



RUHANI COLLEGE
OF HEALTH BUSINESS AND TECHNOLOGY

LECTURE 6

Neuroanatomy and Pathophysiology 2

*The Brain: Organization, Protective Coverings, Blood Supply,
Cerebrospinal Fluid, and the Brain Stem*

RU RMT 16 – Neurology 2
Ruhani College of Massage Therapy



Learning Objectives

- Describe the four major divisions of the brain and the function of each.
- Identify the protective coverings of the brain: scalp, cranium, meninges, and CSF.
- Explain the dural folds (falx cerebri, falx cerebelli, tentorium cerebelli) and dural venous sinuses.
- Trace the arterial supply of the brain, cerebellum, and spinal cord, including the Circle of Willis.
- Describe cerebral venous drainage and the blood–brain barrier.
- Outline the formation, circulation, and function of cerebrospinal fluid (CSF).
- Recognize relevant pathologies — TIA/stroke, aneurysm, hydrocephalus, raised intracranial pressure.
- **Apply this anatomy to safe massage practice: screening, contraindications, and red flags.**



Review – Spinal Cord & the Spinal Reflex

- Spinal cord grey matter (H-shaped) contains cell bodies; white matter contains ascending sensory and descending motor tracts.
- Dorsal (posterior) horn = sensory input; ventral (anterior) horn = motor output; the central canal carries CSF.
- A spinal reflex (e.g. withdrawal from a hot object) is processed at the cord level — sensory neuron → interneuron → motor neuron — before the brain is consciously aware.
- This reflex arc lets protective movement happen faster than conscious thought.

MASSAGE THERAPY RELEVANCE

- Reflexes (e.g. deep tendon reflexes) are assessed to screen for nerve-root or cord involvement.
- Absent, reduced, or exaggerated reflexes are red flags that warrant referral.
- Understanding the arc explains why gentle stimulation can produce involuntary muscle responses during treatment.



Brain Organization – Four Major Divisions

Organized rostral (front) to caudal (back):

- 1. Cerebrum**

The major integrating centre of the CNS — higher-order thinking, voluntary movement, and decision making.
- 2. Diencephalon**

Thalamus, hypothalamus, epithalamus, subthalamus. Relays sensory information to the cerebrum; regulates sleep and hormone release.
- 3. Cerebellum**

The “little brain,” posterior to the brainstem. Coordinates movement — precision, timing, and balance.
- 4. Brainstem**

Midbrain, pons, and medulla oblongata. Controls basic survival functions and connects the brain to the spinal cord.



Cerebrum & Diencephalon

CEREBRUM

- Largest part of the brain and the primary integrating centre.
- Site of most conscious thought, perception, language, and voluntary motor control.
- Divided into two hemispheres and into frontal, parietal, temporal, and occipital lobes.

DIENCEPHALON

- Composed of the thalamus, hypothalamus, epithalamus, and subthalamus.
- Thalamus: main relay station for sensory information travelling to the cerebrum.
- Hypothalamus: regulates autonomic function, temperature, hunger, and hormone release (via the pituitary).
- Epithalamus (pineal gland): melatonin and sleep–wake regulation.

MASSAGE THERAPY RELEVANCE

- The hypothalamus drives the autonomic “rest-and-digest” shift that relaxation massage encourages.



Cerebellum & Brainstem

CEREBELLUM

- Sits posterior to the brainstem; the “little brain.”
- Coordinates movement — precision, timing, and smoothness — and helps maintain balance and posture.
- Does not initiate movement; it fine-tunes it.

BRAINSTEM

- Inferior to the diencephalon; continuous with the spinal cord; anterior to the cerebellum.
- From superior to inferior: midbrain, pons, medulla oblongata.
- Controls basic survival systems — cardiovascular centre, respiratory centre, and alertness.

MASSAGE THERAPY RELEVANCE

- Cerebellar dysfunction shows as ataxia, tremor, or poor coordination — signs an RMT may notice during gait or balance observation and should document and refer.



Brain Protection – Overview

- Like the spinal cord, the brain is protected by bone and by the meninges with CSF beneath them.
- From superficial to deep the barriers are:
 - Skin and the aponeurosis (galea) of the scalp — extra padding unique to the head.
 - The cranium (skull bone).
 - The three meninges: dura mater, arachnoid mater, pia mater.
 - Cerebrospinal fluid in the subarachnoid space.
- The spinal cord has surrounding back muscles in place of a scalp, but shares the meninges and CSF.

MASSAGE THERAPY RELEVANCE

- Scalp and suboccipital tissues are common treatment areas — work here is superficial to bone and meninges.
- The paraspinal and back muscles and RMT treatments form part of the mechanical protection of the cord.



The Three Meninges

Dura mater

Tough, outermost layer. In the cranium it has two layers (periosteal + meningeal) that are fused except where they separate to form the dural venous sinuses. Unlike the spinal dura, there is no epidural space around the brain.

Arachnoid mater

Delicate, web-like middle layer. The subarachnoid space beneath it holds CSF and the major cerebral vessels.

Pia mater

Thin, innermost layer that adheres directly to the surface of the brain and follows every contour.

Mnemonic (superficial → deep): Dura – Arachnoid – Pia (“D-A-P”).



Dural Folds (Extensions)

Extensions of the dura project into the major grooves of the brain to compartmentalize and stabilize it:

Falx cerebri

A sickle-shaped vertical fold that separates the two cerebral hemispheres (in the longitudinal fissure).

Falx cerebelli

A smaller vertical fold that separates the right and left cerebellar hemispheres.

Tentorium cerebelli

A horizontal fold that separates the cerebellum below from the cerebrum above.

MESSAGE THERAPY RELEVANCE

- Dural tension and headache have overlapping presentations; RMTs work the suboccipitals and upper cervicals that share fascial and neural links with the cranial dura, but do not treat undiagnosed severe or “worst-ever” headaches.



Dural Venous Sinuses & Cerebral Venous Drainage

- Where the two dural layers separate they form dural venous sinuses — endothelial-lined channels that collect venous blood from the brain.
- Cerebral veins on the supero-lateral surface drain into the superior sagittal sinus.
- Veins on the postero-inferior aspects drain into the inferior sagittal, straight, and transverse sinuses.
- These sinuses ultimately drain into the internal jugular veins, returning blood to the heart.

MASSAGE THERAPY RELEVANCE

- The internal jugular vein and carotid vessels lie in the anterior triangle of the neck.
- Avoid deep or sustained pressure on the anterior neck; RMT neck work targets muscles, not the vascular bundle.
- Venous return can be affected by prolonged positioning — monitor client comfort in prone/head-turned positions.



The Brain's Metabolic Demand

~2%

of total body weight

~20%

of oxygen & glucose at rest

- The brain preferentially uses glucose (with oxygen) to make ATP.
- It does not store glucose the way other organs do, so it needs a continuous blood supply.
- Low blood glucose (hypoglycemia) can cause confusion, dizziness, and loss of consciousness.

MASSAGE THERAPY RELEVANCE

- Screen before treatment: has the client eaten? Diabetic clients or those who are fasting can become hypoglycemic on the table.
- Signs on the table: shakiness, sweating, confusion, pallor, faintness. Stop, sit or lay them safely, offer fast-acting sugar if conscious, and get help if severe.



Arterial Supply – Two Systems

Blood reaches the brain through two arterial systems that meet at the base of the brain to form the Circle of Willis:

INTERNAL CAROTID ARTERIES (ICA)

- Arise from the common carotid arteries in the neck (anterior circulation).
- Anterior cerebral artery (ACA): medial/superior frontal, temporal, parietal lobes.
- Middle cerebral artery (MCA): lateral surfaces of frontal, temporal, parietal lobes.

VERTEBRAL ARTERIES

- Branch from the subclavian arteries; travel through the cervical transverse foramina (posterior circulation).
- Unite at the caudal pons to form the basilar artery.
- Give off the posterior cerebral arteries (PCA): mainly the occipital lobes.

Fast-onset functional deficits can signal damage to a specific cerebral artery territory (ACA / MCA / PCA).



Cerebellar Supply, Circle of Willis & Aneurysm

BLOOD SUPPLY OF THE CEREBELLUM

- Superior cerebellar artery (SCA) — branch of the basilar.
- Anterior inferior cerebellar artery (AICA) — branch of the basilar.
- Posterior inferior cerebellar artery (PICA) — branch of the vertebral.

CIRCLE OF WILLIS

- The key anastomosis linking the internal carotid and vertebral systems at the base of the brain.
- Provides collateral (back-up) circulation if one vessel is compromised.

CLINICAL / MT ALERT

- Aneurysms are common in the Circle of Willis, especially the communicating arteries (anterior ~30%, posterior ~25%).
- A ruptured aneurysm produces a sudden, severe “thunderclap” headache — a medical emergency.
- A new, worst-ever, or thunderclap headache is an ABSOLUTE contraindication to massage: stop and refer to emergency care immediately.



Cervical Vascular Safety for the RMT

- **Carotid arteries and the carotid sinus lie in the anterior triangle of the neck near C3–C4.**
 - Sustained pressure on the carotid sinus can trigger reflex bradycardia and a drop in blood pressure.
 - Plaque in an atherosclerotic vessel could be dislodged. Avoid deep/sustained anterior-neck pressure and never clamp the vessel.
- **Vertebral arteries are vulnerable to end-range cervical rotation and extension.**
 - Cervical Arterial Dysfunction (CAD) / vertebrobasilar insufficiency can reduce posterior brain perfusion.
 - Screen for the “5 D’s and 3 N’s”: Dizziness, Diplopia, Dysarthria, Dysphagia, Drop attacks; Nausea, Nystagmus, Numbness.
 - If these appear with neck position, avoid the position and refer for medical assessment.

PRACTICE POINTS

- Take a vascular/cardiovascular history before cervical work.
- Favour neutral-range techniques; avoid combined rotation + extension held at end range.
- Document any dizziness or visual symptoms and refer.



Spinal Cord Blood Supply & Venous Drainage

ARTERIAL SUPPLY

- One anterior spinal artery (from the vertebral arteries), nestled in the anterior median fissure.
- A pair of posterior spinal arteries (from the vertebral arteries or PICA).
- Reinforced inferiorly by segmental branches: cervical, intercostal, lumbar, and lateral sacral arteries, which enter through the intervertebral foramina.

VENOUS DRAINAGE

- A venous plexus runs the length of the cord and drains to different destinations by spinal level.
- This plexus lies outside the dura mater (epidural).
- Anterior and posterior spinal veins run longitudinally along the cord.



Transient Ischemic Attack (TIA) & Stroke

- A TIA is a neurological deficit caused by temporary ischemia (deficient blood supply) to the brain.
- Symptoms include dizziness, light-headedness, fainting, and paraesthesia.
- “Transient” = temporary — usually minutes up to about an hour — but a TIA is a serious warning sign that a full stroke may follow.

RECOGNIZE STROKE — F.A.S.T.

Face drooping Arm weakness Speech difficulty Time to call emergency services

CLINICAL / MT ALERT

- TIA/stroke signs are an absolute contraindication and a medical emergency.
- Do not treat — activate emergency services immediately.
- A prior TIA/stroke history requires physician clearance and adapted, gentle treatment.



The Blood–Brain Barrier (BBB)

- The BBB protects neurons by preventing many blood-borne substances and pathogens from entering brain tissue.
- Three components:
 - Tight junctions sealing the endothelial cells of the brain capillaries (no pores — unlike “fenestrated” capillaries elsewhere).
 - A thick basement membrane around those endothelial cells.
 - Astrocyte foot processes lining the capillaries.
- Because it is so selective, even many antibiotics cannot readily cross the BBB — which complicates treating CNS infections.

MESSAGE THERAPY RELEVANCE

- Explains why CNS infections (e.g. meningitis, encephalitis) are serious and hard to treat.
- Supports understanding of client medications and why some act centrally while others do not.



CSF – Function

- A clear, colourless liquid surrounding the brain and spinal cord.
- Functions:
 - Cushions the brain and cord against physical blows (shock absorption).
 - Provides buoyancy, effectively reducing the brain's weight so it is not crushed under its own mass.
 - Delivers some nutrients and removes metabolic waste.
- Circulates from the ventricles within the brain, into the subarachnoid space, and is returned to the venous blood.

MESSAGE THERAPY RELEVANCE

- CSF buoyancy is why careful head/neck support and positioning matter — sudden jarring is what CSF normally cushions.
- Support the head through position changes for clients with headache or neck pain.



CSF – Formation & Circulation

- Produced in the ventricles by the choroid plexus, where ependymal cells (neuroglia) filter blood plasma.
- The ventricular system:
 - Two lateral ventricles (one in each cerebral hemisphere) → interventricular foramina →
 - Third ventricle (midline, between the halves of the thalamus) → cerebral aqueduct →
 - Fourth ventricle (posterior to the pons) → continues as the central canal of the spinal cord.
- From the fourth ventricle, CSF exits through the median and lateral apertures into the subarachnoid space.
- CSF is reabsorbed into the dural venous sinuses via arachnoid villi. Production is balanced against drainage to keep volume constant.



Hydrocephalus & Raised Intracranial Pressure

- Hydrocephalus = excess CSF in the ventricles and subarachnoid space.
- Cause: overproduction, or blockage of CSF circulation/drainage (tumour, developmental anomaly, or inflammation).
- The ventricles expand and push the brain against the cranium; in infants the head enlarges before the sutures fuse.
- Any cause of raised intracranial pressure (ICP) is dangerous because the skull is a fixed space.

CLINICAL / MT ALERT

- Refer for raised-ICP red flags: severe/worsening headache (worse lying down or in the morning), vomiting, visual changes, drowsiness or altered consciousness.
- These are contraindications — do not treat; direct the client to medical care.



Brain Stem – Structure & Function

- The brainstem lies between the spinal cord and the diencephalon.
- Three sections (superior → inferior): midbrain, pons, medulla oblongata.
- Main functions:
 - Almost all cranial nerves emerge from the brainstem.
 - It is the conduit through which the main ascending (sensory) and descending (motor) tracts pass.
 - Autonomic control of multiple vital systems — cardiovascular and respiratory centres, and alertness/arousal.

MASSAGE THERAPY RELEVANCE

- Massage promotes a parasympathetic (“rest-and-digest”) shift mediated through brainstem autonomic centres — the basis of the relaxation response.
- Brainstem signs (sudden vertigo, double vision, slurred speech, swallowing trouble) are emergencies — stop and refer.



Key Clinical Take-Aways for RMTs

- Brain = cerebrum, diencephalon, cerebellum, brainstem — protected by scalp, cranium, meninges, and CSF.
- Dural folds (falx cerebri/cerebelli, tentorium cerebelli) partition the brain; dural venous sinuses drain to the internal jugular veins.
- Two arterial systems (internal carotid + vertebral) join at the Circle of Willis; aneurysms favour the communicating arteries.
- **Protect the anterior neck: no deep/sustained pressure on the carotid; screen for CAD/VBI before end-range cervical work.**
- CSF is made by the choroid plexus and reabsorbed by arachnoid villi; blockage → hydrocephalus / raised ICP.
- **Emergency red flags = do not treat, refer now: thunderclap headache, F.A.S.T. stroke signs, raised-ICP signs, hypoglycemia.**