0:00:00.030,0:00:03.959In lecture 11 we are going to continue
our discussion of tissues we're going to

0:00:03.959,0:00:07.500
be talking about muscle tissue nervous
tissue and we're also going to be

0:00:07.500,0:00:11.219
talking about an important topic called
inflammation this material is from

0:00:11.219,0:00:16.920
chapter 4 in Marieb let's begin by
talking a little bit about how the

0:00:16.920,0:00:21.090
connective tissues that we've already
talked about integrate in the body and

0:00:21.090,0:00:25.199
how they function in the body one of the
things they do is they form a connective

0:00:25.199,0:00:29.609
tissue framework and some of these
framework type tissues are known as

0:00:29.609,0:00:34.200
fascia and as you see down the lower
left of this slide fasciae connects the

0:00:34.200,0:00:38.399
organs of the dorsal and ventral body
cavities with the rest of the body and

0:00:38.399,0:00:41.100
as we'll see in a couple of minutes one
of their most important functions is

0:00:41.100,0:00:45.270
that they surround muscles and basically
separate muscles and hold the entire

0:00:45.270,0:00:49.980
body wall intact in general fascia
provides strength for the body they

0:00:49.980,0:00:54.899
stabilize the positions of different
structures in the body they also help

0:00:54.899,0:01:00.210
maintain organ position and finally they
act as conduits now a conduit is nothing

0:01:00.210,0:01:03.329
more than a passageway something that
you've probably seen if you've gone into

0:01:03.329,0:01:08.159
a classroom or something like that
you've seen tubes that basically form

0:01:08.159,0:01:12.180
tunnels where the wires go conduits in
the body you've served the same purpose

0:01:12.180,0:01:16.229
they provide passageways for blood
vessels and nerves so that they don't

0:01:16.229,0:01:19.740
get crushed when the body moves so these
are all the functions of fascia

0:01:19.740,0:01:23.850
and there are three different kinds of
fascia that we want to talk about the

0:01:23.850,0:01:28.650
first kind is known as superficial
fascia so named because it's more

0:01:28.650,0:01:32.759
superficial in the body that is it's the
outer layer of the tissue that you see

0:01:32.759,0:01:36.810
right here just beneath the skin here we
have the skin below that we have a layer

0:01:36.810,0:01:41.909
that sometimes known as the subcutaneous
layer also known as the hypodermis this

0:01:41.909,0:01:45.990
forms the superficial fascia this is
constructed areolar type of

0:01:45.990,0:01:50.430
connective tissue as well as fat now the
next type of fashion that we want to

0:01:50.430,0:01:55.140
talk about is the deep fascia these form
connective tissue sheets between muscles

0:01:55.140,0:01:59.759

so they surround muscles they separate
them and they also serve as attachments

0:01:59.759,0:02:04.409
as we'll see in a little while these are
very strong fibrous pieces of connective

0:02:04.409,0:02:09.509
tissue that are constructed of dense
type connective tissue and these are

0:02:09.509,0:02:14.130
bound to capsules around organs to
tendons to ligaments and we'll look at

0:02:14.130,0:02:18.420
sample of that in a couple of minutes
the very last type of fascia that we

0:02:18.420,0:02:22.650
want to talk about is known as sub
serous fascia the serous membranes of

0:02:22.650,0:02:27.270
the body as you see on the bottom of the
slide would be here just outside of that

0:02:27.270,0:02:32.040
we have a layer of fascia and that is
known as the sub serous fascia because

0:02:32.040,0:02:36.630
it's just outside the serous membrane
this is also a loose areolar connective

0:02:36.630,0:02:41.190
tissue similar to the superficial fascia
and this basically separates the organs

0:02:41.190,0:02:46.260
inside from the body wall and provides a
layer between the visceral membranes

0:02:46.260,0:02:50.520
that we have and the body wall let's
take a look at a couple of other

0:02:50.520,0:02:54.450
examples of how connective tissue
integrates with other tissues and

0:02:54.450,0:02:59.340
basically serves to hold the body
together and form this connective tissue

0:02:59.340,0:03:04.620
framework what we're looking at here is
a bone in this case this is the femur a

0:03:04.620,0:03:08.850
leg bone and we're looking at a muscle
attached to the bone now we're not

0:03:08.850,0:03:12.570
really interested right now anyway in
the parts of the muscle we're going to

0:03:12.570,0:03:16.230
talk about this much more extensively
when we cover muscle a little way down

0:03:16.230,0:03:20.940
the road however what I am interested in
is looking at the connective tissues and

0:03:20.940,0:03:24.750
how they help muscle do its job so in
this diagram you'll notice that we have

0:03:24.750,0:03:29.010
connected to the bone the tendon and if
you remember from connective tissue

0:03:29.010,0:03:34.890
lectures the tendon was a dense regular
type connective tissue this serves to

0:03:34.890,0:03:38.580
connect muscles to bone and we see that
right here now the tendon will get a

0:03:38.580,0:03:42.090
little bit thinner as it approaches the
muscle and will become fascia

0:03:42.090,0:03:45.720
this in fact is the deep fascia that we
just finished talking about in the

0:03:45.720,0:03:49.350
previous slide and then the fascia in
turn will become a little bit thinner

0:03:49.350,0:03:55.080
and become something that's known as an
epimysium mysium means muscle epi means

0:03:55.080,0:03:59.520

on or on top of so this is the layer of connective tissue that surrounds the

0:03:59.520,0:04:04.920
entire muscle and it's thinner than the fascia if you look at the muscle itself

0:04:04.920,0:04:09.000
and we take a cross-section through the muscle you'll notice that inside we have

0:04:09.000,0:04:14.910
several bundles of muscle fibers so this is a bundle bundle here bundle there and

0:04:14.910,0:04:20.940
these bundles are known as fascicles now surrounding each fascicle we have

0:04:20.940,0:04:24.540
another layer of connective tissue called a perimysium and then finally if

0:04:24.540,0:04:27.750
we look at the individual bundles or fascicles

0:04:27.750,0:04:32.400
you notice inside here we have individual muscle cells or muscle fibers

0:04:32.400,0:04:35.730
which we're going to talk about in a little while this is an example of one

0:04:35.730,0:04:39.600
of them being illustrated here and we're kind of telescoping out the muscle fiber

0:04:39.600,0:04:43.830
you'll notice that surrounding the individual muscle fibers we have yet one

0:04:43.830,0:04:49.020
more layer of connective tissue this is known as endomysium so this is the

0:04:49.020,0:04:52.290
innermost layer of connective tissue now all these layers of connective

0:04:52.290,0:04:56.760
tissue work with the muscle because when the muscle shortens and basically

0:04:56.760,0:05:02.310
creates tension what happens is the
muscle pulls on the endomysium which

0:05:02.310,0:05:08.070
pulls on the perimysium which pulls on
the epimysium on the fascia and on the

0:05:08.070,0:05:12.750
tendon eventually this pulls on the bone
and we'll change the position of joints

0:05:12.750,0:05:17.669
so the connective tissues are extremely
important in helping muscle do its job

0:05:17.669,0:05:21.870
so this is another way the connective
tissues invest in the body and basically

0:05:21.870,0:05:25.830
form a connective tissue supporting
framework another example is the

0:05:25.830,0:05:29.310
connective tissues that are around the
heart around the heart if you remember

0:05:29.310,0:05:32.610
we have a couple of visceral membranes
remember we have a visceral pericardium

0:05:32.610,0:05:37.590
we also had a parietal pericardium the
heart is unique because it has an

0:05:37.590,0:05:42.419
additional layer on the outside known as
a fibrous pericardium this is a layer of

0:05:42.419,0:05:46.500
fairly dense fibrous connective tissue
and this does a couple of important

0:05:46.500,0:05:50.190
things for the heart on top of the heart
you'll notice these big blood vessels

0:05:50.190,0:05:54.479
one is called the superior vena cava the
other is the aorta the other is the

0:05:54.479,0:05:58.650

pulmonary trunk and these are known as
great vessels and if you look at the

0:05:58.650,0:06:03.120
fibrous pericardium you'll notice that
it goes up and around all these great

0:06:03.120,0:06:07.740
vessels one of the things this does is
help lock the great vessels in place on

0:06:07.740,0:06:12.000
top of the heart the other connection of
the fibrous pericardium is down here to

0:06:12.000,0:06:15.090
the diaphragm you can see this a little
bit better on the left side of this

0:06:15.090,0:06:19.140
slide right down here you'll notice the
fibrous connection between the bottom of

0:06:19.140,0:06:22.950
the heart or what we call the apex of
the heart to the diaphragm which is this

0:06:22.950,0:06:26.669
broad muscle if you remember this
separates the thorax from the abdomen

0:06:26.669,0:06:30.360
so this anchors the apex of the heart so
that when it beats the heart blue

0:06:30.360,0:06:33.240
doesn't flop around in the chest so
these are a couple of ways that

0:06:33.240,0:06:37.590
connective tissues support the rest of
the body now let's turn our attention to

0:06:37.590,0:06:41.710
muscle some of the characteristics of
muscle are that these are general

0:06:41.710,0:06:46.060
elongated cells the major property of
all muscle is what's known as

0:06:46.060,0:06:49.870
contractility each of the three types of
muscle that we see on the bottom of this

0:06:49.870,0:06:53.940
slide are all contractile that is they
all have the capability of generating

0:06:53.940,0:06:58.510
tension and if whatever they're
connected to is able to move it will

0:06:58.510,0:07:02.560
pull those things closer together now
muscle cells can also be called myocytes

0:07:02.560,0:07:07.330
myo- meaning muscle cyte- meaning cell
sometimes these are also known as muscle

0:07:07.330,0:07:11.970
fibers the reason for this is that
muscle cells typically are long and thin

0:07:11.970,0:07:16.990
inside the muscle we use actin and
myosin to accomplish the contraction and

0:07:16.990,0:07:20.920
we're going to take a very close look at
actin and myosin and their structure and

0:07:20.920,0:07:24.490
their function when we talk about muscle
a little bit later in the course let's

0:07:24.490,0:07:27.460
turn our attention to the three
different types of muscle and take a

0:07:27.460,0:07:30.580
look at each of them in turn
first of all skeletal muscle is attached

0:07:30.580,0:07:34.450
to bones we said this in the very first
lecture remember skeletal muscle is

0:07:34.450,0:07:38.980
called skeletal muscle because it's
attached to the skeleton this type of

0:07:38.980,0:07:44.080
muscle is what we call striated if you
look at this particular muscle cell

0:07:44.080,0:07:48.610

right here the long axis of this muscle cell goes this way

0:07:48.610,0:07:52.690
and you notice these stripes that go across the long axis of the muscle cell

0:07:52.690,0:07:57.550
these are known as striations and we'll talk about the origin of striations and

0:07:57.550,0:08:01.960
why we see those in a couple of minutes the other thing about skeletal muscle

0:08:01.960,0:08:06.400
remember this is a voluntary kind of muscle we consciously send impulses to

0:08:06.400,0:08:10.120
our skeletal muscle to have it contract some of the characteristics that you've

0:08:10.120,0:08:14.110
probably seen in lab or that skeletal muscle is multinucleated and it's

0:08:14.110,0:08:18.280
unbranched you'll notice in the light micrograph at the right we see a nucleus

0:08:18.280,0:08:22.600
in this muscle cell here we see another one over here in the adjacent muscle

0:08:22.600,0:08:26.800
cell that has one nucleus here one nucleus here so these are multinucleated

0:08:26.800,0:08:31.420
cells these are also unbranched you notice this straight tube of a muscle

0:08:31.420,0:08:36.130
cell that we see right here sends off no branches now like most other highly

0:08:36.130,0:08:40.660
differentiated or specialized cells skeletal muscle is incapable of cell

0:08:40.660,0:08:45.100
division but we can form some new fibers through the presence of some other cells

0:08:45.100,0:08:48.520
that remain outside the muscle cells
themselves we'll take a look at those in

0:08:48.520,0:08:51.670
a second another thing to think about is
that since these cells are

0:08:51.670,0:08:55.630
multinucleated think of how hard it
would be to coordinate

0:08:55.630,0:08:59.140
cell division or mitosis in a
multinucleated cell

0:08:59.140,0:09:03.940
so generally multinucleated cells are at
their terminal end of differentiation

0:09:03.940,0:09:07.960
and they don't divide any longer let's
take a look at where these skeletal

0:09:07.960,0:09:12.550
muscle cells arise and how they get to
be multinucleated here you'll see a

0:09:12.550,0:09:17.230
group of immature muscle cells these are
known as myoblasts-- these are the

0:09:17.230,0:09:21.730
progenitor cells that will eventually
give rise to the muscle cell if we have

0:09:21.730,0:09:26.980
a couple of these merged together they
will form a structure like this so this

0:09:26.980,0:09:31.890
is basically a couple of myloblasts
that have merged together to form a new

0:09:31.890,0:09:36.850
immature muscle fiber this continues and
you notice the immature muscle fiber

0:09:36.850,0:09:41.560
that we have right here this is the
beginnings of our mature muscle fibers

0:09:41.560,0:09:45.670

which we see over here this is how they become multinucleated they basically

0:09:45.670,0:09:51.220
fuse with other cells and the nuclei remain now you'll also notice in this

0:09:51.220,0:09:56.050
diagram that outside of this immature muscle fiber we have another cell here

0:09:56.050,0:10:00.910
that we term a satellite cell and a satellite cell is a progenitor cell that

0:10:00.910,0:10:05.530
can differentiate and produce additional muscle fibers in some cases when the

0:10:05.530,0:10:10.180
muscle is damaged now you'll notice in this muscle fiber that the nuclei lie

0:10:10.180,0:10:14.560
just inside the cell membrane however the satellite cells that we see over

0:10:14.560,0:10:19.330
here remain outside in other words the satellite cells stay outside the

0:10:19.330,0:10:23.020
individual muscle fibers so that if they have to they can differentiate to form

0:10:23.020,0:10:27.450
more immature muscle fibers and eventually generate new muscle fibers

0:10:27.450,0:10:31.750
now when we look at a skeletal muscle cell or what we call a muscle fiber

0:10:31.750,0:10:36.970
these are very very long cells inside then they have these structures that are

0:10:36.970,0:10:43.240
known as myofibrils these are long tubes as you see here and each myofibril is

0:10:43.240,0:10:47.710
capable of getting shorter that is contracting so we have a bunch of

0:10:47.710,0:10:52.990
myofibrils inside the muscle cell all of
them usually contract at the same time

0:10:52.990,0:10:57.670
and what these basically will do is
shorten the entire muscle cell and that

0:10:57.670,0:11:00.940
will cause contraction of the muscle
cell that will eventually pull on the

0:11:00.940,0:11:05.620
connective tissue fibers which will
eventually pull on the bone muscle cells

0:11:05.620,0:11:09.340
can be extremely long the length can be
up to maybe 30 centimeters or

0:11:09.340,0:11:12.850
a foot or so now if you look at the
diagram on the right you'll see an

0:11:12.850,0:11:18.670
electron micrograph illustrating the
basic unit of structure and function in

0:11:18.670,0:11:24.910
skeletal muscle this is known as the
sarcomere and a sarcomere extended from

0:11:24.910,0:11:31.090
here to here that's one sarcomere the
next sarcomere goes from here to here so

0:11:31.090,0:11:34.960
there are multiple sarcomeres you notice
that the sarcomeres are attached and if

0:11:34.960,0:11:38.410
we look back at the myofibrils in this
diagram up here you'll see that this has

0:11:38.410,0:11:44.320
dark light dark light bands this would
be a dark band light band dark band

0:11:44.320,0:11:49.780
light band so the striations that we see
in a muscle cell here under the

0:11:49.780,0:11:53.890

microscope for example are generated by the overlap of actin and myosin

0:11:53.890,0:11:58.090
filaments as we'll talk about later in the construction of sarcomeres

0:11:58.090,0:12:02.800
which are basically alternate banding patterns of non overlap overlap non

0:12:02.800,0:12:06.640
overlap overlap where they overlap we have dark areas where there's a non

0:12:06.640,0:12:10.630
overlap we have light areas we're gonna talk much more about that when we come

0:12:10.630,0:12:14.680
to muscle you know our muscle cell lectures so let me talk a little bit

0:12:14.680,0:12:18.730
about the way skeletal muscle actually works if you look at the diagram on the

0:12:18.730,0:12:22.330
right side you'll notice that this particular muscle which is called the

0:12:22.330,0:12:26.920
biceps brachii on the upper arm is attached here at the shoulder and also

0:12:26.920,0:12:32.260
has some tendinous attachments down here on the forearm now in order for a muscle

0:12:32.260,0:12:37.120
to move a joint like this at the elbow were to move the joint at the shoulder

0:12:37.120,0:12:41.470
that muscle has to cross that joint in other words it has to go over that joint

0:12:41.470,0:12:46.180
somehow and we see that happening here in fact one of the main functions of the

0:12:46.180,0:12:50.890
biceps brachii muscle is to flex the elbow that is to raise the forearm and

0:12:50.890,0:12:57.160
so imagine holding this area of the body
completely still and allowing this end

0:12:57.160,0:13:02.500
to move when this muscle shortens or
contracts and pulls up this way it will

0:13:02.500,0:13:06.970
basically pull on these tissues here and
move this up so it will raise the

0:13:06.970,0:13:12.100
forearm up this way now remember this
job is not just accomplished by muscle

0:13:12.100,0:13:16.000
alone it's accomplished by the
combination of muscle and connective

0:13:16.000,0:13:20.830
tissue as we said before so we have
those individual myofibrils contracting

0:13:20.830,0:13:25.040
they in turn pull on the endomysium
we said then on the perimysium the

0:13:25.040,0:13:29.990
epimysium the fasciae eventually the
tendon and ultimately the bone and when

0:13:29.990,0:13:33.440
this pulls on the bone here in the
forearm that will raise the forearm and

0:13:33.440,0:13:38.420
change the position of the elbow joint
so this is a general way that the

0:13:38.420,0:13:41.210
muscles work we're going to talk much
more about this a little bit later on in

0:13:41.210,0:13:45.350
the course the next type of muscle is
smooth muscle and the reason we call

0:13:45.350,0:13:50.270
smooth muscle smooth muscle is because
it does not have striations so we don't

0:13:50.270,0:13:53.510

see any striations under the microscope
does you'll notice that these muscle

0:13:53.510,0:13:59.180
cells are long thin type cells with no
striations these cells typically have a

0:13:59.180,0:14:03.740
single nucleus and most often it's
centrally located within the cell this

0:14:03.740,0:14:09.710
is also an unbranched type of muscle and
very importantly this is an involuntary

0:14:09.710,0:14:14.930
type of muscle in other words this type
of muscle contracts by itself we don't

0:14:14.930,0:14:19.940
issue it conscious commands to contract
it normally does this by itself we find

0:14:19.940,0:14:24.500
this type of muscle in the walls of
organs and also in some blood vessels we

0:14:24.500,0:14:27.530
find it in the skin and we're going to
come back and talk about these things as

0:14:27.530,0:14:32.240
we come to those different systems and
organs in the body now smooth muscle

0:14:32.240,0:14:36.590
cells normally don't divide but they can
if there's a need to regenerate tissue a

0:14:36.590,0:14:41.360
good example of this is in the uterus
the uterus is very small when there's no

0:14:41.360,0:14:45.410
fetus in it but over the course of nine
months it has to expand to quite a

0:14:45.410,0:14:49.880
larger size and one of the ways this
happens is not only by expansion of the

0:14:49.880,0:14:55.250
muscle fibers that exist there but
generation of new muscle fibers now if

0:14:55.250,0:14:58.580
we look at a section of smooth muscle
you'll actually see that the arrangement

0:14:58.580,0:15:04.730
of actin and myosin filaments is unlike
what we saw in skeletal muscle so this is

0:15:04.730,0:15:08.810
arranged in more or less a crisscross
pattern in the smooth muscle cells

0:15:08.810,0:15:13.160
rather than a linear pattern where we
had overlapped before skeletal muscle

0:15:13.160,0:15:17.810
now when the smooth muscle is relaxed it
looks more or less like this and when

0:15:17.810,0:15:22.160
it's contracted it looks like this one
of the functions of a smooth muscle cell

0:15:22.160,0:15:26.930
is that it more or less corkscrews when
it contracts this is very useful for the

0:15:26.930,0:15:31.610
organs in which we have smooth muscle
located the intestines for example the

0:15:31.610,0:15:35.180
stomach some of the blood vessels
another thing you'll notice here too is

0:15:35.180,0:15:39.709
that smooth muscle cell
have gap junctions which connect one

0:15:39.709,0:15:43.579
muscle cell to the adjacent muscle cell
these are important because typically

0:15:43.579,0:15:48.379
when we contract one smooth muscle cell
we'd like the adjacent muscle cells to

0:15:48.379,0:15:52.819
contract as well and the gap junctions
if you remember provide a passageway for

0:15:52.819,0:15:59.600

small molecules and ions very rapidly
between cells the last type of muscle we

0:15:59.600,0:16:03.980
want to talk about is cardiac muscle
cardiac muscle cells are also called

0:16:03.980,0:16:09.110
cardiocytes sometimes cardiac myocytes
sometimes called myocardial cells all of

0:16:09.110,0:16:14.089
these refer to cardiac muscle type cells
these are found in the heart wall or

0:16:14.089,0:16:18.439
what we call the myocardium of the heart
and very importantly these cells are

0:16:18.439,0:16:23.240
involuntary and autorhythmic involuntary
just like smooth muscle in the sense

0:16:23.240,0:16:27.769
that we don't send conscious commands to
the heart to beat fortunately and it's

0:16:27.769,0:16:31.699
autorhythmic in the sense that if we
took cardiac muscle cells out

0:16:31.699,0:16:35.600
of the body and gave them enough oxygen
and nutrients these would not only

0:16:35.600,0:16:40.100
contract all by themselves but they
would do so at a certain rhythm and so

0:16:40.100,0:16:44.360
we call those autorhythmic now these
cells are striated so as you might guess

0:16:44.360,0:16:48.889
these have sarcomeres and in fact they
do so we can see some of the striations

0:16:48.889,0:16:53.059
here in the diagrams on the bottom so
these are the thin lines going across

0:16:53.059,0:16:58.430
the long axis of the muscle cells these
cells have something called intercalated

0:16:58.430,0:17:03.439
discs very important in cardiac muscle
cell because only cardiac muscle cell

0:17:03.439,0:17:08.089
has intercalated discs so it's one way
for you to tell cardiac muscle cell from

0:17:08.089,0:17:12.409
others these dark lines that you see
down here in this diagram and the dark

0:17:12.409,0:17:15.140
lines that you see over here in the
light micrograph these are all

0:17:15.140,0:17:20.449
intercalated discs now if we look at one
single cardiac muscle cell it would

0:17:20.449,0:17:26.480
extend all the way from here over to
here down here around and all here all

0:17:26.480,0:17:30.740
of that that I've traced out is one
cardiac muscle cell you'll notice that

0:17:30.740,0:17:34.820
it sends off a branch so this is the
main axis of this muscle cell and

0:17:34.820,0:17:38.750
there's a branch that goes right down
here so we say that cardiac muscle is

0:17:38.750,0:17:43.399
branched for that reason typically
cardiac muscle cells will have one

0:17:43.399,0:17:48.470
nucleus and usually this will be located
in the center now in this view of

0:17:48.470,0:17:50.340
cardiac muscle we can get a better look
at an

0:17:50.340,0:17:54.020
intercalated disk and we'll talk about
that in a second and exactly what it is

0:17:54.020,0:17:59.070

you can see once again that we have striations here and here so all these

0:17:59.070,0:18:02.940
dark light dark light banding patterns are what we'd see under the microscope

0:18:02.940,0:18:09.059
as striations now cardiac muscle is almost totally dependent upon aerobic

0:18:09.059,0:18:13.860
metabolism that is it needs a constant supply of oxygen in order to metabolize

0:18:13.860,0:18:18.690
so anytime cardiac muscle is without blood which means it's without oxygen

0:18:18.690,0:18:24.539
for any length of time these muscle cells can die very quickly another fact

0:18:24.539,0:18:29.490
about cardiac muscle is the intercalated discs consist of gap junctions as well

0:18:29.490,0:18:34.770
as desmosomes the gap junctions allow rapid transit of molecules from one

0:18:34.770,0:18:39.090
cardiac muscle cell to the next and the desmosomes connect the adjacent

0:18:39.090,0:18:43.559
cardiac muscle cells together tightly so that they don't come apart as the heart

0:18:43.559,0:18:47.700
beats now an interesting fact about cardiac muscle is that it's regenerative

0:18:47.700,0:18:52.980
capacity or capability is limited it has no satellite cells like skeletal muscle

0:18:52.980,0:18:57.059
does here you can get a look at a little bit of connective tissue that separates

0:18:57.059,0:19:02.309
two adjacent cardiac muscle cells in fact the fibroblasts in the connective

0:19:02.309,0:19:07.350
tissue will repair damage to heart
muscle so let's say that a heart muscle

0:19:07.350,0:19:11.039
is without oxygen without blood for a
little while and the heart muscle cells

0:19:11.039,0:19:14.100
start to die
well that would leave kind of a hole in

0:19:14.100,0:19:17.730
the heart if you will in the place where
the cardiac muscle cell should have been

0:19:17.730,0:19:22.830
and what fills that gap in so to speak
are the fibroblasts then lay down new

0:19:22.830,0:19:27.419
collagen and they will fill the damaged
area in so once again cardiac muscle

0:19:27.419,0:19:31.710
cannot repair itself any damage in the
heart is replaced by fibrous connective

0:19:31.710,0:19:36.510
tissue and we call that scarring nervous
tissue we're going to talk about pretty

0:19:36.510,0:19:40.559
extensively in the last quarter of the
course so we're not going to go into

0:19:40.559,0:19:46.140
very much detail here the large cells
that you see are neurons and there are

0:19:46.140,0:19:50.370
smaller cells outside which we call
neuroglial cells let's take a brief look

0:19:50.370,0:19:54.570
at these we find nervous tissue in the
brain spinal cord and peripheral nerves

0:19:54.570,0:20:00.179
and this main function is conduction of
nerve impulses remember that the nervous

0:20:00.179,0:20:03.820

system is a very rapidly acting
short-term control system of the body

0:20:03.820,0:20:09.279
and nerve impulses really are at the
heart of that control the basic cells as

0:20:09.279,0:20:13.679
we see below are neurons these are the
large star-shaped cells that we see here

0:20:13.679,0:20:17.499
neurons also function in sensory
reception as we'll talk about in the

0:20:17.499,0:20:21.999
very last lectures of A&P one and
finally the small cells that we see out

0:20:21.999,0:20:28.359
here are known as neuroglial cells some
of the functions of neuroglia are to

0:20:28.359,0:20:32.409
maintain the physical structure around
neurons and here once again you can get

0:20:32.409,0:20:37.119
a look at some of these neuroglial cells
the smaller cells that exist outside the

0:20:37.119,0:20:42.129
neurons they operate more or less like a
connective tissue would outside the

0:20:42.129,0:20:47.440
nervous system so they form a support
structure they form a framework they can

0:20:47.440,0:20:52.330
repair the framework around here after
injury and finally a unique function of

0:20:52.330,0:20:56.259
the neuroglia is that they actually
control the environment around neurons

0:20:56.259,0:20:59.649
so that the neurons function the way
they should function now we're not going

0:20:59.649,0:21:02.409
to talk about the structure of the
neuron here we're going to hold off on

0:21:02.409,0:21:07.389
this until we get to the nervous system
a little later in the course the last

0:21:07.389,0:21:10.749
topic we want to talk about is
inflammation this is a very very

0:21:10.749,0:21:14.489
important topic
not only for us but clinically

0:21:14.489,0:21:19.450
inflammation is at the heart of many
different diseases disorders discomfort

0:21:19.450,0:21:24.039
in patients so this is really a very
important topic one of the things I want

0:21:24.039,0:21:28.629
you to notice on the bottom of the slide
is that tissue just like any other

0:21:28.629,0:21:32.409
system in the body has to be in
homeostasis that is it has to be

0:21:32.409,0:21:36.729
functioning the way it should without
any kind of damage any time that we have

0:21:36.729,0:21:41.529
a disturbance of homeostasis for example
we have some injury or we have

0:21:41.529,0:21:46.179
infections what we have to do is bring
that tissue back into homeostasis and

0:21:46.179,0:21:51.879
the way that's done is two steps one
step is called inflammation the second

0:21:51.879,0:21:56.529
step is repair now it's important for
you to realize that the order of these

0:21:56.529,0:22:01.149
is critical whenever we have tissue
homeostasis disturbed the very first

0:22:01.149,0:22:05.379

thing we have to do is carry out
inflammation and only then can we carry

0:22:05.379,0:22:10.059
out repair of the tissue let's look at
why let's say that we've sustained some

0:22:10.059,0:22:14.109
type of injury in the body there are
many different kinds of injury many

0:22:14.109,0:22:17.230
different kinds of tissue homeostasis
disturbance

0:22:17.230,0:22:21.070
but in general what we have whenever we
have tissue injury are these things

0:22:21.070,0:22:24.520
happening we may have an increased
concentration of pathogens or

0:22:24.520,0:22:29.620
disease-causing organisms we may have an
increase in toxins in the area we may

0:22:29.620,0:22:34.120
have an increased in waste products we
may have some additional chemicals from

0:22:34.120,0:22:37.840
the injured cells so these are soluble
things that injured cells release and

0:22:37.840,0:22:43.390
any or all of these things can stimulate
this cell type down here that we have

0:22:43.390,0:22:48.580
not yet talked about this is known as a
mast cell and in the mast cell you'll

0:22:48.580,0:22:53.980
notice very obviously this has some
really large granules that contain

0:22:53.980,0:22:58.000
chemicals the major chemical that we're
going to talk about is known as

0:22:58.000,0:23:02.710
histamine okay so these granules contain
the chemical histamine as well as

0:23:02.710,0:23:07.120
heparin and some other chemicals and
whenever a mast cell is stimulated by

0:23:07.120,0:23:12.400
any of these injury factors it basically
will degranulate and release these

0:23:12.400,0:23:16.030
chemicals into the surrounding
environment so let's take a look at what

0:23:16.030,0:23:20.200
exactly histamine does there are two
important things that you need to know

0:23:20.200,0:23:25.270
about histamine one thing is that it
increases blood flow the second is that

0:23:25.270,0:23:30.669
it increases blood vessel permeability
so by increasing blood flow we're going

0:23:30.669,0:23:34.870
from a blood vessel like this to a blood
vessel like this in other words the

0:23:34.870,0:23:38.890
radius of the blood vessel the diameter
the blood vessel has gotten bigger and

0:23:38.890,0:23:42.490
this will allow more blood to come into
an area so this is what we mean by

0:23:42.490,0:23:47.620
increased blood flow the second property
of histamine is that it increases blood

0:23:47.620,0:23:52.150
vessel permeability if we look at the
wall of a blood vessel we see that there

0:23:52.150,0:23:57.040
are endothelial cells and between the
endothelial cells in the blood vessel we

0:23:57.040,0:23:59.679
have very small gaps
you'll notice that I'm drawing these

0:23:59.679,0:24:04.750

with gaps and out of these gaps we can have fluid go and small molecules and

0:24:04.750,0:24:10.330
those sort of things however when the blood vessel permeability increases what

0:24:10.330,0:24:14.740
we have instead is we have blood vessels that look like this now there are very

0:24:14.740,0:24:19.660
large gaps between the endothelial cells and not only can we have fluid come out

0:24:19.660,0:24:25.419
but many times we can also have cells exit the blood vessels here so the

0:24:25.419,0:24:29.169
increase in blood vessel permeability leads to increase fluid coming out into

0:24:29.169,0:24:34.090
the tissue area also allows increased exit of blood cells into the

0:24:34.090,0:24:38.919
tissue as well what that does is a few different things for us the increased

0:24:38.919,0:24:43.389
blood flow the increased blood vessel permeability increases oxygen and

0:24:43.389,0:24:48.279
nutrients in the area of damage it increases the number of phagocytes there

0:24:48.279,0:24:51.519
are cells that are called neutrophils in the blood that come out they're very

0:24:51.519,0:24:56.049
actively phagocytic monocytes that can differentiate into macrophages like we

0:24:56.049,0:24:59.740
talked about before these cells are phagocytic and can basically get rid of

0:24:59.740,0:25:04.149
any kind of debris microorganisms that might exist in a tissue and finally

0:25:04.149,0:25:08.080
because we have an increase in the flow
of blood this serves to flush the

0:25:08.080,0:25:13.570
damaged area and remove more toxins and
waste products now as a result of all

0:25:13.570,0:25:18.159
these things what we can do is
eventually come back and be able to

0:25:18.159,0:25:23.019
repair the tissue once we effect tissue
repair all of these things that we saw

0:25:23.019,0:25:27.009
on top that started this whole process
will decrease we decreased tissue

0:25:27.009,0:25:31.240
concentrations of pathogens toxins waste
products chemicals from the injured

0:25:31.240,0:25:37.210
cells and this serves as an inhibitory
signal from mast cells so this is really a

0:25:37.210,0:25:41.470
classic negative feedback loop now
something else that I would like you to

0:25:41.470,0:25:45.159
know are the major signs or cardinal
signs of inflammation

0:25:45.159,0:25:50.860
these include redness heat pain swelling
and loss of function so there are five

0:25:50.860,0:25:56.200
major signs of inflammation the first
one redness is caused by an increased

0:25:56.200,0:25:58.570
blood flow
remember histamine caused an increased

0:25:58.570,0:26:02.169
blood flow anytime we have an increased
blood flow into an area that area

0:26:02.169,0:26:06.580

appears more reddish heat also is due to
increased blood flow we're bringing

0:26:06.580,0:26:10.570
blood from deep in the body up to the
surface or the inflamed area this causes

0:26:10.570,0:26:15.490
it to be warmer swelling is also a
consequence of increased blood vessel

0:26:15.490,0:26:21.009
permeability anytime the vessels become
more leaky and can leak more fluid that

0:26:21.009,0:26:25.840
causes the tissues to accumulate more
fluid and swell now pain is caused by a

0:26:25.840,0:26:30.190
couple of different things there are
soluble mediators like bradykinin even

0:26:30.190,0:26:33.999
histamine can actually activate nerve
endings and cause some pain there were

0:26:33.999,0:26:38.919
also products like prostaglandins that
can cause pain now loss of function can

0:26:38.919,0:26:42.669
be caused by several things one of the
things this can be caused by is by

0:26:42.669,0:26:44.800
swelling you know yourself that if
you've ever

0:26:44.800,0:26:49.090
had a bad injury and the area swelled it
became more difficult to move it for

0:26:49.090,0:26:54.160
example the joint or something like that
another mechanism of loss of function is

0:26:54.160,0:26:58.840
pain so if it's painful to move a joint
or it's painful to do something in the

0:26:58.840,0:27:03.100
body we don't do it and so this would
cause a loss of function as well now

0:27:03.100,0:27:08.650
anytime we inflame a tissue in the body
we tack on the suffix 'itis' to indicate

0:27:08.650,0:27:12.250
that it's inflamed for example if we
have an inflammation in the skin we will

0:27:12.250,0:27:16.570
call that dermatitis if we have an
inflammation in the joint we would call

0:27:16.570,0:27:22.000
that arthritis so really any tissue in
the body we tack on the suffix 'itis' and

0:27:22.000,0:27:25.980
this would indicate that the tissue is
undergoing some type of inflammation

0:27:25.980,0:27:29.770
this is a nice slide for a couple of
reasons it shows things a little bit

0:27:29.770,0:27:35.350
more clearly if you look on the right
side you'll see a mast cell in loose

0:27:35.350,0:27:39.910
areolar connective tissue and you can
see the size of these enormous granules

0:27:39.910,0:27:42.730
these are the ones that contain
histamine and heparin a number of other

0:27:42.730,0:27:47.470
things and when the mast cell is
stimulated by damage all the granules in

0:27:47.470,0:27:52.210
this will be released and go into the
tissue in the surrounding area now if

0:27:52.210,0:27:55.210
you look on the left you'll see an
example of an inflammatory response

0:27:55.210,0:27:59.830
being stimulated by a splinter that
splinter happens to have some bacteria

0:27:59.830,0:28:04.330

on the end of it so these are being
introduced into the tissue as well now

0:28:04.330,0:28:07.870
when the tissue gets damaged remember
that this is going to release soluble

0:28:07.870,0:28:13.060
chemicals that are going to activate
mast cells as we see down here and the

0:28:13.060,0:28:16.750
mast cells will release histamine
heparin a number of other chemicals and

0:28:16.750,0:28:21.250
one of the things these chemicals do as
we said is they increase the diameter of

0:28:21.250,0:28:24.580
blood vessels so the blood vessels in
the area vasodilate

0:28:24.580,0:28:29.410
the other thing is that they increase
permeability meaning that the spaces

0:28:29.410,0:28:32.800
between the endothelial cells get a
little bit bigger and they allow the

0:28:32.800,0:28:37.900
cells from inside the blood to come into
the tissues so here we see several cells

0:28:37.900,0:28:42.280
coming into the tissue these cells are
maybe phagocytic and you see one

0:28:42.280,0:28:47.950
engulfed in a bacterium over here these
cells will clean up the debris take away

0:28:47.950,0:28:53.320
the toxins the bacteria the pathogens
and ultimately this will set up the area

0:28:53.320,0:28:56.650
so that we can repair it so this will
set up tissue repair

0:28:56.650,0:29:00.240
remember inflammation is the first
it has to happen when we disturb tissue

0:29:00.240,0:29:05.520
homeostasis the second thing is tissue
repair now the last thing I want to talk

0:29:05.520,0:29:08.370
about just very briefly and this is not
really something you have to know for

0:29:08.370,0:29:11.700
the exam but I want to mention this
because these compounds called

0:29:11.700,0:29:15.840
eicosanoids are so important in clinical
pain management and management of

0:29:15.840,0:29:20.670
patients eicosanoids are chemicals that
are generated from the cell membrane in

0:29:20.670,0:29:25.200
fact from the phospholipids of the cell
membrane in tissues we have an enzyme

0:29:25.200,0:29:29.310
called phospholipase a2 and what that
can do is convert some of these

0:29:29.310,0:29:34.020
phospholipids into a compound that's
known as arachidonic acid this is the

0:29:34.020,0:29:37.520
starting point for these other
eicosanoids that we're going to look at

0:29:37.520,0:29:44.220
the reason we call these eicosanoids is
because 'eicosa' means 20 typically

0:29:44.220,0:29:47.940
these are 20 carbon or 21 carbon
containing compounds so we call those

0:29:47.940,0:29:51.720
eicosanoids
now arachidonic acid through the action

0:29:51.720,0:29:55.050
of a couple of different enzymes can be
converted into a number of different

0:29:55.050,0:29:57.960

things
one of those is leukotrienes as you see

0:29:57.960,0:30:01.440
down here these are very important in
activating leukocytes or white blood

0:30:01.440,0:30:06.600
cells in the blood also lymphocytes an
example is Leukotriene b4 so there

0:30:06.600,0:30:10.610
are multiple classes of these there's
another enzyme called cyclooxygenase

0:30:10.610,0:30:16.200
that creates compounds such as
thromboxanes prostacyclin prostaglandins

0:30:16.200,0:30:19.980
and in particular prostaglandins are
some of the things in the body that

0:30:19.980,0:30:24.000
cause pain in addition to the bradykinins that we talked about in
addition

0:30:24.000,0:30:28.800
to histamine prostaglandins can also
cause pain in an area see an example of

0:30:28.800,0:30:33.960
one prostaglandin here called PGF 2
alpha interesting to note that we can

0:30:33.960,0:30:38.250
interfere with these pathways through
the action of certain drugs for example

0:30:38.250,0:30:43.530
taking an aspirin or ibuprofen which is
a non-steroidal anti-inflammatory drug

0:30:43.530,0:30:47.640
can interfere with the action of
cyclooxygenase which is abbreviated c-o-x

0:30:47.640,0:30:52.440
or Cox when we take aspirin or ibuprofen
this interferes with the conversion of

0:30:52.440,0:30:56.940
arachidonic acid into thromboxanes
prostacyclin prostaglandins and so

0:30:56.940,0:31:00.390
because we're blocking the production of
prostaglandins we can sometimes block

0:31:00.390,0:31:05.550
the pain as well now if inflammation is
chronic one of the things that can be

0:31:05.550,0:31:10.080
done is to give a patient steroidal
anti-inflammatory drugs or SAIDS

0:31:10.080,0:31:15.120
this would be for example cortisol
hydrocortisone this as you see blocks

0:31:15.120,0:31:18.330
the pathway a little bit further up and
prevents the conversion of phospholipids

0:31:18.330,0:31:22.019
from the cell membrane into arachidonic
acid in the first place

0:31:22.019,0:31:26.370
ultimately what this does is it prevents
the creation of leukotrienes and it also

0:31:26.370,0:31:31.019
prevents the creation of this now that
might be good the only problem is that

0:31:31.019,0:31:36.240
when we prevent creation of things like
leukotrienes we also reduce the

0:31:36.240,0:31:40.919
efficiency of the immune system so
anytime somebody's on a long course of

0:31:40.919,0:31:45.659
steroids one of the side effects is that
the immune system function can be

0:31:45.659,0:31:49.580
decreased and that patient can be open
to more kinds of infections

0:31:49.580,0:31:53.519
the last thing I'll remind you of is
that the inflammatory process and

0:31:53.519,0:31:57.779

inflammation is a natural and healthy
process of the body to restore

0:31:57.779,0:32:02.460
homeostasis so we normally shouldn't
interfere with it by taking drugs

0:32:02.460,0:32:06.600
however the times that these kind of
drugs are useful is when the

0:32:06.600,0:32:11.820
inflammatory process has gone on too
long or has become too severe and may

0:32:11.820,0:32:16.350
cause damage to the body rather than
causing healing of the body so there are

0:32:16.350,0:32:20.100
some cases where we do want to block the
inflammatory process but for the most

0:32:20.100,0:32:23.789
part when there's a minor inflammatory
process going on we should really let

0:32:23.789,0:32:27.809
that process run its course because
that's the first step toward tissue

0:32:27.809,0:32:33.450
repair and tissue homeostasis okay so
that finishes up lecture 11 I will see

0:32:33.450,0:32:35.750
you in class