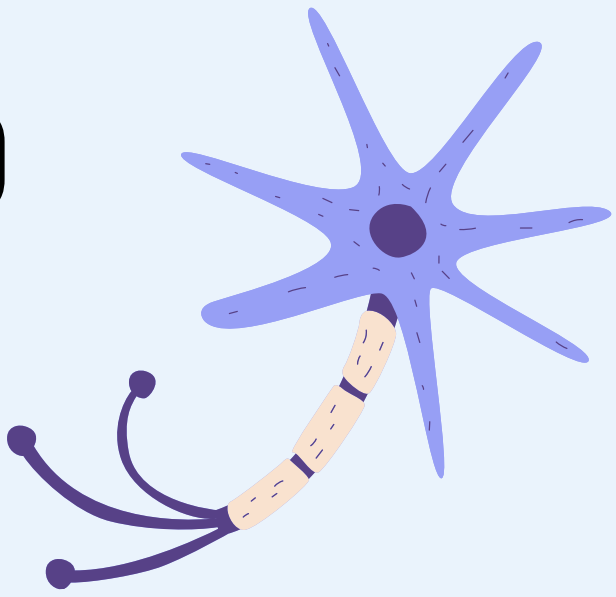
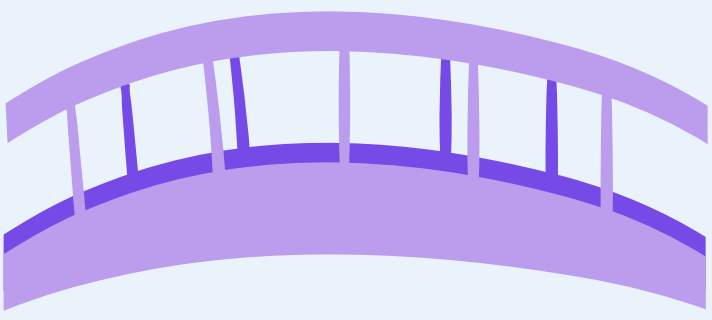
THE ROAD TO MULTIPLE SCLEROSIS



NAVIGATING THE PATH FROM SYMPTOM TO DIAGNOSIS

Multiple Sclerosis is a chronic autoimmune neurological disorder in which the body's immune system attacks the myelin sheath that surrounds the nerves.[1]



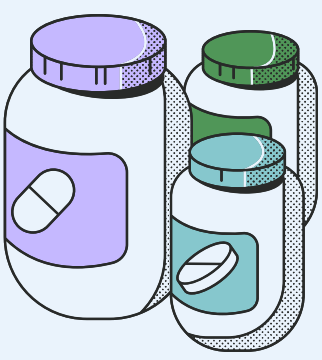
It is like a broken bridge. People have no way of getting to where they need to be.

JUST LIKE THE SIGNALS FROM YOUR BRAIN!

DID YOU KNOW?

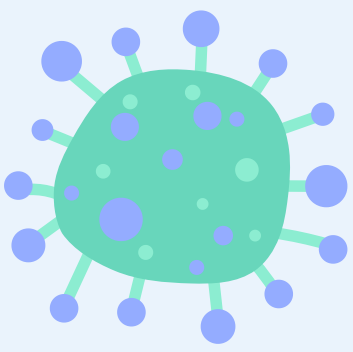
Approximately **2.9 million** people worldwide are impacted by MS.[2]

BUT WHAT CAUSES IT?[3]



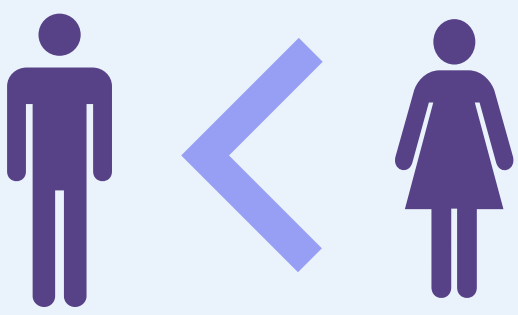
LOW VITAMIN D

CERTAIN INFECTION

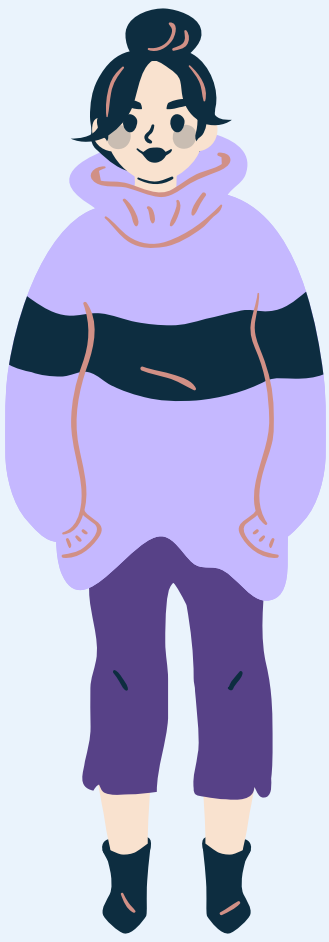


GENETIC FACTORS

It is more likely to develop in **women** than men. It is most commonly diagnosed between the ages of **20 and 40**, but this disease does not largely affect life expectancy.[3]



WANT TO LISTEN ALONG: CLICK HERE FOR INTERATIVE AUDIO



THIS IS MAYA

Maya is a 35 year old woman who has come to the doctor. Her signs and symptoms cause doctors to suspect that she may be suffering from multiple sclerosis. Let's compare and contrast some of the common symptoms of MS to help diagnose Maya!

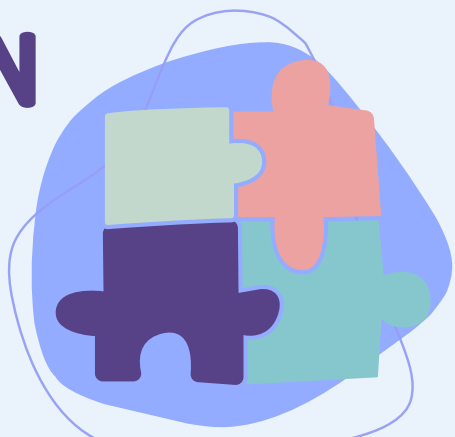
COMMON SIGNS AND SYMPTOMS OF MS [2-4]

- Fatigue
- Numbness or Tingling
- Weakness
- Lack of Coordination
- Vision Problems
- Electric-Shock Sensations (Lhermitte's Sign)
- Mood Changes
- Dizziness and Vertigo
- Difficulty Walking
- Cognitive Problems
- Speech Problems
- Bladder, Bowel, and Sexual Dysfunction

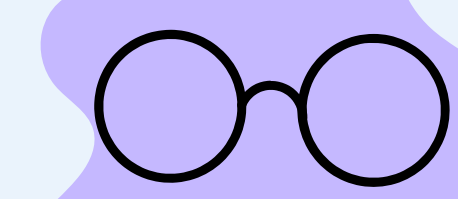
MAYA'S PRESENTATION

FATIGUE

TINGLING

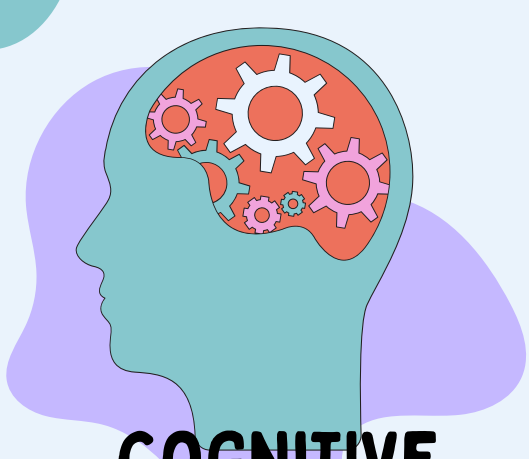


COORDINATION ISSUES



BLURRY VISION

BALANCE ISSUES



COGNITIVE CHANGE

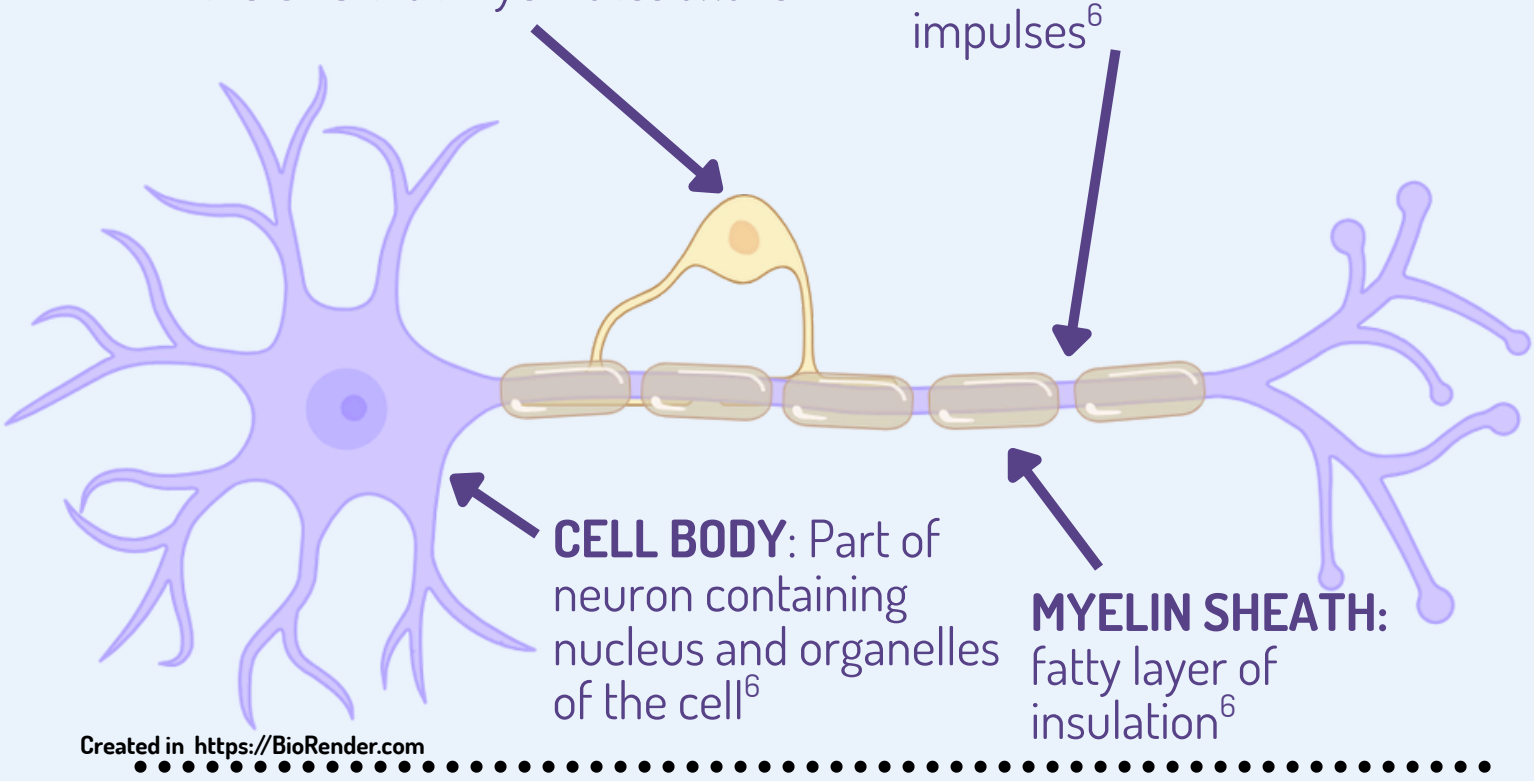
DO YOU THINK DOCTORS CAN DIAGNOSIS MAYA WITH MS NOW? ARE SIGNS AND SYMPTOMS SUFFICENT IN DIAGNOSING A DISEASE?

MAYA'S SYMPTOMS ALIGN WITH THE SYMPTOMS OF MS. THESE SYMPTOMS SEEM TO SUGGEST MAYA HAS MS. HOWEVER, DOCTORS STILL HAVE TO PERFORM PROPER TESTING FOR US TO CONFIRM HER DIAGNOSIS.

BUT FIRST...

WHAT IS OCCURRING AT THE CELLULAR LEVEL?

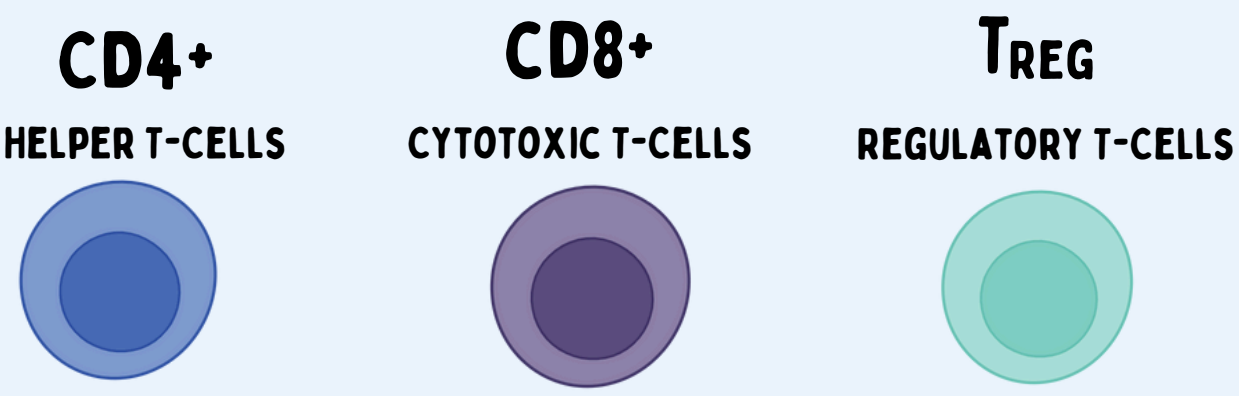
The brain communicates to the rest of the body via the central nervous system (CNS) through **myelinated neurons**[5-6]. **Myelin**, a fatty layer covering the axons of neurons, create an insulation that makes nerve impulses and transmission **more efficient and fast**[5-6].



Created in https://BioRender.com

THE ROLE OF T-CELLS

T cells are a type of white blood cell that plays a crucial role in the **adaptive immune system**, helping the body recognize and respond to foreign invaders.[7] **Main types**[7]**:**



Normally, T cells distinguish between **self (the body's own cells) and non-self (pathogens or foreign antigens)**[7]**.** However, in autoimmune diseases like Multiple Sclerosis (MS), T cells mistakenly attack the body's own tissues —in this case, the myelin sheath.[2]

This self-directed immune response is a hallmark of Type IV hypersensitivity reactions.[5,8]

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TYPE IV HYPERSENSITIVITY

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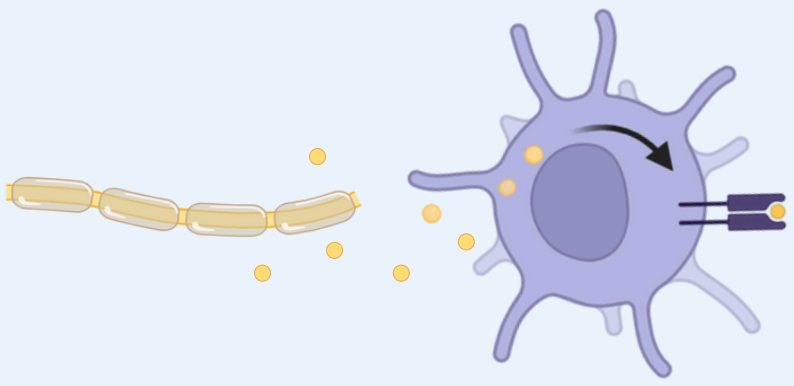
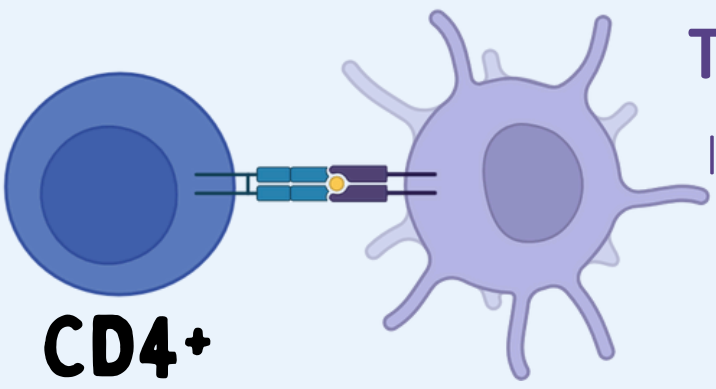
1 SENSITIZATION PHASE

Antigen presenting cells (APCs) like dendritic cells present **myelin proteins** (antigens) on its surface for recognition.[5,10]

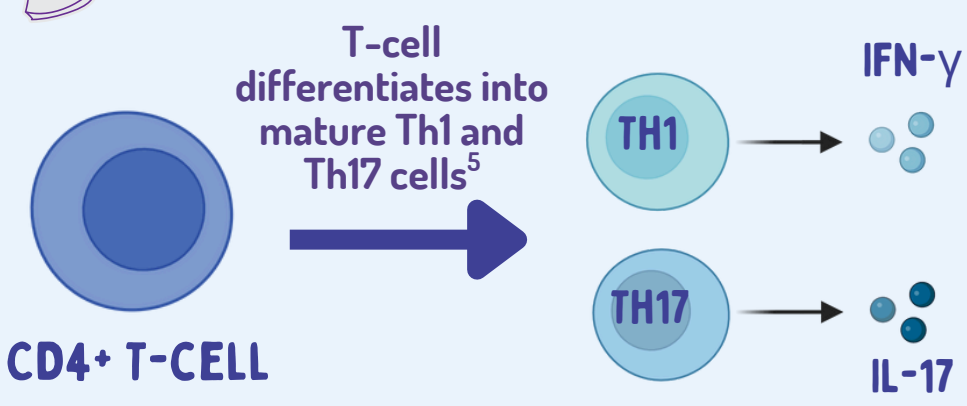


2 T-CELL ACTIVATION



Immature/naive CD4+ T-cells get **abnormally** activated by myelin antigens (doesn't distinguish between self: normal myelin proteins, and non-self: foreign particles/ pathogens).[5,9-10]

3 EFFECTOR PHASE



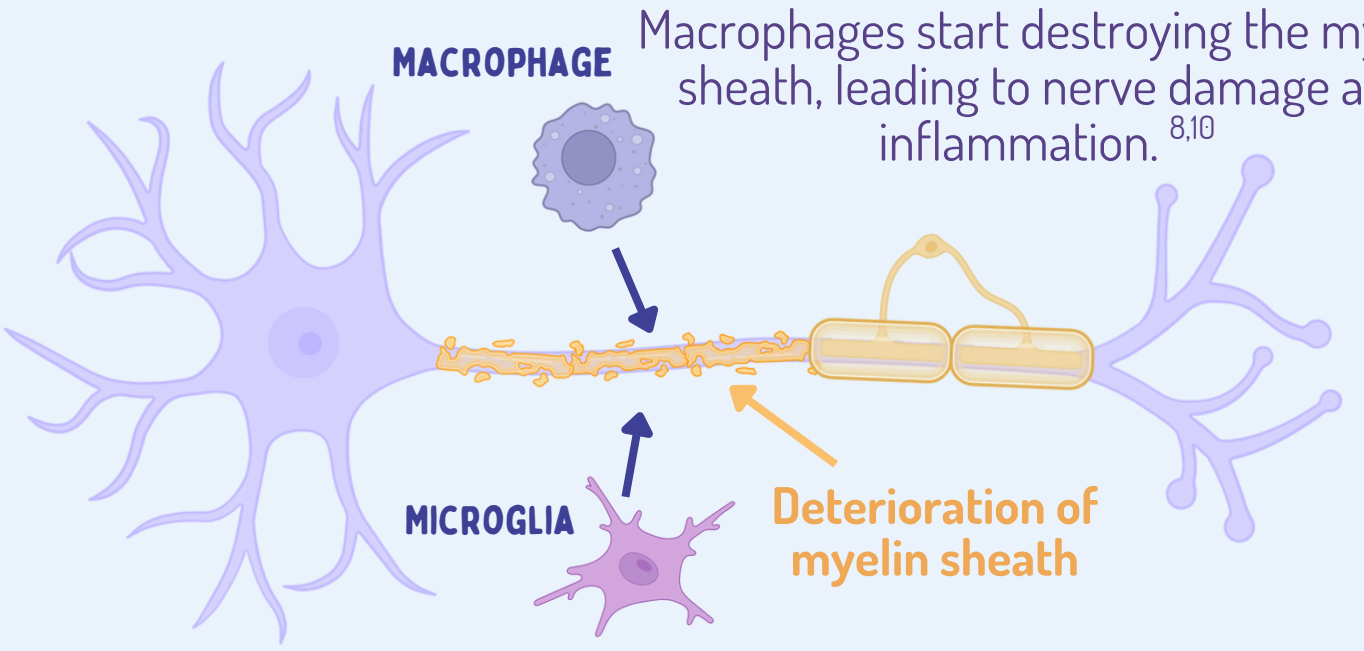
Th1/Th17 cells are mature, specialized T-cells. Cytokines are small proteins that help in cell-cell signalling.[5,8]

Th1 and Th17 cells secrete inflammatory cytokines, which amplify the immune response and promote the recruitment of immune cells like neutrophils and macrophages, while also activating resident microglia, leading to inflammation.[5,8,10]

MICROGLIA: immune cell in CNS, remves debris, fights infection[5]

MACROPHAGE: immune cell, "eats"/engulfs pathogens & proteins[5]

CHRONIC INFLAMMATION & PLAQUES 4



Macrophages start destroying the myelin sheath, leading to nerve damage and inflammation.[8,10]

Overactive microglia due to T-cell activation will also lead to chronic inflammation, further damaging the myelin sheath.[8]

OVER TIME...

As damaged areas in the CNS lose myelin, scar tissue forms (gliosis) resulting in the sclerotic plaques seen in MS.[11]

CHECK YOUR KNOWLEDGE!

AT WHAT STAGE DO NAIVE CD4+ T-CELLS DIFFERENTIATE INTO MATURE T-CELLS TO START THE IMMUNE RESPONSE?

THE EFFECTOR PHASE!

RECALL THAT T-CELLS ARE ABNORMALLY ACTIVATED BY MYELIN ANTIGENS, AND THEN THEY DIFFERENTIATE INTO TH1 AND TH17 CELLS TO RELEASE INFLAMMATORY CYTOKINES.

WHAT CAN THIS LOOK LIKE HISTOLOGICALLY?

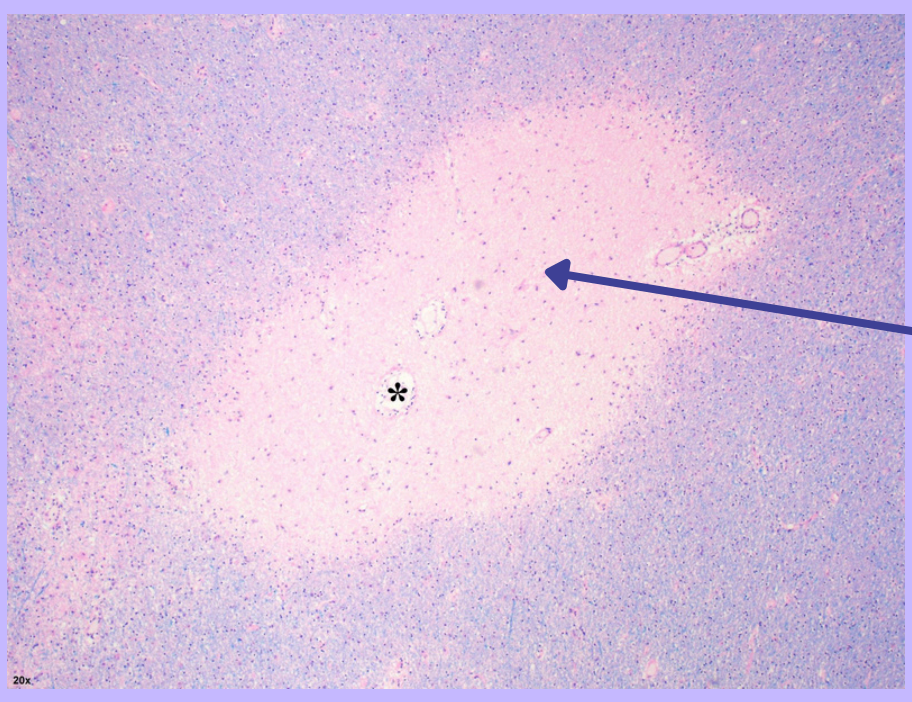


Image courtesy of https://www.pathologyoutlines.com[12]. Click on image to view on site directly. Contributed by Rachel A. Multz, M.D. and Jared T. Ahrendsen, M.D., Ph.D.

On this slide stained with Hematoxylin/ Eosin and Luxol Fast Blue, the lighter staining region shows an area of demyelination, representing a chronic demyelination plaque.

Explore the other slides on the site to see other common histological features in MS, like perivascular infiltration of inflammatory cells.

BASED ON DISEASE PROGRESSION, THERE ARE...

4 TYPES OF MS

RELAPSING-REMITTING MS (RRMS)[13]

- Most common form (85% of patients)[13]
- Characterized by episodes of new/ worsening symptoms, followed by periods of partial or recovery. Can progress to SPMS.[13]

PRIMARY PROGRESSIVE MS (PPMS)[13]

- Less common form (10-15% of patients)[13]
- Symptoms gradually worsen from the onset, without distinct relapse or remission.[12]
- Primarily affects mobility, more challenging to treat.[13]

SECONDARY PROGRESSIVE MS (SPMS)[13]

- Develops in patients who initially had RRMS.[13]
- Steady progression of disease - fewer relapses and more permanent neurological impairment[13]

PROGRESSIVE-RELAPSING MS (PRMS)[13]

- Rare and aggressive form of MS.[13]
- Characterized by a steady worsening of symptoms, with acute relapses with potential recovery periods in between.[13]

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DIAGNOSIS

Due to the complexity of the disease, physicians may use multiple assessments to reach a diagnosis for MS. Let's explore below!

NEUROLOGICAL EXAM

A neurological test can assess a patient for abnormalities in coordination, balance, reflexes, vision, sensory functions and cognition. If deficits are found, the neurologist may require follow up testing.[14,15]

LUMBAR PUNCTURE

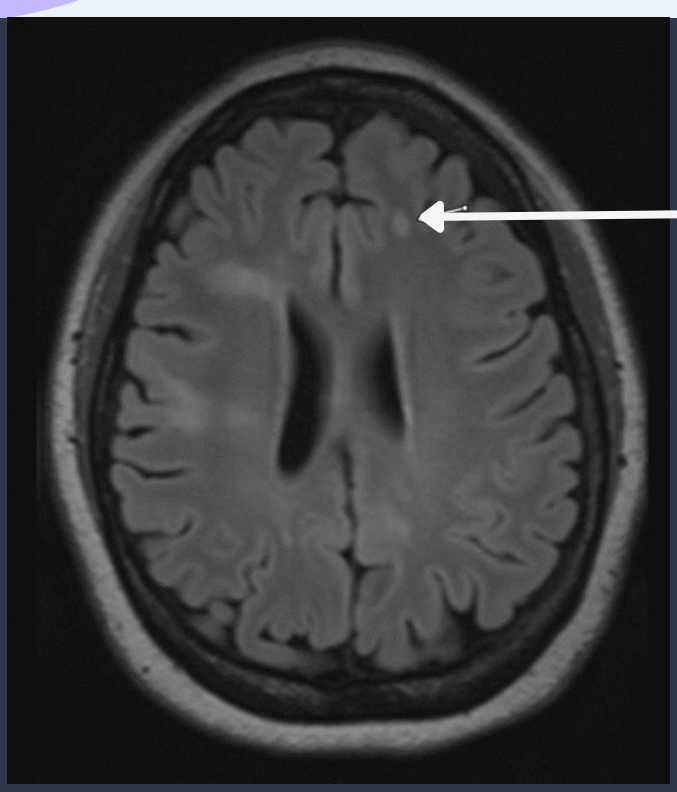
A lumbar puncture (spinal tap) analyzes cerebrospinal fluid (CSF) for oligoclonal bands, which are proteins that indicate inflammation in the CNS. The presence of these bands is common in MS patients but alone cannot diagnose MS.[14,15]

MRI SCAN

MRI is a key tool for diagnosing MS, revealing brain and spinal cord lesions caused by inflammation and demyelination, appearing as bright spots on the scan. Multiple lesions in different CNS regions over time indicate MS.[14,15]

EVOKED POTENTIAL TESTS

Evoked potential tests measure nerve signal speed, detecting slowed conduction from myelin damage in MS. They assess brain responses to visual, auditory, and sensory stimuli, identifying CNS abnormalities even before symptoms appear.[14,15]



SAMPLE MRI

Small light region indicates an inactive lesion in the brain

Recall Due to inflammation and deyelination, acute and chronic lesions form around areas of damage.[9]

LET'S CHECK IN ON MAYA!

Image courtesy of https://www.pathologyoutlines.com.[12] Click on image to view on site directly. Contributed by Jared T. Ahrendsen, M.D., Ph.D. and Pouya Jamshidi, M.D.

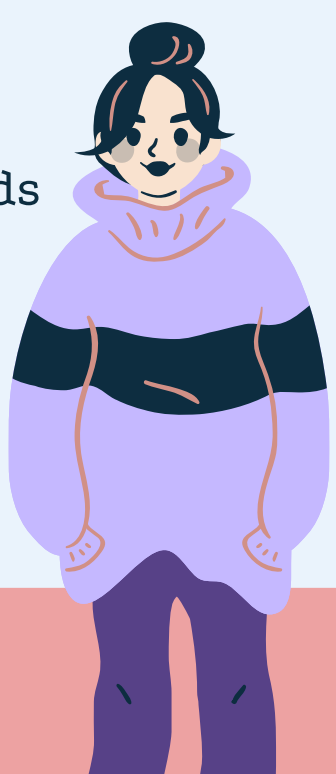
MAYA'S ASSESSMENT OUTCOMES

Over multiple visits, Maya's symptoms were:

- Appearing intermittently over time, with periods of improvement between

Doctors found:

- Multiple brain and spinal cord lesions
- Balance issues & blurry vision
- Slowed nerve conduction via evoked potential tests.



WHAT WOULD YOU DIAGNOSE MAYA WITH?

Doctors classified Maya's MS as **Relapsing-Remitting MS (RRMS)**. Her symptoms appeared intermittently over time, with some periods of improvement. With this diagnosis, Maya's treatment plan will focus on **managing relapses, slowing disease progression**, and **improving her quality of life** through medication and supportive therapies.

PROGRESSION OF MS

Progression of Multiple Sclerosis can be affected by genetics, lifestyle and treatment plan.

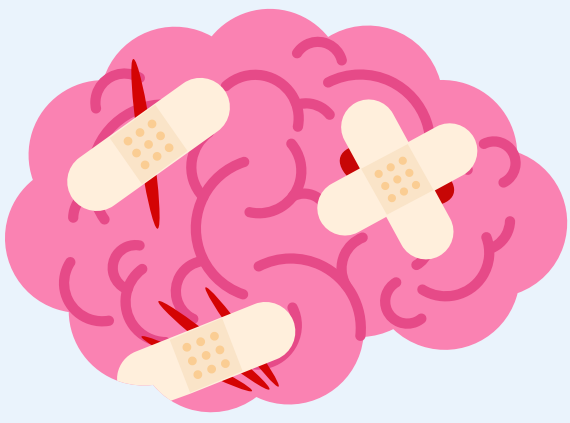
MS progression is based on the type of MS a patient has, so determining type is essential.

WHAT ARE THE BIGGEST FACTORS?[15]

AGE OF ONSET

GENETICS

OF BRAIN LESIONS



ADDITIONAL DISEASES

SOCIOECONOMIC

THESE CAN AFFECT PROGRESSION RATES OF ALL TYPES OF MS

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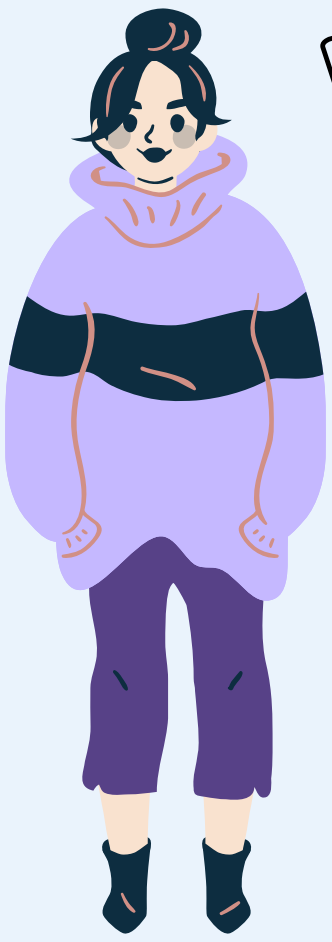
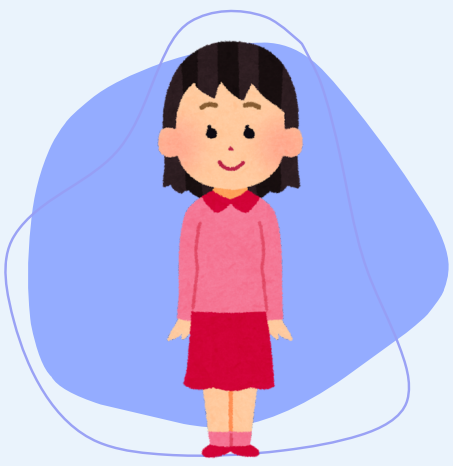


WHAT ABOUT MAYA?

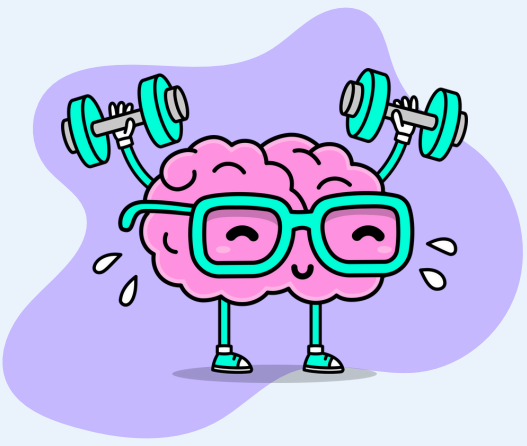
Maya was diagnosed at age 35; she does not have genetic issues and does not have many brain lesions. Maya is a healthy weight, has mild depression, and lives in a big city with easy access to healthcare.

MAYA'S PROGNOSIS



HER DIAGNOSIS ALLOWS HER TO GET TREATMENT FOR HER PAIN. SHE CAN FINALLY START FEELING RELIEF FROM HER SYMPTOMS.

SPECIFIC GENES MAY BE ASSOCIATED WITH MORE RAPID PROGRESSION: ABSENCE OF THE GENES COULD SLOW PROGRESSION.[15]



PATIENTS WITH A LOWER NUMBER OF BRAIN LESIONS TEND TO HAVE SLOWER PROGRESSION OF MS.[15]

PATIENTS WITH HEALTHY WEIGHT AND NO MAJOR ADDITIONAL DISEASES TEND TO HAVE SLOWER RATES OF PROGRESSION.[16]

PEOPLE WHO HAVE ACCESS TO SPECIALISTS, MEDICATION AND PHYSICAL THERAPY ARE MORE LIKELY TO SLOW THE PROGRESSION OF MS.[17]

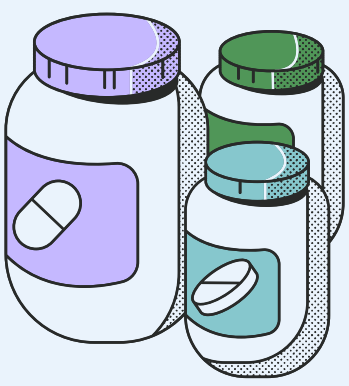
DO YOU THINK MAYA HAS A GOOD CHANCE OF SLOWING THE PROGRESSION OF MULTIPLE SCLEROSIS?

MAYA IS IN A GREAT POSITION WHEN IT COMES TO SLOWING THE PROGRESSION OF THIS DISEASE. IT'S RECOMMENDED THAT SHE CONTINUE TO BE MONITORED BY HER FAMILY DOCTOR AND AN MS SPECIALIST ON A REGULAR BASIS.

A

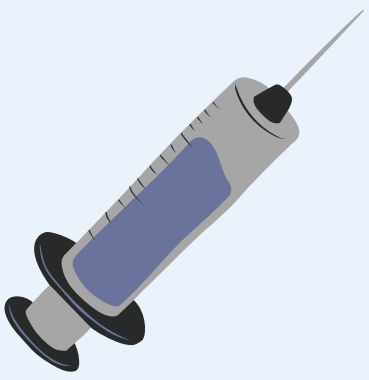
TREATMENT OF MULTIPLE SCLEROSIS

THERE IS NO CURE. TREATMENT FOCUSES ON REDUCING THE SEVERITY AND FREQUENCY OF ATTACKS.



Treatment with corticosteroids is usually the first line of defense during an active attack.[14]

Drugs within this family can reduce nerve inflammation and thus reduce the severity of the attack.



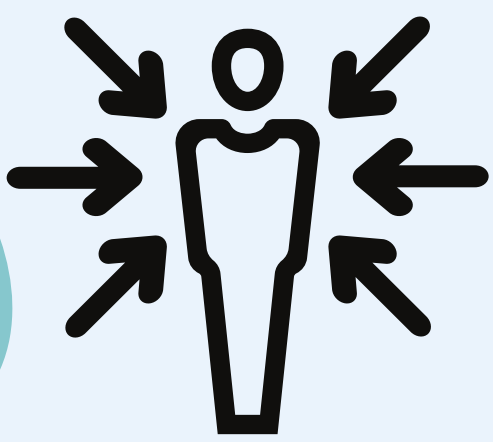
Disease-Modifying Therapies (DMT's) are typically used for relapsing-remitting MS and are designed to slow the progression of the disease.[15]

DMT's can be oral, injectable or infusions, and they can reduce the number of new lesions in the brain which reduces the frequency and severity of attacks.[18]

Physical therapy is recommended for patients with MS, and eating a balanced diet, avoiding stress and exercising regularly can help.[14]

DID YOU KNOW?

Treatment needs to be individualized as each case is different.



Symptoms are widespread, so therapies need to be as well.[15]

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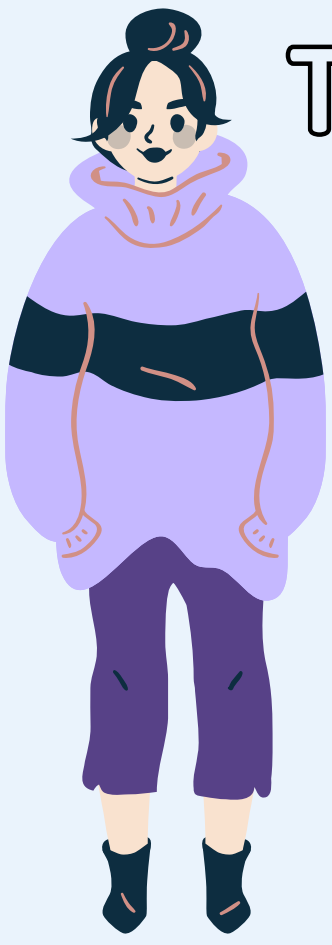
TREATMENT FOR MAYA



Maya is having problems walking, and she is feeling very stiff on a daily basis. She has moderate fatigue and has recently noticed some tremors in her hands when she is eating or writing. Maya's pain level is usually at a 7 out of 10 and she has mild depression.

MAYA'S TREATMENT

WALKING AIDS

STIMULANTS

MUSCLE RELAXANTS

ANTICONVULSANTS

ANTIDEPRESSANTS

PAIN MANAGEMENT

WHAT OTHER TREATMENTS DO YOU THINK MIGHT BENEFIT MAYA AND OTHERS SUFFERING FROM MULTIPLE SCLEROSIS?

MAYA MIGHT BENEFIT FROM ADDITIONAL THERAPIES SUCH AS MASSAGE THERAPY AND MEDITATION TO ENSURE STRESS IS REDUCED.

LIVING WITH MS

Living with MS comes with many hardships, and one that is hard to face is the amount of emotional distress a patient may endure.

DID YOU KNOW?

Depression is **THREE TIMES** more likely in patients living with MS than that in the general population.[19]

WHO FACES THESE CHALLENGES?

PATIENTS CARETAKERS

MENTAL HEALTH STRUGGLES

Studies show that nearly 50% of MS patients may experience some form of mental illness during the course of the disease.[19]

Of those, depression and anxiety are the most common. This is common due to the unpredictable nature of the disease.

IT IS RECOMMENDED THAT PATIENTS JOIN MS SUPPORT GROUPS

- Provide a sense of belonging
- Share their experiences
- Learn how to cope

CHECK OUT: THE MS SOCIETY OF CANADA

MS patients can join to connect with other MS patients.

https://mscanada.ca/

WANT TO LISTEN ALONG: CLICK HERE FOR INTERATIVE AUDIO

THE MS PROGNOSIS: ADVANCES IN TREATMENT & PERSONALIZED CARE

Multiple Sclerosis (MS) is a disease that affects everyone differently, with symptoms ranging from mild to severe. While it can shorten life expectancy by about eight years, most people do not die from the disease itself[20]. Early detection and treatment are key to managing symptoms and improving long-term outcomes.[20]

ADVANCES IN TREATMENT

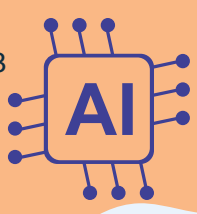
- **New medicines calm the immune system, reduce relapses & slow damage.[21]**
- **Research is making treatments safer and more effective with fewer side effects.[21]**
- **Personalized treatments focus on specific symptoms for better results.**

PRECISION MEDICINE & FUTURE RESEARCH

New MS drugs help reduce inflammation and prevent nerve damage.[22]

Scientists are also exploring stem cell therapy as a potential way to reset the immune system and halt MS progression.[21]

AI and genetics help predict disease progression and personalize treatment.[23]



Additionally, high-dose vitamin D supplementation is being studied for its potential to reduce MS activity and inflammation.[23]

FUTURE OF MS

The future of MS looks hopeful, though standardized tests and treatment guidelines are still needed. Ongoing research continues to improve care and long-term outcomes.

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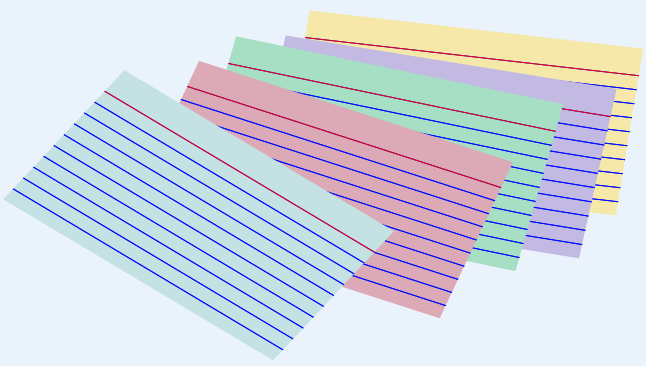
THE MS JOURNEY: WHAT WE'VE DISCOVERED

Clearly, the journey through navigating an MS diagnosis is not a smooth trek. It comes with many hardships that may be discouraging at times. Through this journey, we were exposed to:

1. HOW THE DISEASE MANIFESTS
2. SIGNS AND SYMPTOMS
3. THE PATHOPHYSIOLOGY
4. TYPES OF MS
5. THE PROGRESSION OF MS
6. THE TREATMENT
7. MENTAL HEALTH STRUGGLES
8. POSITIVE PROGNOSIS

By better understanding this disease, we as a society are able to move towards a favourable prognosis of this disease. Improved research and funding from people like us will allow MS to become less of a challenge and foster empathy and awareness.

WANT MORE RESOURCES?



CLICK THE ICON FOR MULTIPLE CHOICE QUESTIONS!

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