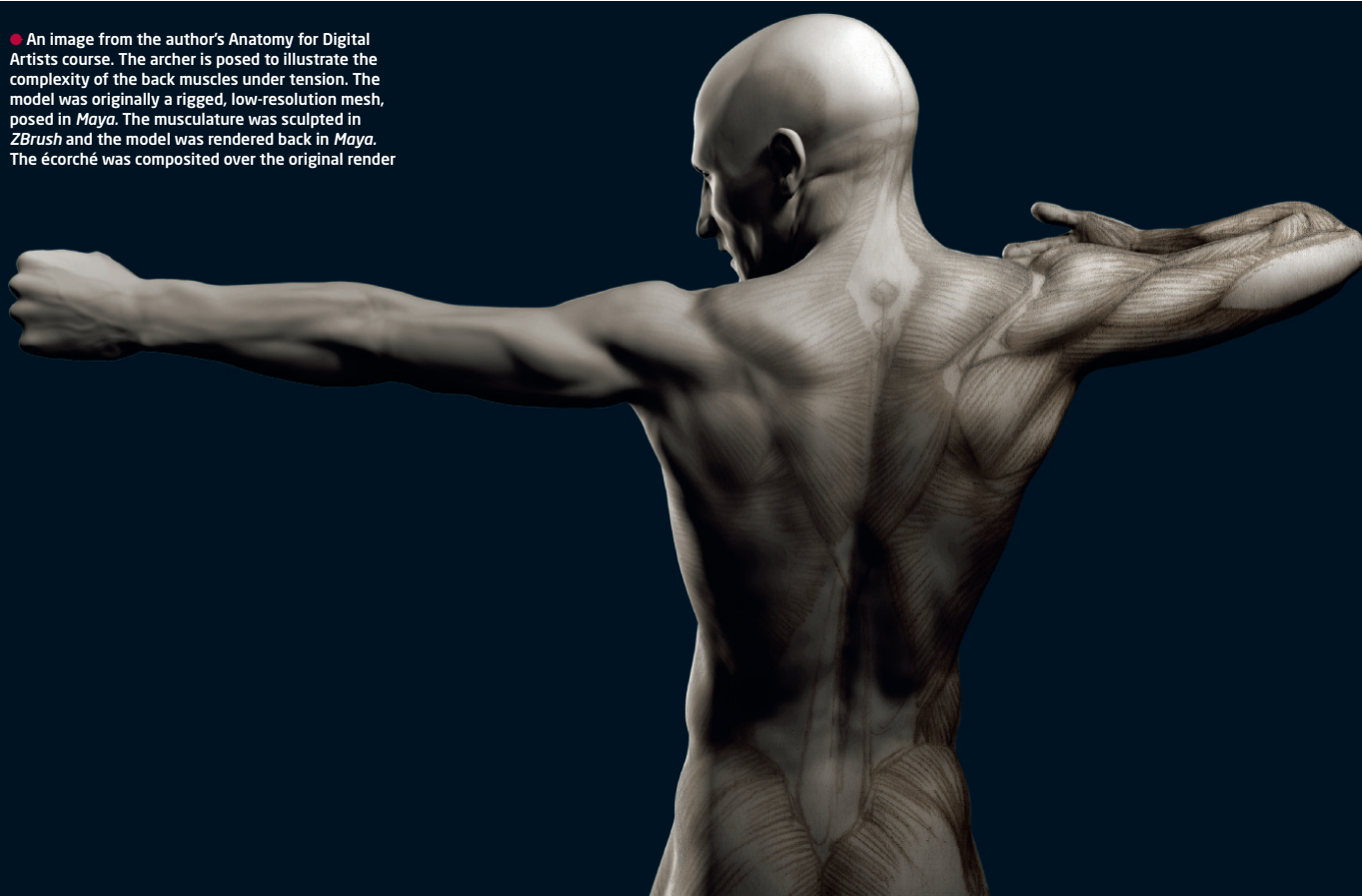




● An image from the author's Anatomy for Digital Artists course. The archer is posed to illustrate the complexity of the back muscles under tension. The model was originally a rigged, low-resolution mesh, posed in *Maya*. The musculature was sculpted in *ZBrush* and the model was rendered back in *Maya*. The écorché was composited over the original render



TIPS & TRICKS

Anatomy for 3D artists

However far technology advances, anatomical knowledge will still form the basis of good character design. Follow this set of expert tips to get better results from your own work

BY SCOTT EATON

Our expert this issue...



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An aspiring character artist might ask: "How is anatomy important to my work?" The emphatic answer is that as a character artist, anatomy should inform every aspect of your work! Anatomy is the structural foundation that grounds characters in the physical world and makes them believable, even if they are cartoons or imaginary creatures.

Of course, every CG artist needs to know how to use software applications, but what really separates an accomplished artist from a mere operator is artistic vision and a firm grounding in the fundamentals of human form. Artistic vision can't easily be taught, but the enterprising artist will find that there's a wealth of resources available that will help them discover more about anatomy.

Fortunately for us, the fundamentals of artistic anatomy have been known for thousands of years. Unfortunately, there's

little opportunity to learn these anatomical fundamentals in art schools today. Like most of the knowledge of the great masters, the subject has fallen out of favour in education and, as a result, there are currently very few people who are qualified to teach the subject. This makes finding good instruction difficult and it transfers the responsibility of learning anatomy onto the artists themselves.

This collection of tips will help you on your way towards the mastery of these fundamentals. Once you've finished, why not check out the list of recommended books on anatomy so you can increase your skills even more?

These tips are intended to provide a foundation for your own learning. Some relate to muscles, some to bones and others to proportion. If you can assimilate these principles and combine them with your own anatomy study, your character work will go from strength to strength.



● A quick silhouette check of a work in progress. Even though the base model is very low-resolution, this helps assess proportional difficulties

APPROACH BIG SHAPES LIKE A SCULPTOR

Always subordinate small details to the big shapes. In computer graphics, especially in newer programs that let you sculpt fine details quickly and easily, it's simple to start right into the details (wrinkles, texture, veins and so on) of a character before the larger shapes are correctly established. If you approach the task of making a CG model like the sculptors of old approached working in stone, it will help to structure the construction process.

Think of how a stone sculptor has to carve a chunk of stone into a blocky model first, taking care to establish the correct proportions and big shapes. Only once this stage is complete do the actual muscular shapes and details get carved in.

CHECK SILHOUETTES

Checking the silhouette of your model is a good way to assess the larger proportions and gesture of your model, without being distracted by the lack of finer details, which will be established later. Set your model to a flat, unshaded colour and zoom out to where it's small but still readable on the screen. Check the outline of the model, looking for the big shapes and proportions. A dark, unshaded colour helps you concentrate on the big shapes and ignore the fact that the model isn't finished.

STUDYING A SKELETON

The skeleton is the foundation of any character – human, animal or otherwise – and must be understood before the muscles will make sense. Say a client asks you to model a coat hanging in a closet. Being a dutiful artist, you would have to ask two questions to make sure the client gets what he or she was looking for: most obviously, what kind of coat is it? However, perhaps more importantly, you'd also ask, what's the shape of the hanger? Just as the hanger dictates the shapes of the hanging jacket, the skeleton dictates the shape of the body and hanging muscles. Besides being the scaffolding that establishes the proportion of the body, the skeleton serves as the start point and end point for all of the skeletal muscles.

MASS CONCEPTIONS

It's important to have a mental simplification of the large shapes of the skeleton. With a simple mass conception of the skull, rib cage and pelvis, a figure can be sketched quickly to show balance and proportion. Each of these masses is decidedly complicated when

IN FOCUS | Écorché



This word is French for 'flayed' and it describes the practice of drawing or sculpting a figure without the skin. Drawing écorché figures dates back to the 15th century and is a great way of learning anatomy. The technique is simple. Start with a reference image showing good muscular detail and tape a piece of tracing paper over it. Now find the bony landmarks on the figure and use these as reference points to locate and place the muscle groups in the surrounding areas. Draw in the muscles, taking care to indicate the direction of the muscle fibres, and continue until it's complete.

● Écorché image by the author, showing the back muscles. This image also highlights the smoothing effect of skin and fat over the underlying muscles

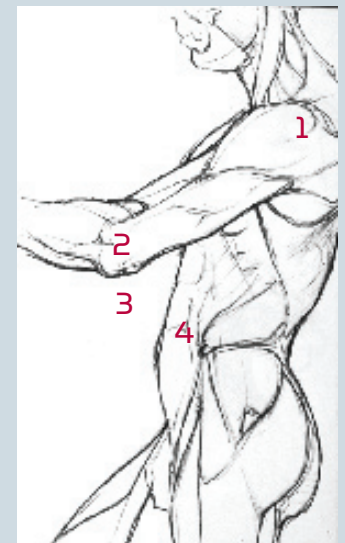
examined in detail, but it's enough for the artist to understand the large masses of these forms and use them to establish the large shapes and planes of the figure. Both Bammes and Loomis present excellent simplifications of the main masses of the skeleton – see 'Further reading' on page 55.

PUT MASSES IN YOUR MODEL

There should always be a sense of underlying structure in your models. This is achieved by maintaining your mass conceptions as you start to place the muscles onto the body. A simple technique in CG is to actually create simplified mass conceptions underneath the skin of your model. These will serve as a reference for both modelling the muscular forms on top, and also a reference during rigging to make sure the deformations don't violate what's meant to be the rigid skeleton underneath.

THE BONY POINTS

We acknowledge the importance of the skeleton and understand the simplification of the big masses of the pelvis and rib cage, but what next? Well, you need to learn the key bony points on the surface of the body. These are the places where the skeleton lies directly underneath the skin. They're great reference markers for establishing the proportions of the body and for accurately placing the surrounding muscle groups. Not only that, but these are the places on your model that, when you're rigging, shouldn't deform at all – they should only move rigidly with the joint. Some of the most important are the point of the shoulder (acromion process),



● An image showing a few of the critical bony points of the skeleton: 1. Acromion process; 2. Lateral epicondyle of the humerus; 3. Olecranon; 4. Anterior superior iliac spine



● A study highlighting the complexity of the muscles of the back. Note the interlocking of the shoulder muscles onto the upper arm, and the interplay of the upper arm and forearm muscles

the spine of the scapula, the seventh cervical vertebra, the points of the hip (anterior and posterior superior iliac spines), and the elbow (olecranon and the epicondyles of the humerus). See the diagram on the previous page.

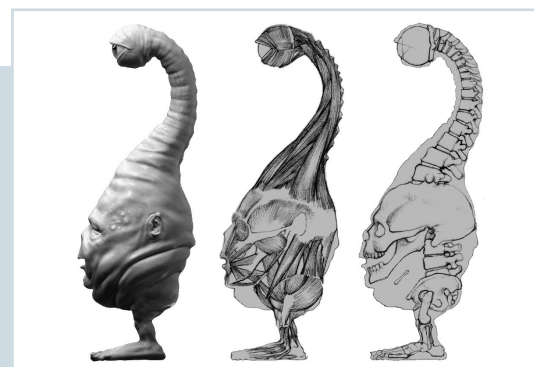
ORIGINS AND INSERTIONS

What are the bony points good for? Well, like the coat hanger example, they dictate how and where the muscles originate and insert. Understanding these muscular attachments will help you to determine the direction of pull of the muscle, no matter what pose the figure is in. This dictates how edge flow should be laid out.

PULLING POWER

One of the most important structural aspects to understand about muscles is that they must span at least one joint to function. This simple mechanical principle gives muscles their pulling power. They originate on one bone and insert on another bone further down the hierarchy. It's a simple concept, but it makes the interplay of muscles across joints both dynamic and believable.

At the elbow, for example, there's considerable interlocking between the upper and lower arm muscles. The forearm muscles extend well above the elbow, attaching onto the upper arm bone (humerus). Likewise, the biceps and triceps extend below the elbow,



● Even aliens have anatomy! This character design borrows from human anatomy, modifying the proportions for a creature of this stature

attaching into the forearm. The principle of interlocking holds true right across the body, so emphasising this will make your models become much more powerful.

THE FOREARM

The two most complicated areas of the body are the forearm and the scapula. Both owe their complexity to the number of muscles and the numerous directions in which they pull. Mastery of these areas will require additional study, so do pay attention to them. When it comes to the arm muscles, the origins and insertions of the biceps and triceps are relatively simple, but the muscles of the forearm are much more complex.

As a roadmap to help you in your study, begin by understanding the structure of the lower end of the upper arm bone (humerus). There are two important bumps there (epicondyles): one on the outside and one on the inside. From these two bumps respectively, the extensors and flexors of the hand originate. The flexors then travel on the inside of the forearm, while the extensors travel over the outside.

THE SCAPULA

Much of the complexity of the back – which beginners often incorrectly approximate with a few arbitrarily placed lumps and bumps – is due to the scapula (shoulderblade) and all its muscles sliding to and fro over the rib cage. Again, to tackle this complicated area, start by understanding the bony form of the scapula. The shape of the bone is like a guide map for placing the muscle. The spine of scapula is an important bony landmark that will give away the orientation of the bone and the disposition of the muscles that reside there. Approach this area like a detective.

THE SKIN AND FAT

Your investigation of anatomy will certainly have you studying from reference plates. These plates show every muscle in fine dissected detail, but it's important to remember that this is what the muscles look like without their top layer of fat and skin. This layer acts to soften and, in some cases, entirely obscure the muscular detail.

The effect of skin and fat on the underlying muscles is like looking through a piece of frosted glass – you can still see the shapes and masses behind the glass, but the edges are blurred and many of the details are lost. Always cross-reference what you see on the muscular plate with photos or drawings of what the area looks like in real life.

IN FOCUS | Observe variation



● A drawing from life. A long pose in front of a model gives an artist the time to carefully study the anatomy and proportions of the figure. Life drawing classes with extended poses are difficult to find, but are very useful for carefully studying figures

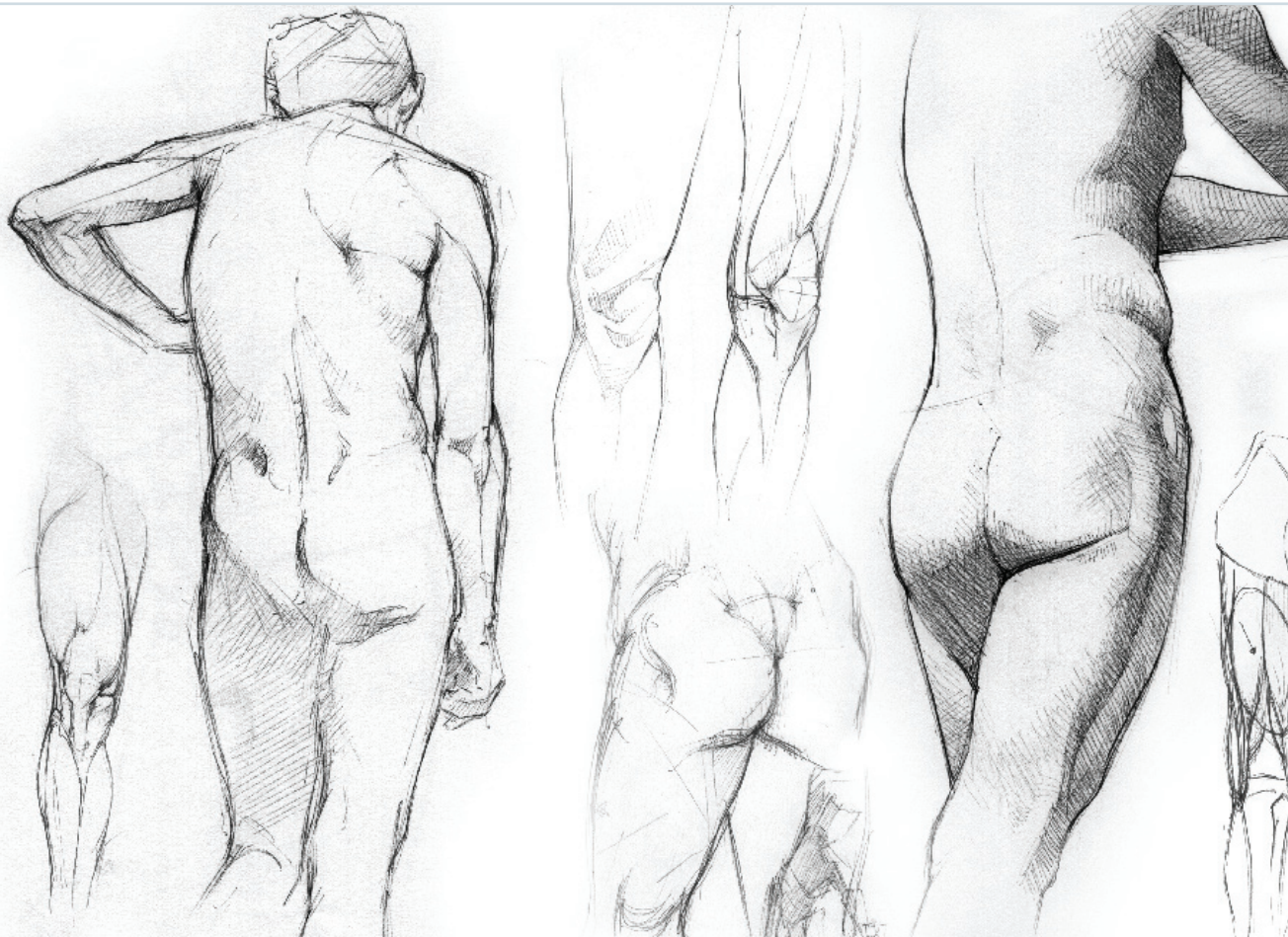
It must be understood that the figures presented in anatomy books are often limited to a single idealised human figure. In reality, though, the marvellous unpredictability of the gene pool creates remarkable variations from this ideal. This is where direct observation becomes important. Take every opportunity to study these individual variations. If you commute using public transport, there's no better opportunity to study the differences in facial structure and features. Buy a small sketchbook and make notes – the variation will astonish you.



LIFE DRAWING

There's no substitute for studying anatomy on a live figure, so find a life drawing course near you and drop in. The poses in classes are often too quick to complete an entire figure study accurately, so here's a recommended technique: during any one pose, focus your drawing on a specific part of the body and take your time studying the bony and muscular forms in that area. Do a finished study of that small section. With this method, you'll have more time to observe the forms and details of the muscles in the area, rather than putting down a slapdash drawing of the entire figure. It's time better spent and will accelerate your anatomical learning.

● A collage of drawings from life. These illustrate the softness of the body due to skin and fat accumulation. Even on athletic figures, skin and fat still have a softening effect on muscular details



ANIMAL ANATOMY

Once you have human anatomy under your belt, it's quite easy to learn animal anatomy. You may be surprised to learn that animals have anatomy that's very similar to humans, varying mostly in proportion. They have scapulae, flexors, extensors and all the things we've talked about, only in a different size and shape. The wing of a bat, for example, has the exact same bone hierarchy as a human arm and hand, right down to the smallest digits of the fingers – only the proportions and function are different. Learn human anatomy well and you'll soon be able to understand animal anatomy.

PLAUSIBLE ANATOMY

The principles outlined above can and should be applied to fantasy creatures as well. Given that a creature is situated in a world with physics similar to our own, it will have evolved similar mechanisms for dealing with gravity, mass and momentum. Use your knowledge of human anatomy to imagine how the creature might be constructed with muscles and bones so that it can react to the environment around it. Take into consideration all the points mentioned here. Make note of an underlying skeleton, its bony points, muscular origins and insertions. Consider the interlocking of muscles and tendons across joints. Borrow from human anatomy but change the proportions and functions as necessary. ●

FURTHER READING | Anatomy reference books

Even a casual glance in your local bookstore will reveal that there are shelves full of anatomy books available to the eager student. There are some great titles out there, but there are also lots of bad ones too. A student of anatomy should study from only the best, so here's a list of recommended anatomy books:

Title: Artistic Anatomy
Author: Dr Paul Richer & Robert Beverly Hale
ISBN: 0823002977
• The authoritative reference in the field
• Difficult text, but well worth the effort
• Clear, extremely accurate plates

Title: Atlas of Human Anatomy for the Artist
Author: Stephen Rogers Peck
ISBN: 0195030958
• A classic, must-have reference
• Many illustrations that explain difficult concepts
• Lucid text

Title: Human Anatomy for Artists
Author: Eliot Goldfinger
ISBN: 0195052064

- A contemporary reference
- Encyclopedic coverage of the individual muscles
- An essential resource

Title: Anatomy Lessons from the Great Masters
Author: Robert Beverly Hale & Terence Coyle
ISBN: 0823002810
• Uses master drawings to explain a range of anatomical concepts
• Exhaustive coverage of the body
• Highly recommended for intermediate and advanced students of anatomy

Title: Die Gestalt des Menschen
Author: Gottfried Bammes
ISBN: 3473610992
• Constructionist approach to the skeleton and figure
• Excellent simplification of forms
• Recommended for its illustrations, even if you don't read German!

Title: Figure Drawing For All It's Worth
Author: Andrew Loomis
ISBN: 067031255X
• Quality introduction to anatomy, proportions and figure drawing from a master illustrator
• Text is extremely readable
• Not in print, but second-hand copies can be found online from specialist stores or sites like eBay