

Understanding How the Brain Naturally Learns

- The brain is the most complex part of the human body. It is about the size of a cantaloupe.
- This three pound organ is the seat of intelligence, interpreter of the senses, initiator of body movement, and controller of behavior.
- The brain is the crown jewel of the human body.

Understanding How the Brain Naturally Learns



What happens inside your brain?

Brain-friendly ways to learn better

How homework helps your brain

**How emotions affect learning and
memory**

How We Learn

10% of what we ???

20% of what we ???

30% of what we ???

50% of what we ???

70% of what is ???

80% of what is ???

95% of what we ???

How We Learn

10% of what we **READ**

20% of what we **HEAR**

30% of what we **SEE**

50% of what we **SEE** and **HEAR**

70% of what is **DISCUSSED** with **OTHERS**

80% of what is **EXPERIENCED PERSONALLY**

95% of what we **TEACH TO SOMEONE ELSE**

Natural Learning Process

- More than 8,000 people – from 2nd graders to graduate students have reported how they learned to be good at something outside of school.
- Every group, without exception, has reported the same **sequence of stages** by which they learned.
- What have you learned to be good at outside of school?

The Natural Learning Process

This is how the brain learns.

The brain learns by constructing knowledge through sequential stages.

Stage 1: **Motivation**/watch, have to, show interest

Stage 2: **Start to Practice**/practice, trial and error, ask questions

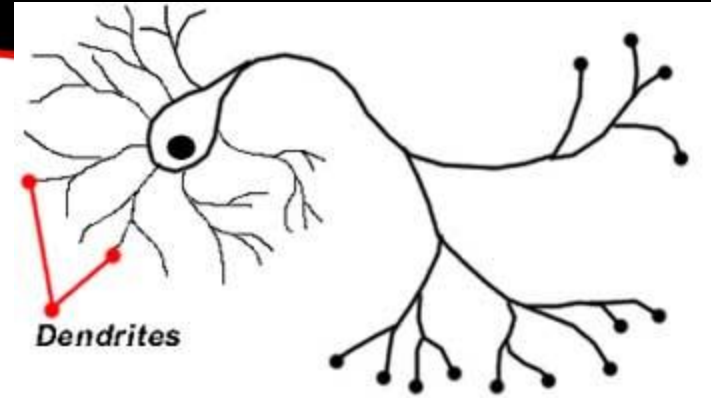
Stage 3: **Advanced Practice**/practice lessons, read, confidence

Stage 4: **Skillfulness**/some success, enjoyment, sharing

Stage 5: **Refinement**/improvement, natural pleasure, creative

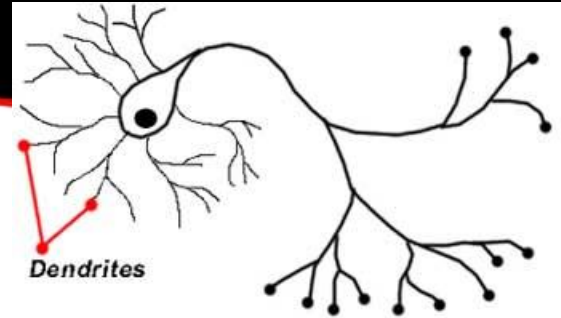
Stage 6: **Mastery**/teach, recognition, higher challenges

How the Brain Learns



- Brain cells are called *neurons*.
- You are born with at least 100 billion *neurons*.
- ***Dendrites*** (fibers) grow out of the neurons when you listen to/write about/talk about/ practice something.

Dendrites can grow only from a ***dendrite*** (fiber) that is already there – from something the learner already knows.

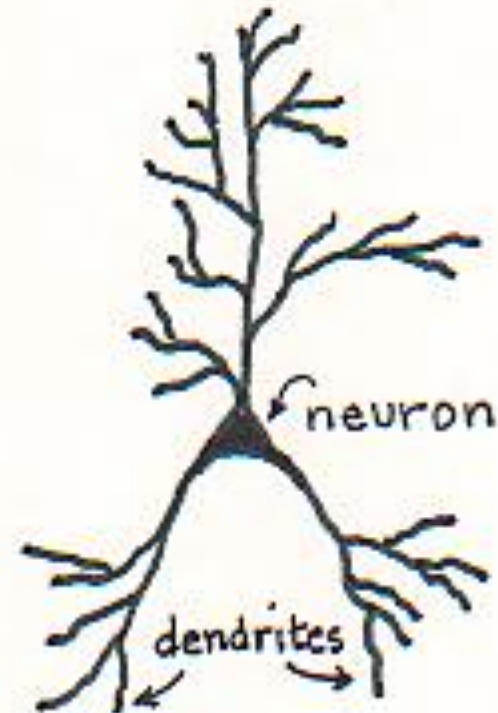


How the Brain Learns

- Like twigs on a tree dendrites can grow only from a twig or branch that is already there.
- Then like twigs growing on a tree, learning is constructed, higher and higher.
- As dendrites get higher and higher, what do you think happens?

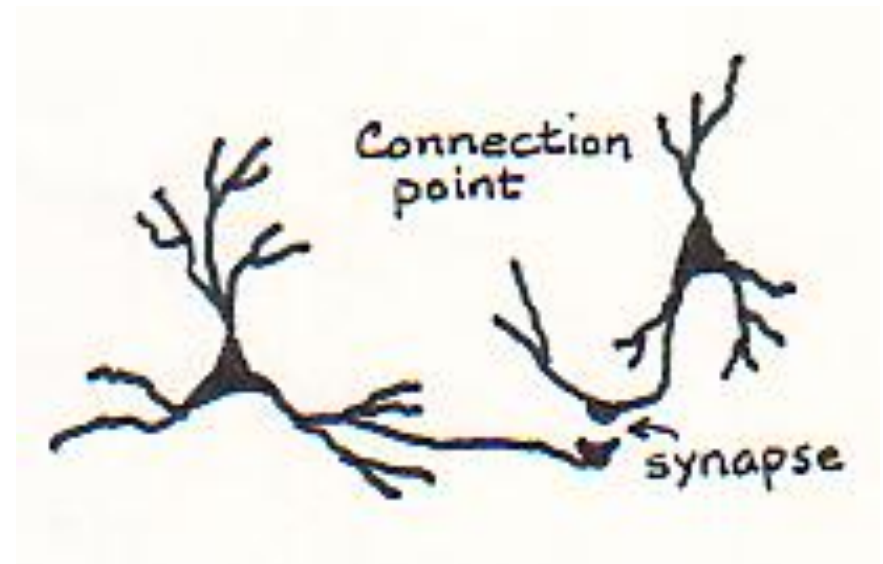
Learning is Natural!

- **Neurons (brain cell)** know how to grow **dendrites**, just like a stomach knows how to digest food.
- **Learning = Growth of dendrites.**
- New **dendrites** take time to grow; it takes a lot of **practice** for them to grow.

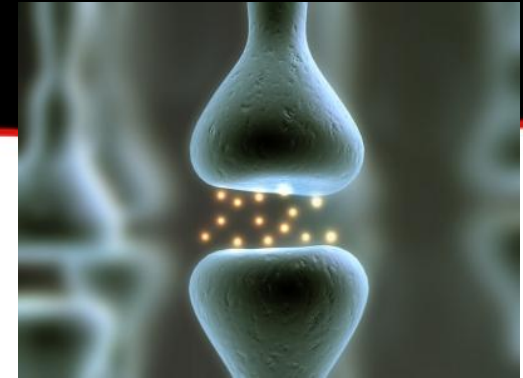


Connections Form Between Neurons (Brain Cells)

- When two *dendrites* grow close together, a contact point is formed.
- A small gap at the contact point is called the *synapse*.
- Messages are sent from one neuron to another as electrical signals travel across the *synapse*.

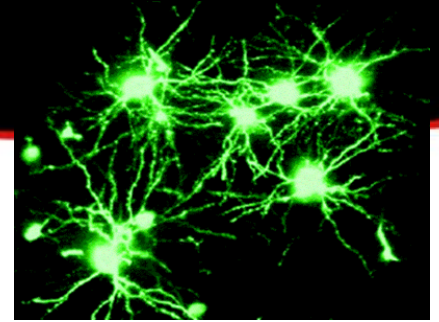


As We Learn...



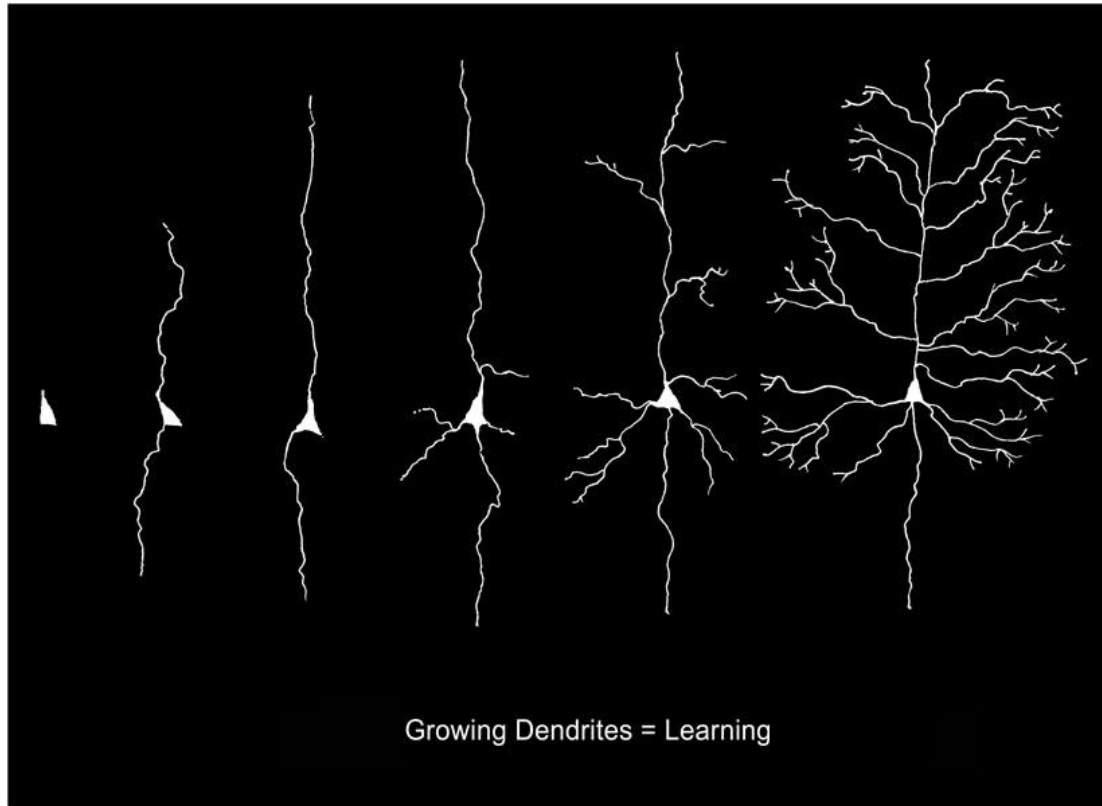
- As we learn, specific dendrites grow so that specific neurons connect at specific synapses to create large and more complex networks.
- There can be as many as 10,000 connections (synapses) per neuron (100 billion neurons.
- Do the math!! - a very complex network.

As We Learn ...



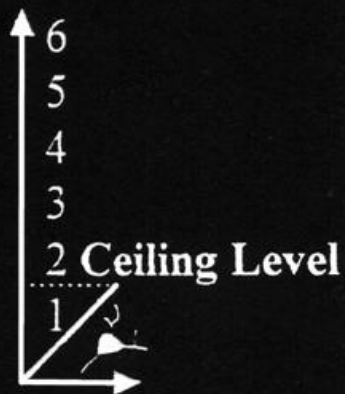
- Synapses can change in number minute by minute.
- Some synapses are strong, and some are weak – so weak they don't even send a signal.
- Through learning, weak synapses can become strong.
- No matter how many synapses a neuron has, it also has the potential to grow more.

Growing Dendrites = Learning



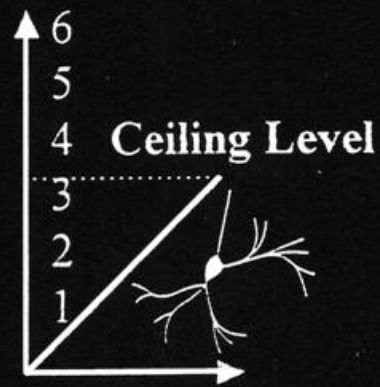
Neural Network Growth

Knowledge and Ceiling Level Increase with Neural Network Growth



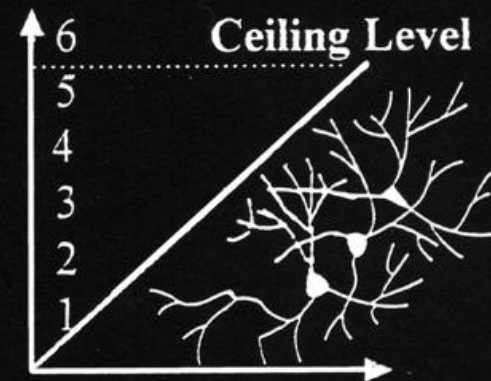
Little time and effort

Low ceiling level



More time and effort

Medium ceiling level

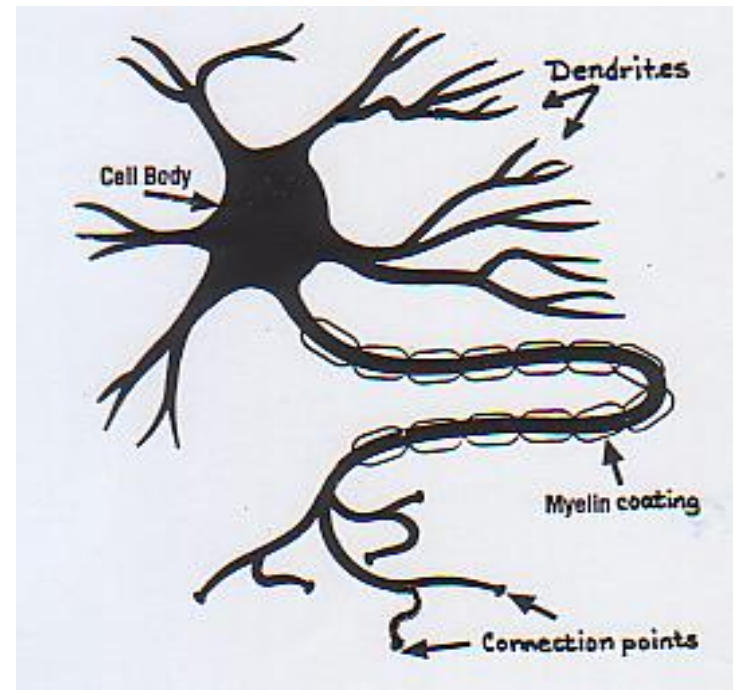


Much more time and effort

High ceiling level

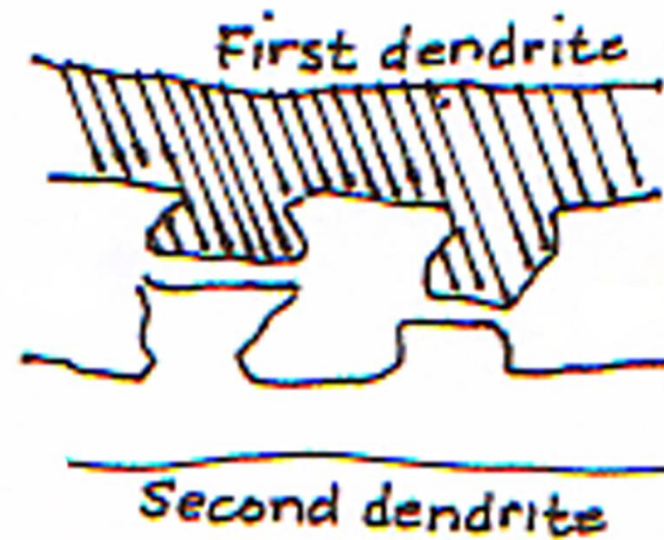
“Practice” Builds Stronger Connections

- When you practice something, the *dendrites* grow thicker with a fatty coating.
- The thicker the *dendrites*, the faster the signals travel. The coating also reduces interference.
- Have you ever noticed how some people seem to come up with the answer quicker than others?
Thicker dendrites.



“Practice” Builds Double Connections

- With enough practice, the dendrites build a ***double*** connection.
- Faster, stronger, double connections last a very long time.
You remember what you learned!



Implications

If students have not had the opportunity to grow the foundation *dendrites* for a new topic or skill, they don't have the basis from which to grow – on which to connect and construct – the *dendrites* for the higher levels of skill and knowledge.

Should we judge students as incapable or of less intelligence or talent and throw them and their potential away because they never had that opportunity?

No one can understand anything if it isn't connected in some way to something they already know.

Short-term Memory Is Very Short!

- If you learn something new and do it only ***once*** or ***twice***, the ***dendrite*** connection is very fragile and **can** disappear within hours.
 - Within 20 minutes, you remember **only 60%**.
 - Within 24 hours, you remember **only 30%**.

But if you practice within 24 hours, and then practice again later, you **remember 80%**.

Make the Most of Practice Time

$$\begin{array}{r} 82 \\ - 77 \\ \hline \end{array}$$

$$31 \overline{)12,012}$$

$$8^2 + 2(A + A^2) = 27$$

- You grow *dendrites* for **exactly** the same thing you are practicing.
- If **you listen or watch** while math problems are solved, **you grow dendrites for listening or for watching.**
- If **you actually solve** the problems **yourself**, you grow dendrites for solving.

$$\sqrt{6} \quad 3 \frac{8}{9}$$

DANGER

Emotions Affect Learning

- When learners feel unconfident or anxious, certain chemicals flow into the *synapses* to shut them down.

Danger! No time to think! Just run away!

This is the flight reaction = "run for your life!"

Students mistakenly think they have a poor memory, but it is their emotions that are sabotaging them.

- When learners feel confident, different chemicals flow into the *synapses* that make them work quickly and well:

"I can handle this." *This is the fight reaction.*

Emotions Affect Learning

- Feelings and emotions always affect reasoning and memory, either in a positive way or a negative way.
- Feelings can help us remember and can also make us forget.

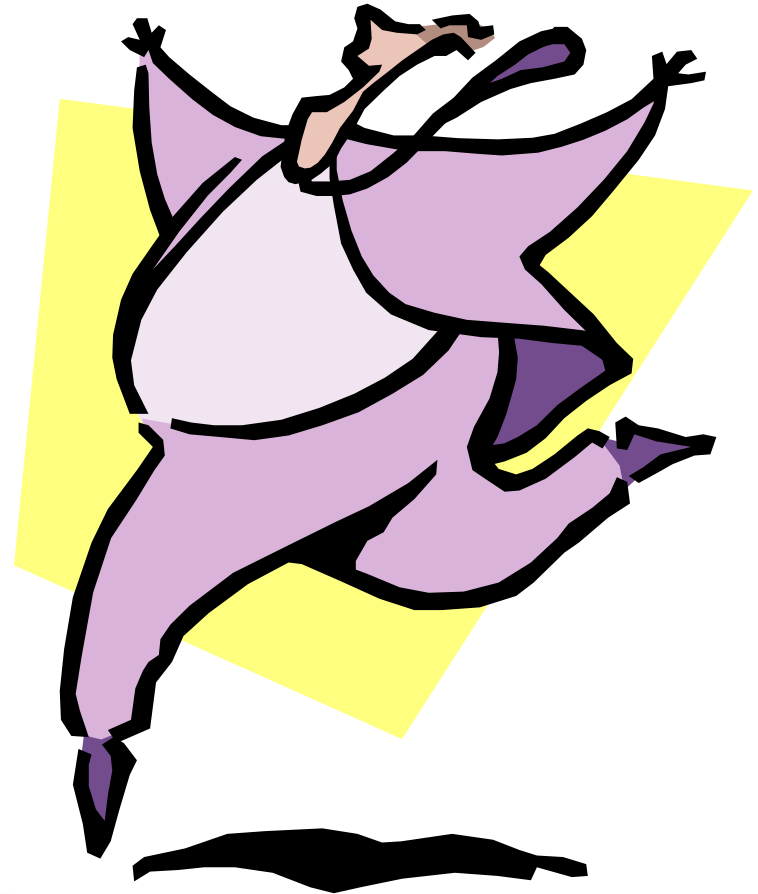
What Can Emotions Do to You?



- Anxiety floods your body with **adrenaline** (“fight or flight”).
- **Adrenaline** makes it hard for the neuro-transmitters to carry messages across the **synapses** in your brain.
- That causes “blanking out” on a test. And that is called test anxiety.

How Can Emotions Help You?

- **Endorphins** make you feel calm.
- Your body produces **endorphins** when you relax, exercise, laugh, or learn new things.
- If you practice producing calming hormones, it will help when you are under stress.



Brainology

- Throughout our lives our brains change constantly with learning and experience.
- Does this have implications for students' motivation and learning? YES!
- What students believe about their brains – whether they see their intelligence as something that is fixed or something that can grow and change – has profound effects on their motivation, learning, and school achievement. (Dweck, 2006).
- These mindsets create different psychological worlds:
 - One in which students are afraid of challenges and devastated by setbacks
 - One where students relish challenges and are resilient in the face of setbacks

Fixed Mindset

- Many students believe that intelligence is fixed, that each person has a certain amount and that is that.
- These students worry about how much of this fixed intelligence they possess.
- A fixed mindset makes challenges threatening for students because the student believes that his fixed ability may not be up to the task.
- Mistakes and failures become demoralizing because the student believes that such setbacks reflect badly on his level of fixed intelligence.

Growth Mindset

- Other students believe that intelligence is something that can be cultivated through effort and education. They don't necessarily believe that everyone has the same abilities or that anyone can be as smart as Einstein.
- They understand that even Einstein wasn't Einstein until he put in years of focused hard work.
- Students with this growth mindset believe that intelligence is a potential that can be realized through learning.
- Getting smarter comes from confronting challenges, profiting from mistakes and persevering in the face of setbacks.

Students with Fixed Mindset

- Believe that intelligence is just “fixed.”
- Cares more about how smart they appear than how smart they really are.
- Believes that if you worked hard in school it meant you didn’t have ability.
- If you are smart, things will just come naturally to you.
- Since just about every worthwhile pursuit involves effort over a long period of time, this belief is potentially crippling, not only in school, but also in life.
- After a setback in school they were more likely to feel dumb, study less the next time, and seriously consider cheating.
- If you feel dumb – permanently dumb – in an academic area, there is no good way to bounce back and be successful in the future.
- This is why so many bright students stop working when school becomes hard.

Students with Growth Mindsets

- Believe that intelligence is a potential that can be realized through learning.
- Confronting challenges, profiting from mistakes, and persevering in the face of setbacks become ways of getting “smarter.”
- Much more interested in learning than in just looking smart in school.
- Believe that the harder you work the more your ability will grow, and that even geniuses have had to work hard for their accomplishments.
- After a setback in school, these students simply study more or study differently the next time.
- It is the belief that intelligence can be developed that opens students to a love of learning, a belief in the power of effort and constructive, determined reactions to setbacks.

How do students learn these mindsets?

The Praise Movement

- In the 1990s parents and schools decided that the most important thing for kids to have was self-esteem.
- Almost 85% of the parents in the 1990s endorsed the notion that it was necessary to praise their children's abilities to give them confidence and them achieve.
- Students praised for their intelligence did not want to learn.
- For students that are praised for their intelligence, it is too humiliating for them to admit mistakes
- When offered a challenging task, the majority opted for an easier one, one on which they could avoid making mistakes.
- Intelligence praise makes students fragile.
- Students praised for intelligence will lose their confidence as soon as the problems get more difficult.

How do students learn these mindsets?

The Effort Praise

- Students praised for their efforts in school will maintain their confidence, their motivation and their performance.
- Students praised for their efforts in school want a task they can learn from
- Believe that intelligence can be developed
- Believe they are in control of their brain and its development.

Students as Empowered, Engaged, Successful Learners



When students self-evaluate how much their *dendrites* have grown, they see that they are in control of their learning.

They know their learning increases as they put in more time and effort.

About Learning and Teaching

Learning is all about empowerment.

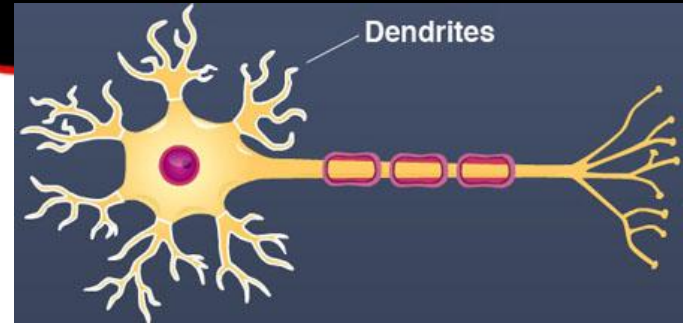


The brain is our survival organ. It is born to learn, is impelled to learn.

The brain starts all learning from where it is and constructs the new from there.

REVIEW

You are naturally smart, because ...



- Your brain knows how to grow *dendrites* just like your stomach knows how to digest food.
- Think about a baby who learns to speak in its native language without any special classes or training!

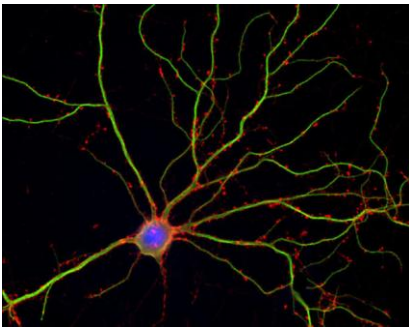
REVIEW

- You must do something active (explain, solve, draw, write, etc.) in order to learn, because...



REVIEW

You must do something active to learn,
because...

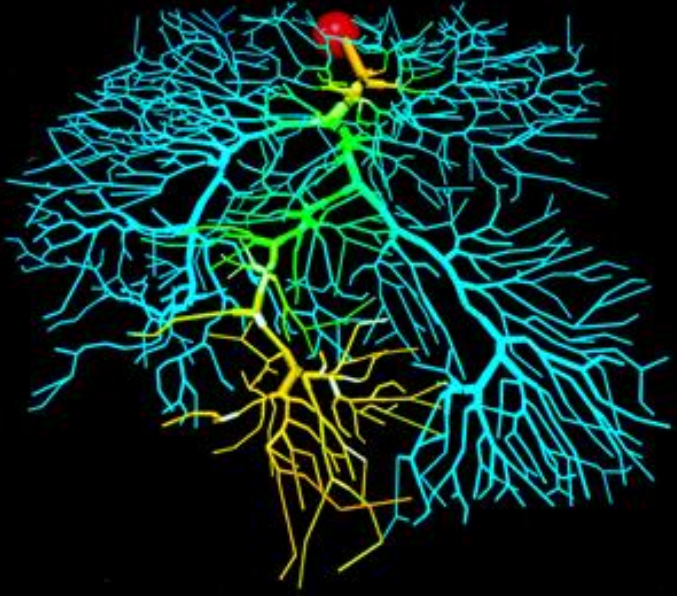


- ***Dendrites*** grow **ONLY** when you are actively doing something.
- No one else can grow ***dendrites*** for you!

REVIEW

Dendrites cannot grow in a void

- New *dendrites* can only grow off of what is already there. New skills must connect to, and grow off of, previously learned skills.
- If you do **not** have the necessary *dendrites* in place, new material will seem to go “right over your head”.
- So, start with a course that matches your skill level.
- If you don’t have the necessary foundation, you will struggle.



REVIEW

Dendrites take time to grow, because...

- It takes a **lot** of **practice** for *dendrites* to grow.
- This is why you do homework.
- This is why trying to cram everything into your brain the night before a test doesn't work.

Review

- Making mistakes, and getting feedback so you can correct them, allows you to check the accuracy of the connections in your brain.
- Be sure to get feedback quickly so you don't practice the wrong thing and build a strong but wrong connection!



Use dendrite theory to answer these questions...



1. I understand what's going on in the lecture just fine. But when I get home and start on the homework assignment, why am I lost?
2. I attend class and do all the homework and feel like I understand everything. Then why do I just "blank out" on the test and can't do anything?



Can you answer these?

3. Why should I do all this homework? It's just the same thing over and over.
4. I work full time. Can I do homework only on weekends and still pass the course?



More questions...

5. I've been absent for a week but there's a test tomorrow. Can I cram it all in tonight?
6. Why can't I take this math course even if I haven't passed the prerequisite course (or gotten a high enough score on the placement test)?

So what should you do?

- Start with the right math course; then skills build from one course to the next. Take the rest of your math courses one at a time, in order.
- Do some of the homework as soon as possible after class, before you forget.
- Try to practice math every day.
- To manage anxiety, learn simple relaxation techniques such as slow, deep breathing.

More things you can do...

- Make sure you are **actively** DOING something when you study.
 - Make study cards.
 - Draw pictures or diagrams.
 - Solve lots of problems; check your answers.
 - Check your understanding by explaining how to do a problem to another student.
 - Create a practice test for yourself. Work it in the same amount of time you'll be given in class.

Enjoy Using Your Brain!

