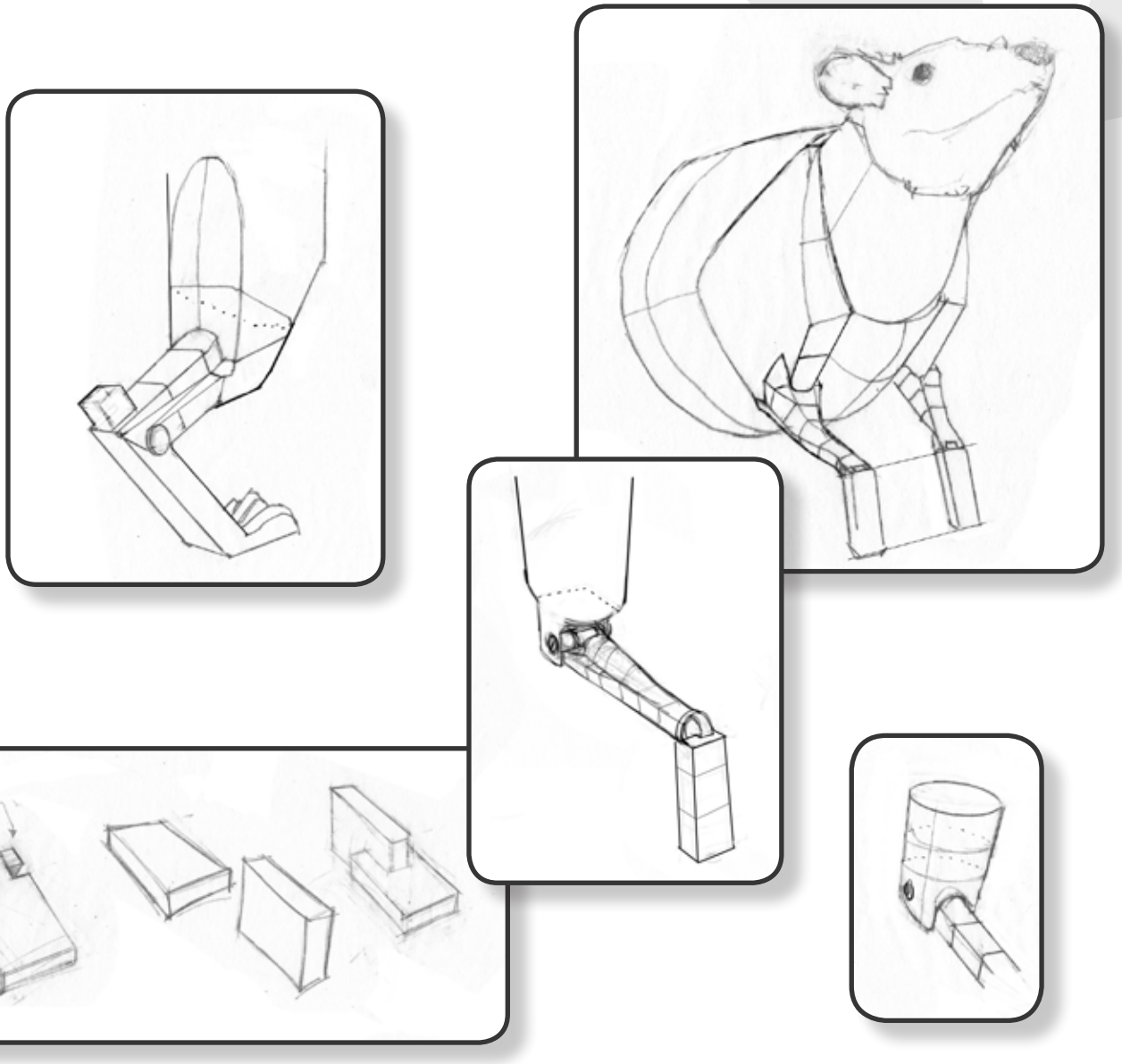
If you study any animal long enough, you reach a level where you simply know the shape so well that you can imagine it, draw it, or model it accurately. Think about how well you know the alphabet, and you get the idea. It is a complex collection of shapes, but the more you use it, the more it becomes part of your deep, familiar knowledge.

A3D Rat Anatomy LESSON 1.10

INTERLOCKING COMPONENTS

When you get close to an animal, you see that the details of anatomy are not just details, they are smaller forms that interlock with each other.

Here is how to learn this: draw an animal as if it were assembled from blocks that insert into each other, or wedge together, or grip each other like wrenches or pliers. 3D models appear authentic when they are not just rounded out blobs of forms, but well-chiseled forms based on mechanisms that fit together, overlap, and work like a machine.

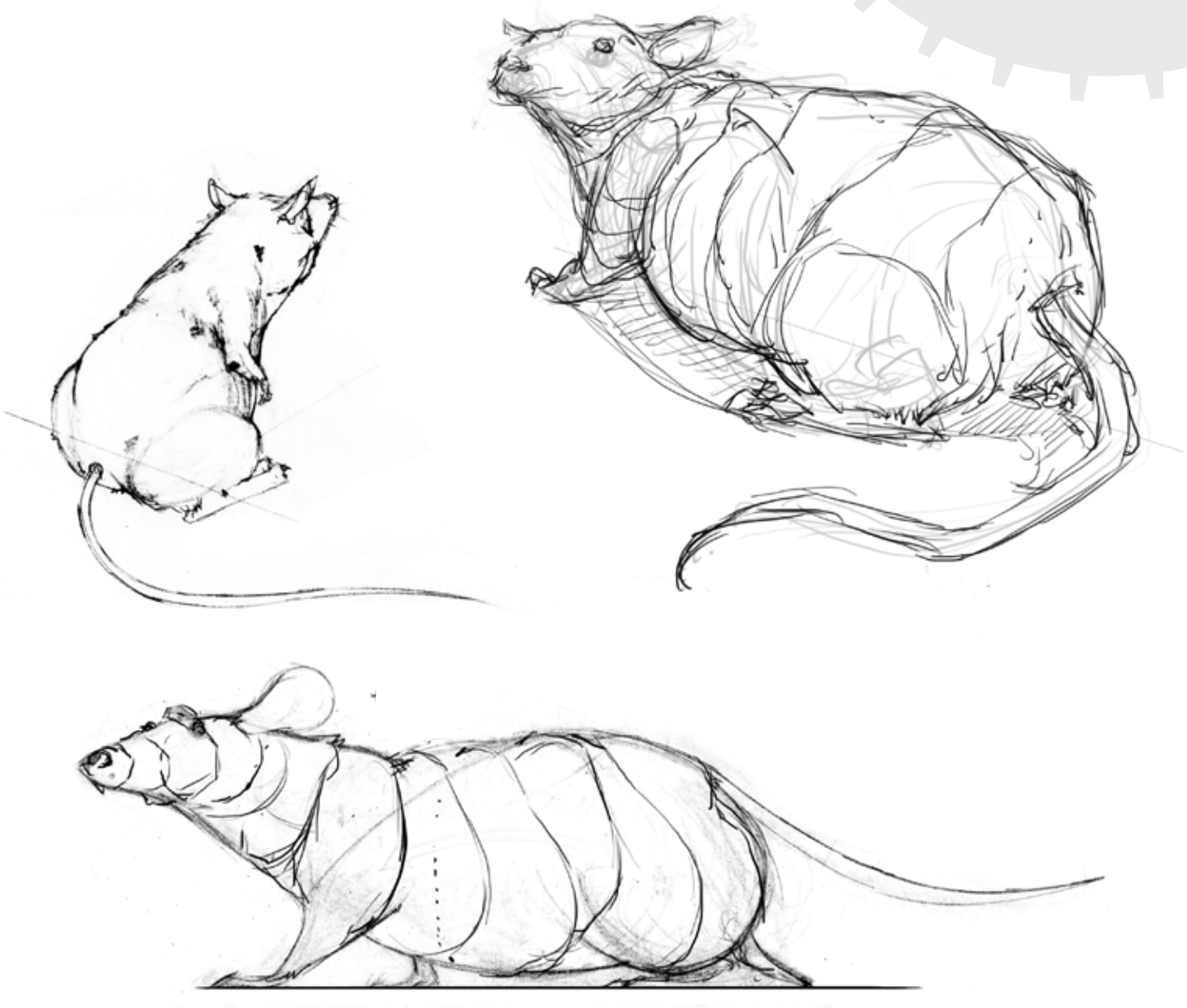


EXERCISE:

DRAW SOME FORMS

If the logic of these drawings confuses you, try copying them. If, while you are copying them, they begin to make sense, try applying the same logic to another viewing angle.

Notice that the cross-contour lines (the lines that wrap around the forms) are the secret to making these limbs look thick. They are perspective lines. If they seem difficult, imagine that each limb is a simple block with a rubber band wrapped around it. This is as basic as a human or a computer can draw anything and still make it look 3D.

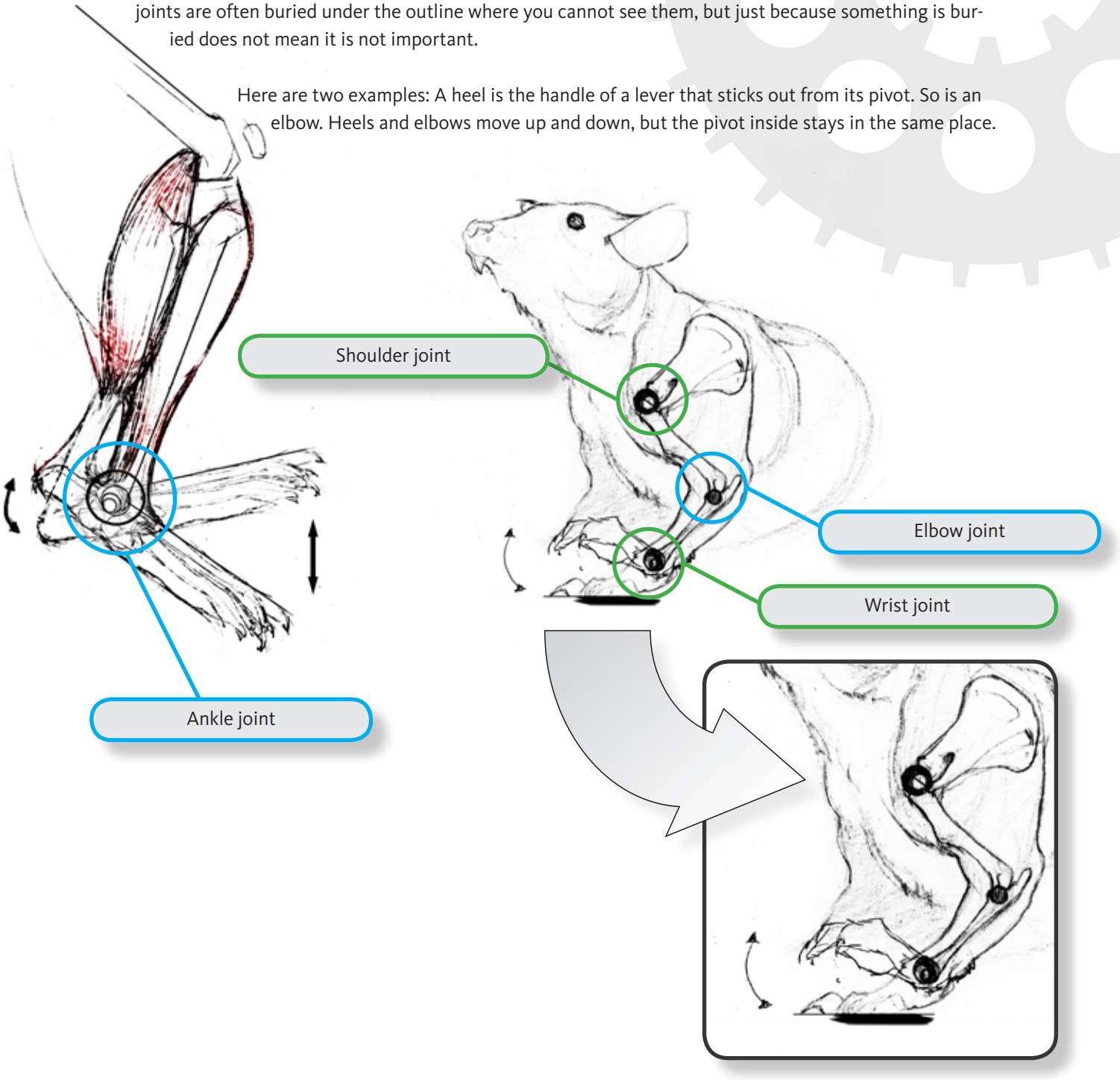


A3D Rat Anatomy LESSON 1.11

BONES AFFECT ANIMATION

Riggers prepare the bone joints to change directions so that an animated creature moves realistically. Bone joints are often buried under the outline where you cannot see them, but just because something is buried does not mean it is not important.

Here are two examples: A heel is the handle of a lever that sticks out from its pivot. So is an elbow. Heels and elbows move up and down, but the pivot inside stays in the same place.



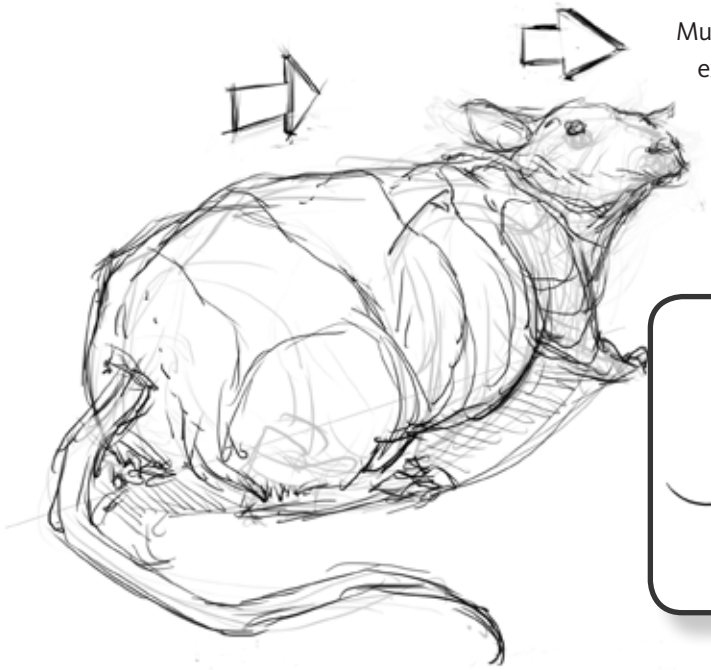
A3D Rat Anatomy LESSON 1.12

MUSCLES AFFECT ANIMATION

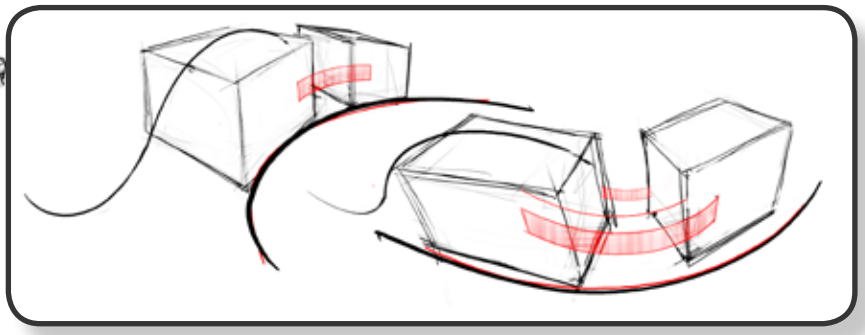
When a rat extends its legs, it changes shape from when the legs were pulled together. Animators call this squash and stretch.

The technical term for squashing is compression and for stretching is distension. But it might be simpler to say that the animal's body is like an accordion: when it bends, one side stretches out, the other side bunches up.

But it is not just the body that changes. Muscles do the pulling, so the muscles them-selves squash and stretch. When a limb bends, the muscles on the inside of the bend "crunch together" as they pull the bones closer. The muscles outside of the bend spread out and get thinner.



Muscles swell and shrink as they move bones. 3D artists can exaggerate this or use it subtly. Either way, flexible muscles make an animated rat seem more real.



A3D Rat Anatomy LESSON 1.13

RAT SURFACES

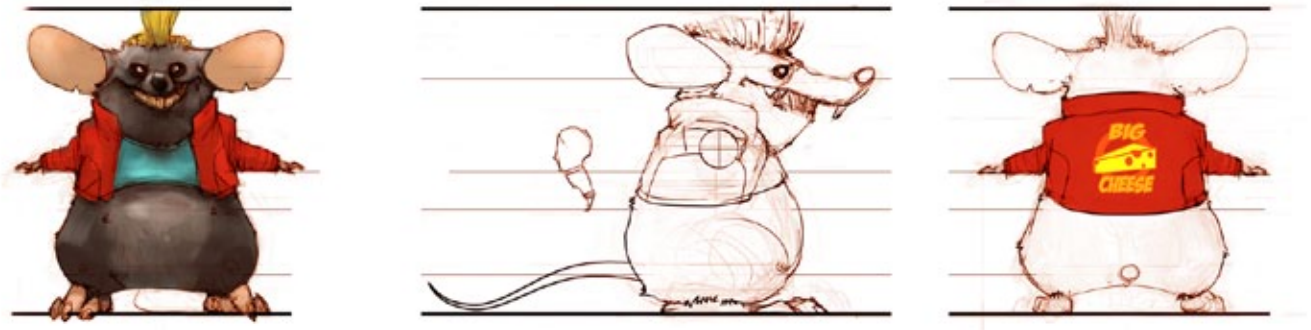
All this talk of anatomy—it is so under-the-surface. Eventually, you see a surface. Big difference between a white plaster rat and one with hair. Bigger difference between a wire-frame rat and one with any surface.

Modeling is not enough. You want to see a rendered surface. Rendering means showing how something looks, and most rats do not look like wire frames. They have a skin that reflects light or blocks light so that part of their body is in shadow. They have color. They have little bumps and fur and textures.

Artists create these surfaces, and the same model can have many different surfaces. The same rat model can be black or white, or black and white, hairy, shaved, wet or dry.

This is good news. It means that a single model, well built, well rigged, and anatomically sound can multiply. You can make a pack of rats of all variations out of a single model faster than anyone ever hoped to breed or clone them.

Surfaces come last. They are important, but they are like paint on a house. It is best to build a good house before painting it.



A3D Rat Anatomy LESSON 1.14

QUESTIONS AND REMINDERS

You have been studying rat anatomy so that you can build a cartoon rat—one that does not look like a real rat, but also does not look like a human with a snout and tail. Here are some questions and reminders:

- Does your character's bone structure include joints and pivots inside that can be rigged?
- Are you considering the multiple views necessary to model this character?
- Do the muscles get progressively thinner as they move toward the ends of the limbs? (Did you know that there are no muscles in fingers and toes?)
- Do you understand the forms of your creature well enough to draw it with inter-locking components?
- Could a sculptor build this character from your drawings and understand every shape, form, and plane?

You may not be at a stage where all these questions apply, but they are a list that can guide you toward designing characters like a professional.

Next, you look at some comparisons between rats and humans to see if you can learn some secrets about bringing a rat into our world of dignified, standing creatures.