

CNS Part 2 - Meninges and Ventricles of the Brain

0:00:00.770,0:00:05.220

welcome to lecture 19 part 2 in this lecture we're going to talk about the

0:00:05.220,0:00:08.940

meninges which are coverings of the brain in the spinal cord we're also

0:00:08.940,0:00:12.690

going to talk about the ventricles which we mentioned in part 1 these are fluid

0:00:12.690,0:00:18.119

filled chambers that produce and circulate the cerebrospinal fluid and so

0:00:18.119,0:00:24.150

we'll talk about those this is from chapter 12 in Marieb so let's talk a

0:00:24.150,0:00:26.039

little bit about the protection of the brain

0:00:26.039,0:00:30.269

obviously the brain is so important that it has to be well protected and there

0:00:30.269,0:00:34.200

really are two different mechanisms by which the brain is protected there are

0:00:34.200,0:00:40.050

physical mechanisms and here they're indicated as being mechanical and what

0:00:40.050,0:00:44.309

we're talking about are the skull bones and the meninges which we're going to

0:00:44.309,0:00:47.579

cover here these are more or less connective tissue coverings around the

0:00:47.579,0:00:52.800

brain and then also the cerebral spinal fluid the cerebral spinal fluid not only

0:00:52.800,0:00:57.539

nourishes the nervous system tissue but it also serves as kind of a shock

0:00:57.539,0:01:01.800
absorber around the brain
so the cerebral spinal fluid surrounds

0:01:01.800,0:01:05.909
the entire brain and keeps it from
banging up against the skull bones so

0:01:05.909,0:01:10.380
these are physical or mechanical
protections of the brain the brain is

0:01:10.380,0:01:14.010
also protected physiologically by
something that's known as the

0:01:14.010,0:01:21.299
blood-brain barrier and what this is is
that the vessels the capillaries that

0:01:21.299,0:01:26.640
surround the brain are interconnected by
tight junctions and if you remember from

0:01:26.640,0:01:30.540
what we talked about when we talked
about epithelial tissues tight junctions

0:01:30.540,0:01:36.299
are junctions that do not allow fluid to
go between the cells instead they force

0:01:36.299,0:01:40.619
fluids to go through the cells and
certainly this is the case here we

0:01:40.619,0:01:43.979
wouldn't want just anything that's
circulating around the brain to be able

0:01:43.979,0:01:48.600
to get into the brain so these can be
more highly selective and we also have

0:01:48.600,0:01:53.430
glial cells including astrocytes and
ependymal cells that control the

0:01:53.430,0:01:57.990
permeability of not only the general
capillaries but the capillaries of the

0:01:57.990,0:02:02.479
choroid plexuses that will make the

cerebral spinal fluid so these are two

0:02:02.479,0:02:06.540

physiological mechanisms by which the brain is protected biochemically and

0:02:06.540,0:02:12.030

this is called the blood-brain barrier this can actually be an obstacle to the

0:02:12.030,0:02:15.689

delivery of drugs into the brain for example if someone has an

0:02:15.689,0:02:19.890

encephalitis which is an inflammation in the brain a clinician has to be aware of

0:02:19.890,0:02:23.939

which drugs can get into the brain and which ones can't so that the infection

0:02:23.939,0:02:28.829

can be resolved and also it seems that the blood-brain barrier becomes more

0:02:28.829,0:02:33.540

permeable during times of stress so this would allow maybe more things to get

0:02:33.540,0:02:38.280

into the brain then could otherwise get through so these are mechanisms of

0:02:38.280,0:02:43.170

protection of the brain and what we're going to focus on here are the meninges

0:02:43.170,0:02:47.459

of the brain so these are as I said more or less the connective tissue coverings

0:02:47.459,0:02:51.359

of the brain now if we look at the skull on the upper left you'll see we take a

0:02:51.359,0:02:57.269

section of the skull and the brain and that blow up you see here and basically

0:02:57.269,0:03:01.200

what we're looking at is the scalp is on the outside have you see as you see here

0:03:01.200,0:03:05.939
so this is the skin and then inside that
we would have the periosteum of the

0:03:05.939,0:03:10.260
skull bone so here would be the bone of
the skull and the periosteum that

0:03:10.260,0:03:13.560
surrounds it remember this is a dense
irregular connective tissue that

0:03:13.560,0:03:19.440
surrounds bone in the body then below
that we have the meninges so here we

0:03:19.440,0:03:24.599
have the scalp and then we would have
what constitutes the skull bones here we

0:03:24.599,0:03:29.400
would have the meninges and finally we
have the brain itself over here and

0:03:29.400,0:03:33.209
we're going to talk about the three
meninges that we have and talk about how

0:03:33.209,0:03:36.959
they're constructed and basically what
they're for now when we talk about

0:03:36.959,0:03:41.310
meninges we're using the term in plural
and if you look at the lower right

0:03:41.310,0:03:46.709
you'll see that the singular of meninges
is this word meninx, so meninx is a

0:03:46.709,0:03:53.549
singular of meninges so let's take a
look at the meninges themselves so once

0:03:53.549,0:03:58.620
we get below the bone of the skull which
is right here the first or outer meninx

0:03:58.620,0:04:05.250
is called the dura mater dura means
tough, mater means mother in Latin so

0:04:05.250,0:04:08.939
literally tough mother probably not the

way you're thinking about it though it's

0:04:08.939,0:04:13.470

more in the form of a tough nurturer of the brain which is why they use the term

0:04:13.470,0:04:18.539

mater and this is a very tough layer that's about the thickness of a kitchen

0:04:18.539,0:04:22.740

rubber glove so it's a very thick layer hopefully you'll be able to see this

0:04:22.740,0:04:26.849

when you dissect sheep brains in the laboratory if you pull on it you'll see

0:04:26.849,0:04:29.550

that it's a very very tough layer and the dura

0:04:29.550,0:04:33.090

mater in the vicinity of the brain has two layers as you see here there's an

0:04:33.090,0:04:37.289

outer layer called the periosteal layer an inner layer called the meningeal

0:04:37.289,0:04:42.090

layer let's take a closer look at these this layer that you see in gray here

0:04:42.090,0:04:47.460

right below the skull bone is the periosteum layer so for obvious reasons

0:04:47.460,0:04:51.599

this is more or less adherent to the skull bone so it forms more or less a

0:04:51.599,0:04:57.150

periosteum around that the tan looking layer that's here is the meningeal layer

0:04:57.150,0:05:02.520

of the dura mater the outer tough anchoring fold and you'll notice that in

0:05:02.520,0:05:07.740

the vicinity of the longitudinal fissure it separates from the periosteal layer

0:05:07.740,0:05:11.789
and it actually goes down between the
two cerebral hemispheres and if you

0:05:11.789,0:05:15.180
remember that area between the two
cerebral hemispheres we referred to as

0:05:15.180,0:05:19.949
the longitudinal fissure or gap between
those hemispheres you'll notice that

0:05:19.949,0:05:24.930
because it separates from the periosteal
there it forms this structure here which

0:05:24.930,0:05:31.259
is known as a sinus and the sinus really
is a big vein and we have several of

0:05:31.259,0:05:34.770
these in the brain which we'll see in
the next slide and this is an area where

0:05:34.770,0:05:38.849
we have blood that's collected that's
going to be returned to the heart as

0:05:38.849,0:05:43.620
well as cerebrospinal fluid that's going
to be returned to the heart and so we'll

0:05:43.620,0:05:48.289
take a look at those a couple of where
those sinuses are in the next slide so

0:05:48.289,0:05:53.219
that's the outer layer which is called
the dura mater the next layer down is

0:05:53.219,0:05:58.349
referred to as the arachnoid mater and
this is the middle layer of the meninges

0:05:58.349,0:06:04.530
and you probably know that arachnid
means spider or spider-like and you'll

0:06:04.530,0:06:09.240
notice that this layer here which is
this very thin transparent layer has

0:06:09.240,0:06:14.070
these small tiny projections coming down

from it these are delicate projections

0:06:14.070,0:06:16.800
that connect to the next layer down
which we're going to look at in a second

0:06:16.800,0:06:21.419
called the pia and so this is called the
arachnoid because these look like spider

0:06:21.419,0:06:28.289
webs and you notice that this has a big
space in it and in the space below here

0:06:28.289,0:06:32.789
we have the circulation of cerebrospinal
fluid in what we call the subarachnoid

0:06:32.789,0:06:37.800
space now the dura that we just talked
about does also have a subdural space

0:06:37.800,0:06:43.050
however this is normally very very thin
it's a very thin layer of fluid almost

0:06:43.050,0:06:47.520
non-existent and the subdural space as
you see below is filled with fluid

0:06:47.520,0:06:51.450
that's more like interstitial fluid that
is the fluid that's between cells

0:06:51.450,0:06:56.910
however below the arachnoid mater down
here in the subarachnoid space we have

0:06:56.910,0:07:01.230
cerebral spinal fluid this has a
definite chemical composition different

0:07:01.230,0:07:06.030
than that of interstitial fluid and then
the innermost layer of the meninges is

0:07:06.030,0:07:11.460
called the Pia mater and this refers to
delicate so Pia means delicate this

0:07:11.460,0:07:15.480
layer is as you see right here directly
adherent to the tissue of the brain

0:07:15.480,0:07:19.620
itself you'll notice some blood vessels
here these are within the subarachnoid

0:07:19.620,0:07:23.850
space so not only do we have cerebral
spinal fluid there we also have some

0:07:23.850,0:07:29.010
blood vessels now as we talked about
before the meningeal layer of the dura

0:07:29.010,0:07:33.360
goes down between the two cerebral
hemispheres and the name that's given to

0:07:33.360,0:07:37.830
this is called the falx cerebri and
we're gonna look at a couple of other

0:07:37.830,0:07:43.410
dura mater partitions in a little bit in
the next slide but this particular one

0:07:43.410,0:07:48.390
that lies in the longitudinal fissure is
known as the falx cerebri so once

0:07:48.390,0:07:52.260
again we have three layers of the
meninges the outer is known as the dura

0:07:52.260,0:07:57.150
mater this is a tough outer layer the
middle one is called the arachnoid mater

0:07:57.150,0:08:01.800
very importantly in the subarachnoid
space we have the flow of cerebrospinal

0:08:01.800,0:08:06.540
fluid and then finally the innermost
layer of the meninges is called the Pia

0:08:06.540,0:08:12.030
mater the delicate layer and this layer
is directly adherent to the nervous

0:08:12.030,0:08:17.460
tissue of the brain itself you'll also
notice on this slide that from the

0:08:17.460,0:08:21.330
arachnoid mater

we have projections that go up into the

0:08:21.330,0:08:27.510

sinus the superior sagittal sinus what happens is these projections which are

0:08:27.510,0:08:32.370

known as arachnoid villi these projections actually will carry the

0:08:32.370,0:08:36.630

cerebrospinal fluid from here and return it into the sagittal sinus and as we

0:08:36.630,0:08:40.800

said before this will return this fluid back to the heart to be recirculated

0:08:40.800,0:08:45.480

around the body now in this slide you can see a little bit better the dural

0:08:45.480,0:08:49.680

folds how the dura actually goes and makes these connective tissue partitions

0:08:49.680,0:08:53.250

this one is the one we looked at before if you remember we talked about the

0:08:53.250,0:08:56.560

falx cerebri in the slide and we said that we're the

0:08:56.560,0:09:00.730

meningeal layer of the dura separates from the periosteum layer it goes down

0:09:00.730,0:09:05.470

between the two cerebral hemispheres so this is a tough connective tissue fold

0:09:05.470,0:09:10.660

you can also see here the sinuses up here would be what we call a superior

0:09:10.660,0:09:15.730

sagittal sinus down here would be an inferior sagittal sinus we have another

0:09:15.730,0:09:20.200

one called the straight sinus which is over here and you'll notice that these

0:09:20.200,0:09:24.940
sinuses once again are just large veins
what they're collecting is blood from

0:09:24.940,0:09:30.130
the brain as well as cerebrospinal fluid
that will ultimately lead back to the

0:09:30.130,0:09:35.080
heart now you'll see that not only do we
have the falx cerebri but we also have a

0:09:35.080,0:09:38.770
dural fold that lies above the
cerebellum if you remember the

0:09:38.770,0:09:42.850
cerebellum was this highly folded layer
that was down below the cerebral

0:09:42.850,0:09:49.390
hemispheres and you can see that this
particular fold of the dura is known as

0:09:49.390,0:09:54.010
a tentorium cerebelli
and what tentorium means basically is a

0:09:54.010,0:09:59.500
roof so this is a covering over the
cerebellum and this is called the

0:09:59.500,0:10:03.310
tentorium cerebelli
you can see them both down here on the

0:10:03.310,0:10:07.690
bottom of the slide so let's talk a
little bit about the ventricles of the

0:10:07.690,0:10:11.950
brain and as you see here these are
interconnected cavities within the

0:10:11.950,0:10:17.170
cerebrum within the cerebral hemispheres
and the brainstem so we find these in

0:10:17.170,0:10:22.090
the brain and the brain stem we also
have down the center of the spinal cord

0:10:22.090,0:10:26.080
something that's known as a central

canal and the central canal is also

0:10:26.080,0:10:30.250
filled with cerebrospinal fluid now in
the right hand illustrations you can see

0:10:30.250,0:10:34.960
the size of these two ventricles we have
one on the right side which is a lateral

0:10:34.960,0:10:39.040
ventricle the other one on the left side
of the brain another lateral ventricles

0:10:39.040,0:10:44.800
so we have two lateral ventricles one on
either side of the brain that is in each

0:10:44.800,0:10:48.520
cerebral hemisphere you notice that
these have a connection between them

0:10:48.520,0:10:53.170
right here so the lateral ventricles are
connected to each other and they lead to

0:10:53.170,0:10:58.210
something that's called a third
ventricle and the third ventricle is

0:10:58.210,0:11:03.040
right in the vicinity of the thalamus
and it actually looks something like

0:11:03.040,0:11:07.390
this if you look at the illustration
below it's kind of this area that lies

0:11:07.390,0:11:11.470
between the
two halves of the thalamus so if you

0:11:11.470,0:11:15.610
were to separate the brain sagittally
you really wouldn't have that third

0:11:15.610,0:11:18.519
ventricle you wouldn't have that space
in there anymore it's really just a

0:11:18.519,0:11:23.290
space between those two halves of the
thalamus so you'll notice that these two

0:11:23.290,0:11:27.189
canals that connect the lateral
ventricles connect those with the third

0:11:27.189,0:11:30.970
ventricle and in turn we have a
connection between the third ventricle

0:11:30.970,0:11:34.930
and the fourth ventricle and that
connection is something that's known as

0:11:34.930,0:11:39.490
the cerebral aqueduct as you can see on
the bottom of the slide so this is

0:11:39.490,0:11:42.699
called the cerebral aqueduct and this
connects the third with the fourth

0:11:42.699,0:11:48.069
ventricle which lies just in front of the
cerebellum and then from here you notice

0:11:48.069,0:11:52.810
that this goes down to the central canal
of the spinal cord which as we said

0:11:52.810,0:11:58.480
before is filled with cerebrospinal
fluid so all of these areas are filled

0:11:58.480,0:12:02.920
with cerebrospinal fluid
in fact the ventricles are what make the

0:12:02.920,0:12:07.899
cerebrospinal fluid as we'll see in a
second so let's talk a little bit more

0:12:07.899,0:12:12.009
about the cerebrospinal fluid or CSF
and this is made by structures called

0:12:12.009,0:12:16.509
choroid plexuses one of them is
called a choroid plexus these together

0:12:16.509,0:12:21.009
produce cerebrospinal fluid in the
quantity of about 500 milliliters per

0:12:21.009,0:12:26.319
day if we were to look at the cerebral

spinal fluid in any given time we only

0:12:26.319,0:12:29.230
have about a hundred and fifty
milliliters of cerebrospinal fluid

0:12:29.230,0:12:33.699
present throughout the entire central
nervous system so obviously if we

0:12:33.699,0:12:38.589
produce 500 milliliters per day but we
only have present about 150 milliliters

0:12:38.589,0:12:43.089
at a time that means we have to drain a
significant amount out of the central

0:12:43.089,0:12:46.630
nervous system and as we spoke about
before remember the arachnoid

0:12:46.630,0:12:51.790
granulations come from the subarachnoid
space and allow the cerebrospinal fluid

0:12:51.790,0:12:56.529
up into the sinus here to drain so their
role is very important because they keep

0:12:56.529,0:13:00.420
fluid from accumulating in the brain if
that fluid wasn't drained properly

0:13:00.420,0:13:04.809
because the skull bones are very strong
the pressure resulting from that

0:13:04.809,0:13:09.069
increased fluid would actually start
pressing down on the brain and damage

0:13:09.069,0:13:12.970
the nervous tissue of the brain itself
so the drainage function is very

0:13:12.970,0:13:17.769
important so as we said before you can
see that the cerebrospinal fluid

0:13:17.769,0:13:22.270
circulates in the ventricles and also in
the central canal the spinal cord there

0:13:22.270,0:13:26.260
importantly remember that it also
circulates around this sub arachnoid

0:13:26.260,0:13:31.780
space so that spider webby area that was
below the arachnoid membrane itself this

0:13:31.780,0:13:36.580
completely surrounds the brain as well
as the spinal cord and here you can get

0:13:36.580,0:13:40.540
an indication about something I
mentioned before this forms a protective

0:13:40.540,0:13:45.910
layer around the brain and this works
kind of like a shock absorber to help

0:13:45.910,0:13:49.750
keep the brain from banging up against
the skull bones during an event where

0:13:49.750,0:13:54.160
you have enough force to push the brain
up against the skull and you can also

0:13:54.160,0:13:57.520
see some of the things we talked about
before remember we talked about lateral

0:13:57.520,0:14:00.940
ventricles this would be one of the
lateral ventricles from the side

0:14:00.940,0:14:05.320
remember the two lateral ventricles one
in each hemisphere are connected to each

0:14:05.320,0:14:09.730
other and then in turn lead to the third
ventricle which as I mentioned for

0:14:09.730,0:14:14.770
before is around the vicinity of the
thalamus then we have the central canal

0:14:14.770,0:14:19.510
here that goes to the fourth ventricle
in front of the cerebellum and then

0:14:19.510,0:14:23.590
finally we go down to the central canal

of the spinal cord itself you can

0:14:23.590,0:14:28.360

actually see that there's an opening here and so from the ventricles what

0:14:28.360,0:14:33.640

happens is the cerebrospinal fluid exits the ventricles and goes into the

0:14:33.640,0:14:38.350

subarachnoid space here and you can see that it starts flowing down and it also

0:14:38.350,0:14:42.340

starts flowing up around the brain so once again this forms kind of an

0:14:42.340,0:14:47.200

insulating fluid around the brain and the spinal cord so what is a cerebral

0:14:47.200,0:14:50.860

spinal fluid and how is it different from the interstitial fluid well it's a

0:14:50.860,0:14:55.420

nutritive and protective solution or fluid around the brain and the nervous

0:14:55.420,0:15:00.160

system it actually helps to maintain stable ion concentrations in the central

0:15:00.160,0:15:04.720

nervous system very important as you can imagine as we talked about the function

0:15:04.720,0:15:08.650

of neurons and how their function is really dependent upon the correct

0:15:08.650,0:15:14.230

concentration of ions and how those ions flow and so this is a clear liquid but

0:15:14.230,0:15:17.980

it contains a little bit more sodium and chloride but less potassium calcium

0:15:17.980,0:15:23.650

glucose and protein than plasma so it does differ chemically from interstitial

0:15:23.650,0:15:28.390
fluid and from plasma now in the bottom
panel you can actually see a little bit

0:15:28.390,0:15:33.730
better how the cerebrospinal fluid flows
around the bottom of the spinal cord the

0:15:33.730,0:15:36.220
spinal cord actually ends right here
we're going to talk

0:15:36.220,0:15:40.360
about that later on and you'll notice
that the dura mater goes down here and

0:15:40.360,0:15:45.580
then actually returns up goes up here
and eventually will flow around the

0:15:45.580,0:15:49.960
brain this way so once again this fluid
is constantly circulating around the

0:15:49.960,0:15:53.320
brain in the spinal cord constantly
being produced by the choroid plexuses

0:15:53.320,0:15:58.330
that are in the ventricles of the
brain this is a nice slide because this

0:15:58.330,0:16:01.630
will actually give you the manner in
which that fluid comes out of the

0:16:01.630,0:16:06.700
ventricles and then flows around the
brain and around the spinal cord so take

0:16:06.700,0:16:10.600
a look here you'll notice these red
structures that are here in the lateral

0:16:10.600,0:16:14.860
ventricle here in the third ventricle
and some here down on the fourth

0:16:14.860,0:16:21.250
ventricle these are choroid plexuses and
these as I said before are the centers

0:16:21.250,0:16:27.460
that produce the cerebrospinal fluid

so here is one lateral ventricle we see

0:16:27.460,0:16:31.210
one of them there'll be another one on
the other side here is a third ventricle

0:16:31.210,0:16:35.620
that's in the vicinity of the thalamus
right here and remember we have that

0:16:35.620,0:16:39.160
connecting passageway that goes down to
the fourth ventricle this is called the

0:16:39.160,0:16:44.170
cerebral aqueduct and then finally the
fourth ventricle which lies in front of

0:16:44.170,0:16:48.100
the cerebellum and you can see the
choroid plexus down here in the vicinity

0:16:48.100,0:16:52.060
of the fourth ventricle in talking about
the flow of the cerebral spinal fluid

0:16:52.060,0:16:56.440
you'll see the text on the right side
bottom of the slide and you'll also see

0:16:56.440,0:17:01.060
the numbers that are up here on the
slide itself this is nice because it

0:17:01.060,0:17:05.680
tells you how the cerebral spinal fluid
goes from start to finish in other words

0:17:05.680,0:17:09.520
starting at number one you can see that
this is produced in the choroid plexus

0:17:09.520,0:17:14.290
of each ventricle and then we go to
number two which says the cerebrospinal

0:17:14.290,0:17:16.990
fluid flows through the
ventricles and into the subarachnoid

0:17:16.990,0:17:21.840
space so let's take a look at that
lateral ventricle third ventricle

0:17:21.840,0:17:26.560
cerebral aqueduct fourth ventricle now
you'll notice that we have a couple of

0:17:26.560,0:17:31.690
apertures or openings through which the
cerebral spinal fluid will go and will

0:17:31.690,0:17:36.880
actually get into the subarachnoid space
and these are here now you don't have to

0:17:36.880,0:17:40.840
actually remember the names here one is
called the foramen of Luschka the other

0:17:40.840,0:17:43.990
are called foramen of Magendie
you don't have to remember these but

0:17:43.990,0:17:47.620
these apertures it's important for you
to remember that these are here and

0:17:47.620,0:17:50.020
these are the way that the cerebrospinal
fluid

0:17:50.020,0:17:54.910
gets out of where the ventricles are and
into the subarachnoid space so it can

0:17:54.910,0:17:59.110
begin circulating around the brain and
around the spinal cord and then of

0:17:59.110,0:18:02.920
course the cerebrospinal fluid would
flow throughout the subarachnoid space

0:18:02.920,0:18:08.860
and then eventually what happens is the
cerebrospinal fluid as we said before is

0:18:08.860,0:18:13.780
going to be reabsorbed into the sinus
the superior sagittal sinus as you see

0:18:13.780,0:18:18.220
here at number four this fluid is going
to go up through here and eventually go

0:18:18.220,0:18:22.840
into the superior sagittal sinus this is

going to eventually return back to the

0:18:22.840,0:18:26.800

heart so this slide is nice because it gives you the flow of cerebrospinal

0:18:26.800,0:18:31.360

fluid around the brain and around the spinal cord so this would be good for

0:18:31.360,0:18:35.530

you to know basically where the cerebrospinal fluid goes where it's made

0:18:35.530,0:18:40.360

where it goes from there and how it gets out of the area of the ventricles and

0:18:40.360,0:18:44.680

into the subarachnoid space and then how the fluid is drained out of the

0:18:44.680,0:18:49.240

subarachnoid space and back into the sinuses in the brain so you should know

0:18:49.240,0:18:53.770

the flow that you see here okay so that'll do it for part 2 of lecture 19

0:18:53.770,0:18:58.390

in the next part we're going to continue talking about the brain and we're going

0:18:58.390,0:19:01.900

to talk about the functions of the different parts of the brains and we'll

0:19:01.900,0:19:06.550

work our way down to the thalamus hypothalamus and then the brainstem I'll

0:19:06.550,0:19:09.870

see you in the next video