INTRODUCTION

The skeletal system has a number of important functions in the human body. It is the framework around which the body is organized, it provides levers for muscles to pull against, and it surrounds and protects many soft organs. Equally important, bones serve as a "buffer" in which calcium and other ions can be deposited and withdrawn according to the changing needs of the body, and they are the site of almost all blood cell production. Contrary to our popular conceptions, bones are not rigid, inflexible structures: they are constantly changing, and can have a remarkable degree of flexibility before they break.

The organs of the skeletal system are the bones and joints, and like all organs are composed of different types of tissue. Although we tend to classify them into "types" such as "long bones", "flat bones", etc., each is in fact unique and ideally suited to its particular location and function. We classify bones as belonging to either:

a) the axial skeleton (head and trunk)
b) the appendicular skeleton (arms and legs),

However, you should always bear in mind that the entire skeletal system functions as a unit.

If you look at any bone, you will see that it is rarely flat or smooth. Bones have a variety of bumps, grooves, holes, etc. which allow them to serve their specific functions. In fact, it is these markings which will allow you to identify specific bones, including which side of the body they come from. In general, bone will have numerous holes (or foramen, plural = foramina) wherever something like a blood vessel or nerve must pass through. Typically, these will not be visible to the naked eye, but you should be aware of their presence. Enlargements at the ends of a bone allow it to connect, or articulate, with other bones in the proper manner. Bumps, grooves, and ridges on bones indicate where muscles, tendons, and ligaments attach or travel.

We will use a number of lab periods to learn the names of the bones which comprise the human skeleton and their major markings. Since this is more-or-less a matter of simple memorization, there will not be step-by-step instructions: instead, it will be an independent study exercise in which you can proceed at your own pace, using your Saladin textbook (Chapter 8) as reference. You will need to make use of open lab times as well as scheduled lab periods.

Keep in mind that the simple memorization of the actual names and locations of bones is only a small part of the process of really understanding the skeletal system. You will also be responsible for identifying the markings (tubercles, foramina, condyles, etc.) of each bone.

Study the skeletons hanging in the lab and the individual bones found in the cupboard at the back of the lab, and learn the names of the bones and major markings listed below. Some of the skulls, skeletons and individual bones are real, while others are plastic reproductions. Be sure you study both types. The real bone specimens show greater detail and more variation, but they are fragile and many of them are broken or have pieces missing (especially true for the skulls). The plastic reproductions are more durable, but are not as good at showing more intricate details.

Please be careful not to do any further damage. Only soft probes, such as a rolled-up piece of paper or tissue, should be used to identify structures – DO NOT use pens, pencils, or metal probes, and do not mark on any of the specimens.
**Bone Parts and Markings:**

The following terms are used to identify the various parts of a bone. You should understand the meaning of each of these terms and how they apply to specific bones. One or more questions on a lab exam will relate to your understanding of these terms.

**Body**

The main part of a bone from which other markings often extend. 
Example: the *body* of the sphenoid bone.

**Canal**

A tube-like opening through which nerves and blood vessels often pass. 
Example: the *carotid canal* of the temporal bone.

**Condyle**

A large, rounded projection where the bone articulates with part of another bone. 
Example: the *lateral condyle* of the tibia.

**Crest**

A narrow ridge on the bone, usually found where a flat muscle, tendon, or ligament attaches to the bone. 
Example: the *anterior crest* of the tibia.

**Diaphysis**

The cylindrical shaft of a long bone. May have other markings on it. 
Example: the *diaphysis* of the radius.

**Epicondyle**

A relatively small, rounded bump where muscles, tendons, and ligaments attach to the bone. An epicondyle is always located on the surface of a condyle. 
Example: the *medial epicondyle* of the humerus.

**Epiphysis**

The enlarged end of a long bone. Often includes other markings such as condyles or epicondyles. 
Example: the *distal epiphysis* of the tibia.

**Facet**

A smooth, flat area where the bone articulates with part of another bone. 
Example: the *facet* on the superior articular process of a vertebra.

**Fissure**

A narrow elongated opening, usually irregular in shape. Nerves and blood vessels often pass through fissures. 
Example: the *superior orbital fissure* of the sphenoid bone.

**Foramen**

A round or oval hole through a bone, not as long as a canal or meatus. 
Example: the *jugular foramen* of the temporal bone.

**Fossa**

A large, flat region or shallow depression on a bone. 
Example: the *infraespinous fossa* of the scapula.

**Groove**

A narrow depression on a bone through which some other structure runs. 
Example: the *intertubercular groove* of the humerus.

**Head**

A rounded enlargement carried on a neck of a bone which takes part in forming a joint. 
Example: the *head* of the femur.
LINE  A narrow ridge, smaller than a crest, but also a place where a flat ligament, tendon, or muscle attaches to the bone.
Example: the *superior nuchal line* of the occipital bone.

MEATUS  A tube-like opening or passage in a bone.
Example: the *external auditory meatus* of the temporal bone.

NECK  A narrowed region at one end of a long bone, leading to a head.
Example: the *neck* of the femur.

PROCESS  A general term for a long projection from a bone.
Example: the *zygomatic process* of the temporal bone.

PROTUBERANCE  A general term for a small, irregular projection from a bone.
Example: the *external occipital protuberance* of the occipital bone.

RAMUS  A round or flattened extension from the body of a bone, usually for articulation with another bone.
Example: the *ramus* of the mandible.

SINUS  An air-filled cavity within a bone, lined by mucous membrane.
Example: the *frontal sinus* of the frontal bone.

SPINE  A sharp, slender projection of a bone for muscle, tendon, or ligament attachment.
Example: the *anterior superior iliac spine* of the ilium.

TROCHANTER  A large, irregularly shaped projection of a bone.
Example: the *greater trochanter* of the femur.

TUBERCLE  A small round projection of a bone.
Example: the *tubercle* of a rib.

TUBEROSITY  A large, rounded projection of a bone for muscle attachment, usually rough.
Example: the *deltoid tuberosity* of the humerus.

WING  An elongated, flattened extension of a bone.
Example: the *greater wing* of the sphenoid bone.
BONES OF THE SKULL (Figures 8.3 - 8.15)

The skull consists of two separate sets of bones: bones of the cranium surround and protect the brain, while bones of the face support the eyes, nose, and mouth and provide attachment for the muscles of facial expression. These two sets of bones attach to each other in many places, and all bones in the head include a large number of foramina because of the large numbers of nerves and blood vessels which must pass through.

With only one exception, the joints between the bones of the skull are a type which prevents, rather than allows, motion between the bones. These nonmovable joints are called sutures, and they are found only in the head. The exception to this pattern is the joint between the condyle of the mandible and the temporal bone, which allows the mandible to move freely when eating, speaking, yawning, etc.

<table>
<thead>
<tr>
<th>IDENTIFY THE FRONTAL BONE AND ITS FOLLOWING MARKINGS:</th>
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<tbody>
<tr>
<td>Supraorbital margin</td>
<td>Supraorbital foramen</td>
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<tr>
<th>IDENTIFY THE PARIETAL BONE</th>
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<tr>
<th>IDENTIFY THE OCCIPITAL BONE AND ITS FOLLOWING MARKINGS:</th>
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<tbody>
<tr>
<td>Foramen magnum</td>
<td>External occipital protuberance</td>
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<tr>
<td>Occipital condyle</td>
<td>Superior nuchal line</td>
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<td>Hypoglossal canal</td>
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<tr>
<th>IDENTIFY THE TEMPORAL BONE AND ITS FOLLOWING MARKINGS:</th>
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<tbody>
<tr>
<td>Squamous region</td>
<td>Internal auditory (acoustic) meatus</td>
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<tr>
<td>Tympanic region</td>
<td>Styloid process</td>
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<tr>
<td>Petrous region</td>
<td>Jugular foramen</td>
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<tr>
<td>Mastoid region</td>
<td>Foramen lacerum</td>
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<tr>
<td>Mastoid process</td>
<td>Stylomastoid foramen</td>
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<tr>
<td>Mandibular fossa</td>
<td>Carotid canal</td>
</tr>
<tr>
<td>External auditory (acoustic) meatus</td>
<td>Zygomatic process</td>
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<tr>
<th>IDENTIFY THE ETHMOID BONE AND ITS FOLLOWING MARKINGS:</th>
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<tbody>
<tr>
<td>Crista galli</td>
<td>Cribiform plate</td>
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<tr>
<td>Perpendicular plate</td>
<td>Orbital plate</td>
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<tr>
<th>IDENTIFY THE SPHENOID BONE AND ITS FOLLOWING MARKINGS:</th>
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<tbody>
<tr>
<td>Body</td>
<td>Superior orbital fissure</td>
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<tr>
<td>Sella turcica</td>
<td>Optic canal</td>
</tr>
<tr>
<td>Greater wing</td>
<td>Foramen ovale</td>
</tr>
<tr>
<td>Lesser wing</td>
<td>Foramen rotundum</td>
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<tr>
<td>Pterygoid process</td>
<td>Foramen spinosum</td>
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<tr>
<th>IDENTIFY THE MAXILLA AND ITS FOLLOWING MARKINGS:</th>
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<tbody>
<tr>
<td>Alveolar margin</td>
<td>Palatine process</td>
</tr>
<tr>
<td>Frontal process</td>
<td>Zygomatic process</td>
</tr>
<tr>
<td>infraorbital foramen</td>
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<tr>
<th>IDENTIFY THE MANDIBLE AND ITS FOLLOWING MARKINGS:</th>
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<tbody>
<tr>
<td>Body</td>
<td>Ramus</td>
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<tr>
<td>Condyles (right &amp; left)</td>
<td>Angle</td>
</tr>
<tr>
<td>Mandibular notch</td>
<td>Alveolar margin</td>
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<tr>
<td>Coronoid process</td>
<td></td>
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</tbody>
</table>
IDENTIFY THE ZYGOMATIC BONE

IDENTIFY THE NASAL BONE

IDENTIFY THE LACRIMAL BONE

IDENTIFY THE VOMER

IDENTIFY THE FOLLOWING FEATURES OF THE SKULL:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Location</th>
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<tbody>
<tr>
<td>Coronal suture</td>
<td>Anterior cranial fossa</td>
</tr>
<tr>
<td>Sagittal suture</td>
<td>Middle cranial fossa</td>
</tr>
<tr>
<td>Lambdoid suture</td>
<td>Posterior cranial fossa</td>
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<tr>
<td>Squamous suture</td>
<td>Orbit</td>
</tr>
<tr>
<td>Occipitomastoid suture</td>
<td>Nasal cavity</td>
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</tbody>
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IN THE ORBIT, IDENTIFY THE FOLLOWING:

- Superior orbital fissure
- Inferior orbital fissure
- Optic canal

Be sure you can identify where each of these openings leads. Two of them lead back between the cranial cavity and the orbit while one leads from the cranial cavity onto the face behind the zygomatic arch.

IN THE NASAL CAVITY, IDENTIFY THE FOLLOWING:

- Nasal septum (composed of parts of vomer and ethmoid bones)
- Middle nasal concha
- Inferior nasal concha
- Superior nasal concha (cannot be seen on the skull models, but you should know its location)

ON YOURSELF AND/OR ANOTHER PERSON, LOCATE THE FOLLOWING:

- Frontal bone
- Parietal bones
- Occipital bone
- Temporal bones
- Nasal bones
- Zygomatic bones
- Orbits
- Supraorbital margins

- External auditory (acoustic) meatus
- Mastoid processes
- External occipital protuberance
- Nasal septum
- Body, angle, and ramus of mandible
- Temporomandibular joints
- Approximate location of the sagittal, coronal, and lambdoid sutures
THE SPINAL COLUMN (Figures 8.18 - 8.26)

The spinal column consists of 33 individual vertebrae. They surround the spinal cord and the nerves which arise from it, and they provide places for many muscles to attach. The size and shape of each vertebra depends on where it is located, which muscles and ligaments attach to it, etc. Five of them are fused together to carry the weight of the upper body and transfer this weight to the bones of the lower limb.

ON AN INTACT SKELETON, IDENTIFY THE:
- Seven cervical vertebrae
- Twelve thoracic vertebrae
- Five lumbar vertebrae
- Five fused sacral vertebrae
- Four partially fused coccygeal vertebrae

ON A THORACIC OR LUMBAR VERTEBRA, IDENTIFY THE FOLLOWING:
- Body
- Lamina
- Pedicle
- Vertebral foramen
- Transverse process
- Spinous process
- Superior articular process and facet
- Inferior articular process and facet
- Superior notch
- Inferior notch
- Costal facet on thoracic vertebra

Look at an intact skeleton and understand how the inferior and superior notches of adjacent vertebrae form an intervertebral foramen.

EXAMINE TWO OR THREE CERVICAL VERTEBRAE:
- Specifically identify the 1st and 2nd vertebrae, called the Atlas and the Axis.
- Identify the transverse foramen which is characteristic of all cervical vertebrae

EXAMINE TWO OR THREE THORACIC VERTEBRAE:
- Identify where ribs articulate on both the body and the transverse process of each vertebra
- Note the characteristic inferior angle of the spinous processes of thoracic vertebrae

EXAMINE TWO OR THREE LUMBAR VERTEBRAE:
- Note characteristically large bodies and short spinous processes of lumbar vertebrae

IDENTIFY THE SACRUM, CONSISTING OF FIVE FUSED VERTEBRAE:
- Note the thicker medial region where the vertebral bodies are fused
- Note that even though the vertebrae are fused, intervertebral foramina are still present

IDENTIFY THE COCCYX, CONSISTING OF FOUR PARTIALLY FUSED VERTEBRAE:
- Note that these vertebrae are not well formed, lacking most of the markings of other vertebrae, and are partially or completely fused together.

ON YOURSELF AND/OR ANOTHER PERSON, LOCATE THE FOLLOWING:
- Spinous processes of thoracic and lumbar vertebrae
- Border between lumbar vertebrae and sacrum
- Sacrum and coccyx
- Notice the curvatures of the cervical, thoracic, lumbar, and sacral regions of the vertebral column

This will require removal of clothing and exposure of the skin of the back so you should do it at home. Please do not identify these structures through clothing.
THE HYOID BONE (Figure 8.16)
This is the only bone in the human body that does not articulate with another bone. It serves as an attachment for muscles which move the tongue and larynx.

IDENTIFY THE HYOID BONE ON A COMPLETE SKELETON:
IDENTIFY THE HYOID BONE ON YOURSELF AND/OR ANOTHER PERSON

THE PELVIS (Figures 8.35 - 8.37)
The bones of the pelvis surround and protect the organs of the pelvic cavity, transmit weight from the vertebrae to the legs, and provide attachment for muscles which move both the legs and the body. Although in the adult they form a single, solid structure on each side called the coxal bone, each coxal bone is considered to consist of the three individual bones seen earlier in growth and development.

IDENTIFY THE ILIUM AND ITS FOLLOWING MARKINGS:
- Iliac crest
- Anterior superior iliac spine
- Posterior superior iliac spine
- Greater sciatic notch
- Iliac fossa
- Anterior inferior iliac spine
- Posterior inferior iliac spine

IDENTIFY THE ISCHIUM AND ITS FOLLOWING MARKINGS:
- Ischial ramus
- Ischial spine
- Ischial tuberosity
- Lesser sciatic notch

IDENTIFY THE PUBIS AND ITS FOLLOWING MARKINGS:
- Superior ramus
- Inferior ramus
- Pubic tubercle on body of pubis

IDENTIFY THE FOLLOWING:
- Acetabulum
- Pubic symphysis
- Obturator foramen
- Pelvic brim
- Pelvic inlet
- Sacroiliac joint
- True (lesser) pelvis
- False (greater) pelvis

ON YOURSELF AND/OR ANOTHER PERSON, IDENTIFY THE FOLLOWING:
- Anterior superior iliac spines
- Posterior superior iliac spines
- Pubic symphysis
- Pubic tubercles
- Ischial tuberosities
- Iliac crests
- Sacroiliac joints

This will require removal of clothing and exposure of the skin of the pelvis so you should do this at home. Please do not identify these structures through clothing.
THE THORAX (Figures 8.27 - 8.29)

ON THE ARTICULATED SKELETON, IDENTIFY THE STERNUM AND ITS PARTS
- Manubrium
- Body
- Xiphoid process
- Sternal angle

ON THE ARTICULATED SKELETON, IDENTIFY RIBS 1 THROUGH 12 ON EACH SIDE
- Examine their attachments to vertebrae and sternum
- Notice that: ribs 1 through 7 attach directly to the sternum through costal cartilages
  - ribs 8 through 10 attach to the rib above through costal cartilages
  - ribs 11 and 12 do not have an anterior attachment.
- For this reason:
  - ribs 1 through 7 are called “true” ribs
  - ribs 8 through 12 are called “false” ribs
  - ribs 11 and 12 are called “floating” ribs

EXAMINE AN ISOLATED RIB AND IDENTIFY THE FOLLOWING:
- Head
- Neck
- Tubercle
- Angle
- Costal groove

ON YOURSELF AND/OR ANOTHER PERSON, IDENTIFY THE FOLLOWING:
- Sternum
- Sternal angle
- Xiphoid process
- Angles of ribs
- Costal cartilages
  - Follow each rib from its posterior attachment to its anterior attachment
This will require removal of clothing and exposure of the skin of the thorax so you should do this at home.
Please do not identify these structures through clothing.
THE UPPER LIMB (Figures 8.30 - 8.34)

Bones of the upper limb provide attachments for the muscles which move the arm and which attach the upper limb (part of the appendicular skeleton) to the axial skeleton. Note that it includes not only bones of the arm, forearm and hand, but also the scapula and the clavicle. Thus, the sternoclavicular joint separates the axial skeleton from the appendicular skeleton of the upper limb.

IDENTIFY THE CLAVICLE AND ITS FOLLOWING MARKINGS:
- Medial (sternal) epiphysis
- Lateral (acromial) epiphysis

IDENTIFY THE SCAPULA AND ITS FOLLOWING MARKINGS:
- Spine
- Coracoid process
- Acromion process
- Subscapular fossa
- Supraspinous fossa
- Infraspinous fossa
- Glenoid cavity
- Superior, medial, and lateral borders

IDENTIFY THE HUMERUS AND ITS FOLLOWING MARKINGS:
- Head
- Greater tubercle and Lesser tubercle
- Intertubercular (bicipital) groove
- Deltoid tuberosity
- Medial epicondyle
- Lateral epicondyle
- Trochlea
- Olecranon fossa

IDENTIFY THE RADIUS AND ITS FOLLOWING MARKINGS:
- Head
- Radial tuberosity
- Styloid process

IDENTIFY THE ULNA AND ITS FOLLOWING MARKINGS:
- Olecranon process
- Coronoid process
- Styloid process
- Trochlear notch

IDENTIFY THE CARPAL BONES ON EACH HAND:
- Trapezium
- Trapezoid
- Capitate
- Hamate
- Scaphoid
- Lunate
- Triquetrum
- Pisiform

IDENTIFY THE METACARPAL BONES ON EACH HAND
These are named 1 through 5 from the thumb (called the pollex) toward the little finger

IDENTIFY THE PHALANGES ON EACH HAND
The thumb has a proximal phalanx and a distal phalanx
Each of the other fingers has a proximal phalanx, a middle phalanx, and a distal phalanx

ON YOURSELF AND/OR ANOTHER PERSON, LOCATE THE FOLLOWING:
- Clavicle (entire length)
- Acromion process of scapula
- Sternoclavicular joint
- Coracoid process of scapula
- Spine of scapula
- Greater tubercle of humerus
- Medial epicondyle of humerus
- Lateral epicondyle of humerus
- Olecranon process of ulna
- Posterior border of ulna (entire length)
- Styloid process of radius
- Styloid process of ulna
- All eight carpals on posterior wrist
- All five metacarpals
- All fourteen phalanges of the hand

This will require removal of clothing and exposure of the skin of the limb so you should do this at home. Please do not identify these structures through clothing.
THE LOWER LIMB (Figures 8.38 - 8.42)

Bones of the lower limb provide attachments for the muscles which move the leg and which attach the lower limb (part of the appendicular skeleton) to the axial skeleton. Note that it includes not only bones of the thigh, lower leg, and foot, but also the coxal bones of the pelvis. Thus, the sacroiliac joint separates the axial skeleton from the appendicular skeleton of the lower limb.

IDENTIFY THE FEMUR AND ITS FOLLOWING MARKINGS:
- Head
- Neck
- Greater trochanter
- Lesser trochanter
- Gluteal tuberosity
- Medial condyle
- Lateral condyle
- Greater trochanter
- Lesser trochanter
- Gluteal tuberosity
- Patellar surface

IDENTIFY THE TIBIA AND ITS FOLLOWING MARKINGS:
- Medial condyle
- Lateral condyle
- Tibial tuberosity
- Anterior crest or border
- Medial malleolus

IDENTIFY THE FIBULA AND ITS FOLLOWING MARKINGS:
- Head
- Lateral malleolus

IDENTIFY THE PATELLA

IDENTIFY THE TARSAL BONES OF EACH FOOT:
- Calcaneus
- Talus
- Cuboid
- Navicular
- Medial cuneiform
- Intermediate cuneiform
- Lateral cuneiform

IDENTIFY THE METATARSAL BONES ON EACH FOOT
- These are named 1 through 5 from the large toe (called the hallux) toward the smallest toe

IDENTIFY THE PHALANGES ON EACH FOOT
- The big toe has a proximal phalanx and a distal phalanx
- Each of the other toes has a proximal phalanx, a middle phalanx, and a distal phalanx

ON YOURSELF AND/OR ANOTHER PERSON, LOCATE THE FOLLOWING:
- Greater trochanter of femur
- Medial epicondyle of femur
- Lateral epicondyle of femur
- Patella
- Medial condyle of tibia
- Lateral condyle of tibia
- Head of fibula
- Medial malleolus of tibia
- Lateral malleolus of fibula
- All seven tarsals on posterior foot
- All five metatarsals
- All fourteen phalanges of the foot

This will require removal of clothing and exposure of the skin of the limb so you should do this at home. Please do not identify these structures through clothing.