This is Your BRAIN 🧠 on Green Tea 🍵: NEW Science on the Incredible Brain Health Benefits of Green Tea

Note from Dylan:

Thanks for checking out the video! Hope you liked it 😊

Here I've organized the timestamped and annotated transcript of the whole video. You will find numbered citations in [brackets] that correspond with where they appeared in the video. The full 104-article Works Cited located at the bottom of this document is numbered to match their citations in the video and in this transcript. Lastly, I took 16 tables/figures from among the 104 articles cited that I feel are really important and helpful in understanding the key concepts covered in the video. I added custom captions under each figure to provide some nuanced context for the information. Some of the information is extremely technical – don't feel like you need to understand every minute detail in order to get the general idea of what's being communicated. If you enjoyed this project and want to help create more like it in the future, you can support Wu by chipping into our GoFundMe or by grabbing your next bag of premium tea at WuMountainTea.com

00:00:00:00 - 00:00:17:20
Your brain on green tea is more focused, less anxious, and way less likely to develop diseases like Alzheimer's, Parkinson's and dementia [1-6]. Those are the findings of a mountain of fascinating new research that has explored how green tea consumption impacts the human brain.

00:00:17:20 - 00:00:21:16
in this video, we are diving into this research and breaking it right down.

00:00:21:16 - 00:00:29:08
I began researching this topic formally in 2019 when I published an academic review article about tea brain interactions [7],

00:00:29:08 - 00:00:33:04
And this article has been cited over 100 times by researchers around the world.

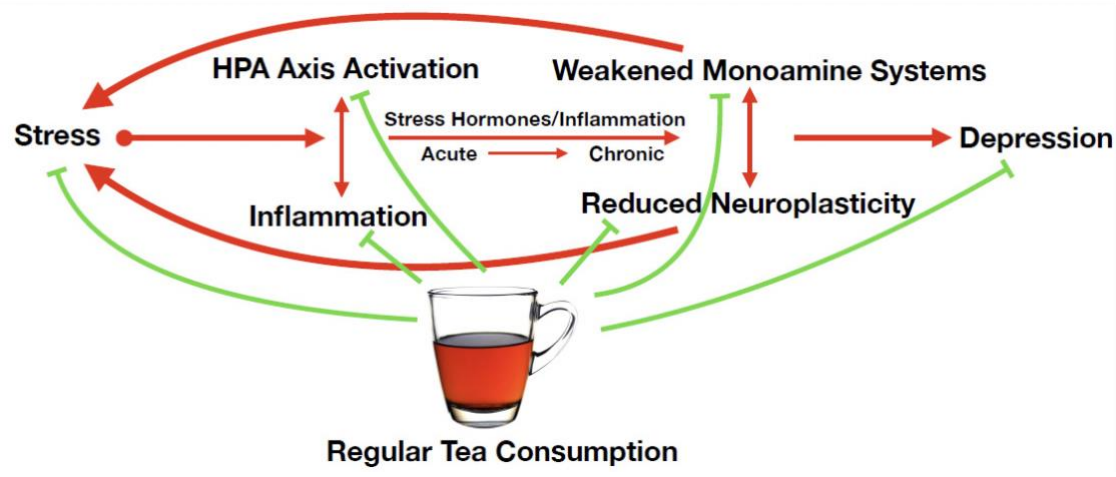

Figure 1 This is the central 'Reduce and Restore' hypothesis proposed by Rothenberg et al. [7] in 2019 to explain the potential mechanisms underlying previously observed reductions in major depressive disorder (MDD) associated with regular tea consumption (other *C. sinensis* tea types too, not just green tea). We examined the effects of regular tea intake in the context of a contemporary unified theory of depression pathology. External stressors induce an HPA-mediated stress response and inflammation. If acute stress and inflammation become a chronic, persisting physiological state, there can be detrimental effects on neuronal health and monoaminergic systems. Compromised cognitive emotional processing resulting from cumulative neuro-pathologies inhibits the ability to cope with future external stressors, re-feeding the state of chronic stress/inflammation. Green lines represent attenuating effect, while red lines represent exacerbating effect. Numerous bioactive compounds in tea, including but not limited to L-theanine, L-arginine, catechins, theasinensis, theaflavins, and saponins have been found in previous research works to alleviate various 'cogs of the wheel' in the depressive pathology framework above. Therefore, in terms of alleviating MDD pathology, various tea constituents may be acting within various relevant pathways with individually modest but collectively significant effect sizes.

00:00:33:04 - 00:00:35:17
with this endorsement from the scientific community

00:00:35:17 - 00:00:39:05
I thought it was about time to bring this fascinating information

00:00:39:05 - 00:00:40:07
to the rest of us.

00:00:40:07 - 00:00:44:08
And what better place to do such a thing than the YouTube.

00:00:44:11 - 00:00:50:00
We're honing in on two key windows of time in terms of the effects of green tea consumption on the brain.

00:00:50:00 - 00:00:57:05
we have the acute effects, which is like 30 to about 120 minute window of time right after you sip a cup of green tea.

00:00:57:05 - 00:00:58:17
These are changes in mood,

00:00:58:17 - 00:01:01:06
attention and cognitive performance [1,8-14].

00:01:01:06 - 00:01:04:00
These are coming from caffeine, l-theanine and some of the other

00:01:04:00 - 00:01:06:14
compounds in green tea that we're going to get into in a second [14-20].

00:01:06:14 - 00:01:10:14
The second window of time is called the chronic effects. And this is how

00:01:10:14 - 00:01:13:06
the brain of a green tea drinker looks different [21]

00:01:13:06 - 00:01:16:11
through years of daily regular green tea intake [22]

00:01:16:11 - 00:01:20:06
and how such a brain is much less likely to develop

00:01:20:06 - 00:01:20:24
diseases

00:01:20:24 - 00:01:23:00
like dementia, Alzheimer's and Parkinson's.

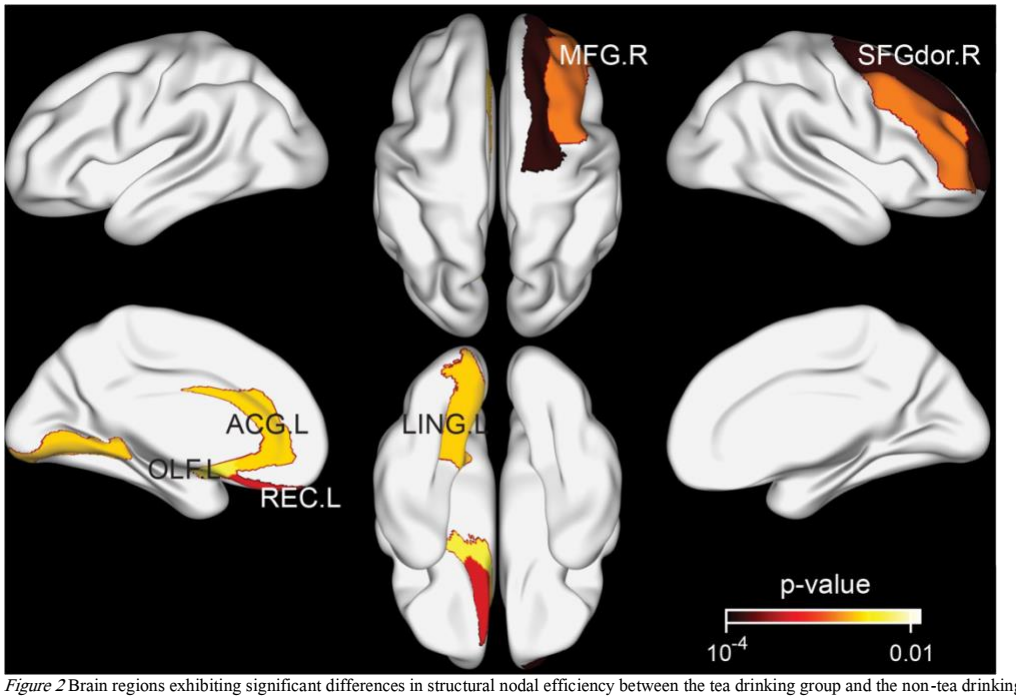

Figure 2 Brain regions exhibiting significant differences in structural nodal efficiency between the tea drinking group and the non-tea drinking group at the significance level of 0.01 (uncorrected) statistical evaluated by a permutation test [21]

00:01:23:00 - 00:01:25:22
for now, let's get into how green tea is impacting the brain.

00:01:25:24 - 00:01:32:23
we have our two windows of time and we have three major green tea molecules, three neuroactive and bioactive compounds

00:01:32:23 - 00:01:36:23
in green tea that will be mediating these effects on the human brain.

00:01:36:23 - 00:01:37:23
our first

00:01:37:23 - 00:01:41:05
key critical compound is caffeine.

00:01:41:05 - 00:01:45:22
Caffeine is the, quote unquote, “most consumed mind-altering drug on earth”

00:01:45:22 - 00:01:47:22
Why is everybody and their mothers

00:01:47:22 - 00:01:49:11
dosing up on caffeine

00:01:49:11 - 00:01:50:04
throughout the day?

00:01:52:24 - 00:01:53:15
Well,

00:01:53:15 - 00:02:00:11

acutely, caffeine is improving mood and cognitive performance [23-25]. It increases attention. People use it as

00:02:00:11 - 00:02:00:19
a

00:02:00:19 - 00:02:03:01
performance enhancing drug

00:02:03:01 - 00:02:04:13
these are very well known

00:02:04:13 - 00:02:05:10
facts about

00:02:05:10 - 00:02:06:12
caffeine intake

00:02:06:12 - 00:02:07:13
in the short run.

00:02:07:13 - 00:02:12:11
But what is a little bit less known about caffeine is that in the long run through chronic intake of

00:02:12:11 - 00:02:16:02
caffeine, you see significant reductions in

00:02:16:02 - 00:02:19:05
risk for Alzheimer's and Parkinson's [26].

00:02:19:05 - 00:02:22:04
Caffeine can actually function as an antioxidant

00:02:22:04 - 00:02:25:05
and anti-inflammatory agent in the brain [27].

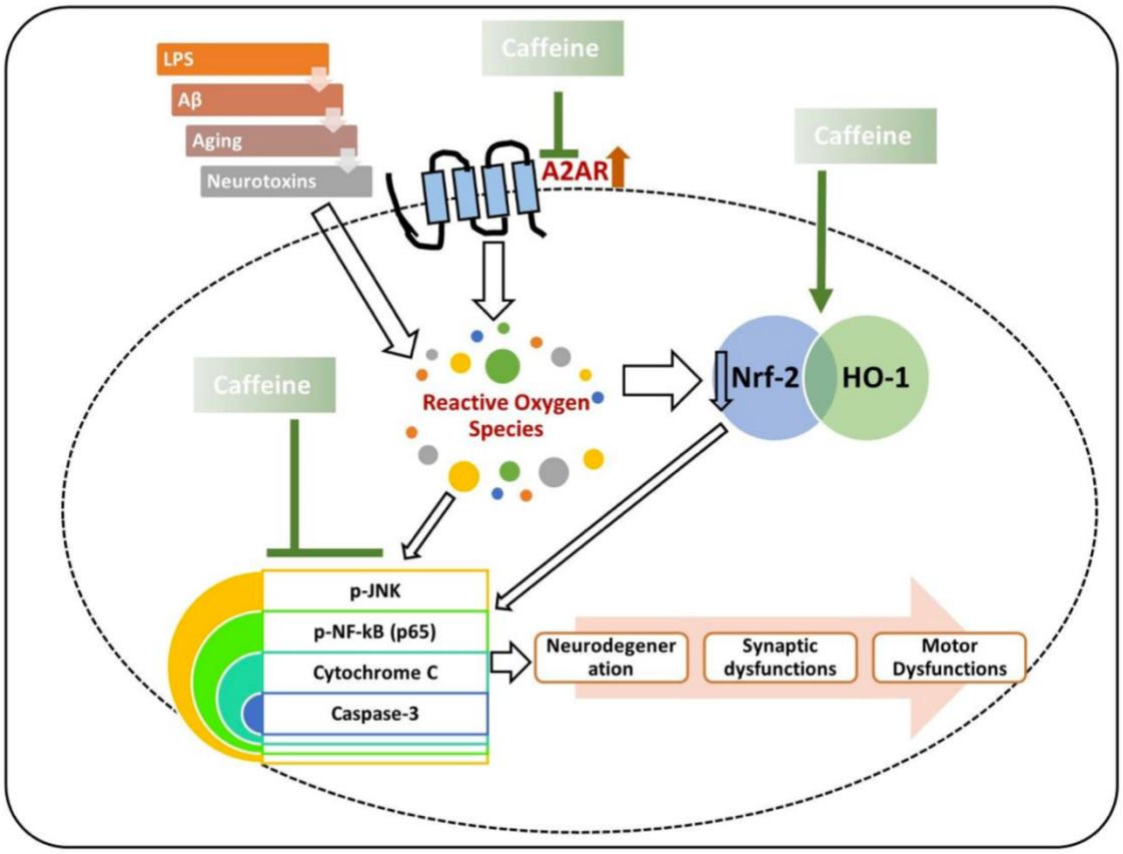

Figure 3 Role of caffeine in the management of neurodegeneration, proposed by Ikram et al. [26]. Above are some of the rescuing effects of caffeine against neurotoxins and age-related neurodegeneration. Caffeine suppresses the expression of the A2A receptor and upregulates the expression of nuclear factor erythroid 2-related factor 2 (Nrf-2, the endogenous antioxidant enzyme discussed later in the video in relation to green tea catechins), thereby regulating the inflammatory mediators (phospho-c-Jun n-terminal kinase (p-JNK), phospho-nuclear factor-kappa B (p-NF-kB)), apoptotic markers (cytochrome C, and caspase-3), synaptic dysfunctions, and neurodegeneration. Green arrows indicate beneficial effects of caffeine. White arrows indicate cause/effect.

00:02:25:05 - 00:02:27:11
moderate. That's the key word here.

00:02:27:11 - 00:02:30:13
Too much caffeine is bad and it affects

00:02:30:13 - 00:02:33:02
your sleep latency, your ability to fall asleep.

00:02:33:02 - 00:02:36:13
And no benefit of caffeine in the long run

00:02:36:13 - 00:02:38:05
can compensate for

00:02:38:05 - 00:02:39:08
a loss of sleep

00:02:39:08 - 00:02:40:05
or sleep quality.

00:02:40:06 - 00:02:41:11
So you need

00:02:41:11 - 00:02:43:08
to take caffeine in moderation.

00:02:43:08 - 00:02:47:11
and what is an appropriate amount of caffeine intake daily for humans depends.

00:02:47:11 - 00:02:50:24
humans have a gene called CYP1A2 [28] and

00:02:50:24 - 00:02:52:01
different variants

00:02:52:01 - 00:02:54:01
of this gene control your

00:02:54:01 - 00:02:58:20
relative ability to degrade and break down caffeine after you've consumed it [29].

00:02:58:22 - 00:03:01:01
So if you have a double copy of the slow

00:03:01:01 - 00:03:01:23
metaboliser,

00:03:01:23 - 00:03:02:14
then

00:03:02:14 - 00:03:05:00
you're going to be the person who sips an

00:03:05:00 - 00:03:07:23
espresso at eight in the morning and they still

00:03:07:23 - 00:03:09:09
are feeling jittery

00:03:09:09 - 00:03:09:20
at

00:03:09:20 - 00:03:10:23
9 p.m..

00:03:10:23 - 00:03:14:06
Then you have the fast metabolisers who can

00:03:14:06 - 00:03:17:05
drink a cup of green tea and fall asleep 20 minutes later.

00:03:17:05 - 00:03:19:03
And then the rest of us are somewhere in between.

00:03:19:04 - 00:03:21:15

So it depends on your genetics [30]

00:03:21:15 - 00:03:26:07
it would be nice if you got your genome tested, but you can generally just feel for yourself

00:03:26:07 - 00:03:28:02
how much caffeine affects you

00:03:28:02 - 00:03:29:09
whatever you can drink

00:03:29:09 - 00:03:33:02
and not have your sleep affected, that's the right amount for you.

00:03:34:05 - 00:03:40:07
Caffeine gets a bad rap, but in reality, if you take it in moderation and you consume it responsibly, it can be pretty good,

00:03:40:07 - 00:03:44:13
So the second green tea, neuro active

00:03:44:13 - 00:03:49:16
that is mediating these really cool effects on the brain is called L-

00:03:49:16 - 00:03:50:09
Theanine [31,32]

00:03:50:09 - 00:03:56:14
and it's this amino acid that has really incredible short term and long-term effects on the brain.

00:03:56:14 - 00:04:00:00
So a really cool review article I found written in 2021 [33]

00:04:00:00 - 00:04:02:13
compiled all of the effects that

00:04:02:13 - 00:04:03:01
Theanine

00:04:03:01 - 00:04:04:20
has been found to have on

00:04:04:20 - 00:04:05:11
the brain.

00:04:05:11 - 00:04:09:23
Some of them were human studies and some of them were animal studies. But

00:04:09:23 - 00:04:10:18
You can see

00:04:10:18 - 00:04:14:20
You have stress and anxiety relieving effects. We have improved sleep quality.

00:04:14:20 - 00:04:16:09
we have alleviation of depression,

00:04:16:09 - 00:04:18:06
have enhanced learning and memory

00:04:18:06 - 00:04:21:10
and decreasing risk of neurodegenerative diseases.

00:04:21:10 - 00:04:22:10
study design

00:04:22:10 - 00:04:24:00
different doses of l-theanine

00:04:24:00 - 00:04:24:16
effects

00:04:24:16 - 00:04:27:06
And all these references I have linked in the work cited

00:04:27:06 - 00:04:27:24
of this video.

Table 1. Recent studies on the effects of L-theanine on various mental and brain conditions

Functions	Study design	Outcomes	Reference
Relieving stress and anxiety	L-theanine (25–50 mg twice daily) for the anxious dogs	Effective for treating anxiety-related behaviors without causing any side effects	Araujo et al. (2010)
	L-theanine (2 and 4 mg/kg) for the stressed mice	Ameliorated chronic stress-induced disorders	Tian et al. (2013)
	4-week L-theanine intake (200 mg/day) on healthy adults	Ameliorated stress-related ailments and cognitive impairments	Hidese et. al., 2019)
	Oral administration of L-theanine (200 mg) on the students	Increased α-brain wave activity in the occipital and parietal regions of the brains	Kobayashi et al. (1998)
	Oral intake of 200 mg L-theanine on the healthy participants with induced high-stress	Attenuated the rise in heart rate, salivary immunoglobulin A responses and blood pressure	Kimura et al. (2007); Yoto et al. (2012)
Improving sleep quality	Low (22.5 and 37.5 mg/kg) and high (75 and 150 mg/kg) doses of L-theanine administration on the rats	Low dose attenuated the caffeine-induced sleep disturbances, while high dose exhibited the opposite effect	Jang et al. (2012)
	4-week administration of L-theanine (200 mg daily) on healthy adults	Improved sleep quality via reducing sleep latency, sleep disturbance, and use of sleep medication	Hidese et al. (2019)
	6-week administration of L-theanine (400 mg daily) on the boys with ADHD	Improved sleep percentage and sleep efficiency scores, along with a non-significant trend for less activity during sleep	Lyon et al. (2011)
Alleviating depression	10-day L-theanine administration (1, 4 and 20 mg/kg) on the depressed mice	Reduced the immobility time in both the forced swim test and tail suspension test	Yin et al. (2011)
	21-day L-theanine administration (2 mg/kg) on the rats with depression	Ameliorate behavioral disorders and increased circulating monoamine neurotransmitters	Shen et al. (2019)
	8-week L-theanine administration (250 mg daily) on the patients with major depressive disorder	Exerted multiple beneficial effects on depressive symptoms, as well as anxiety, sleep disorder and cognitive impairments	Hidese et al. (2017)
Enhancing learning ability and memory	4-month L-theanine administration (180 mg daily) on the rats	Showed improved learning ability and memory	Juneja et al. (1999)
	6-week L-theanine administration (4 mg/kg daily) on young rats	Facilitated neurogenesis in the developing hippocampus, and thus improve recognition memory	Takeda et al. (2011)
	There doses (100, 200 and 400 mg) of L-theanine and a placebo were consumed by 27 healthy young adults	Improved attention in a dose-dependent manner	Dassanayake et al. (2020)
	The combination (200 mg L-theanine and 160 mg caffeine) was consumed by healthy participants	L-theanine and caffeine could exert a synergistic effect to decrease fMRI responses to distractor stimuli	Kahathuduwa et al. (2018)
Decreasing the risks of neurodegenerative diseases	Oral administration of L-theanine (200 mg/kg) by the rats with induced oxidative damage in the brain	Increased the status of antioxidants, and the activities of creatine kinase, AchE, and ATPases	Sumathi et al. (2016)
	L-theanine (25–50 mg/kg) intake by the rats with induced striatal toxicity	Decreased proinflammatory cytokines levels and restored striatal GABA, glutamate and catecholamine levels	Jamwal and Kumar (2017)
	8-week injection of L-theanine (100 or 200 mg/kg/day) in the mice with Cadmium (Cd)-induced brain injury	Reduced Cd level in the brain and plasma, and inhibited Cd-induced neuronal cell death	Ben et al. (2016)

Figure 4 Above is Table 1 of the article, “Theanine as a promising agent for health-promotion: a review” by Wang et al. [33]. You can read the original article and check the references cited in this Table using this DOI link: https://doi.org/10.31665/JFB.2020.13257

00:04:27:24 - 00:04:34:17
personally, to me the most interesting of these effects is the anti-stress and anti-anxiety effects.

00:04:34:17 - 00:04:35:18
First, because

00:04:35:18 - 00:04:37:14
stress and anxiety suck

00:04:37:14 - 00:04:40:13
Gilmore. You suck.

00:04:40:13 - 00:04:44:06
I'd love to punch that guy in the face right now But I can't 'n all because I'd get in trouble.

00:04:44:06 - 00:04:47:08
But secondly, this is the topic that has

00:04:47:08 - 00:04:51:24
the most amount of research done about it [34-40]. When you're looking at the effects of

00:04:51:24 - 00:04:54:21
green tea and specifically l-theanine on the brain.

00:04:54:21 - 00:05:00:02
one of my favorite studies was conducted by Dr. Unno from Japan [36], and she

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took undergraduate students

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who were preparing for a final exam and then

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starting their new job. And so it's a very stressful time in the lives of these students. She had two groups. One was placebo and one was

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200 milligrams of l-theanine twice a day.

00:05:15:12 - 00:05:16:08
she found

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during this time

00:05:17:06 - 00:05:21:00
the both subjective and objective markers of stress

00:05:21:00 - 00:05:25:17
in these students was significantly lower in the L-theanine group than the placebo group.

00:05:25:17 - 00:05:38:06
the subjective stress marker is just asking how stressed out are you right now? And you can rate it 1 to 10. And then the objective marker was measuring the salivary amylase levels

00:05:38:06 - 00:05:41:16
Basically, when we're more stressed out, we have more salivary amylase

00:05:41:16 - 00:05:44:00
that study was fascinating

00:05:44:00 - 00:05:52:04
done in humans subjective and objective measures showing that l-theanine significantly reduced stress in this very stressful time of these student's lives.

00:05:52:04 - 00:05:57:15
so there's all types of studies actually just like that that have used human subjects and found

00:05:57:15 - 00:06:02:17
that L-theanine had a significant stress reducing an anti-anxiety effect [34-40].

00:06:02:17 - 00:06:05:08
it's been so clearly observed at this point that

00:06:05:08 - 00:06:14:18
researchers are hardly even asking, does l-theanine reduce stress and anxiety? They're more asking **how** does l-theanine reduce stress, anxiety? [35]

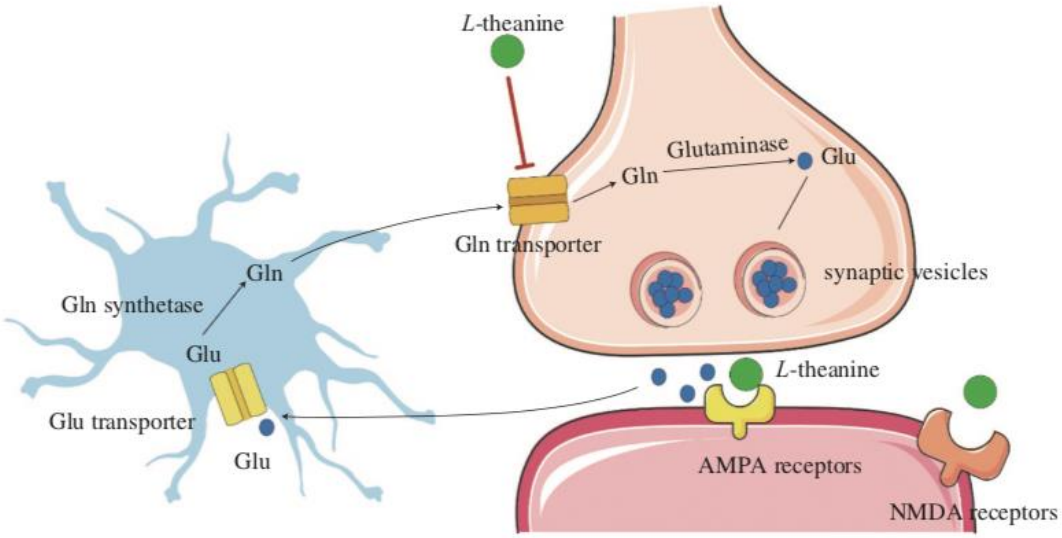

Figure 5 Schematic representation of L-theanine pre- and post-synaptic effects. L-theanine suppresses glutamine (Gln) transporters to inhibit the incorporation of extracellular Gln into the neuron [35]

00:06:14:18 - 00:06:17:03
the mechanisms here are actually still an active

00:06:17:03 - 00:06:18:10
area of research, but

00:06:18:10 - 00:06:23:18
you can check out this article [35] if you want to dive into how this is even humanly possible.

00:06:23:18 - 00:06:26:07
for now, let's switch to the chronic side of things [38,41]

00:06:26:07 - 00:06:35:19
chronically through daily regular intake of green tea, you see L-theanine acting again as an antioxidant and anti-inflammatory agent in the brain [42], which

00:06:35:19 - 00:06:36:16
over time

00:06:36:16 - 00:06:38:12
contributes to a much lower

00:06:38:12 - 00:06:42:06
risk level for Alzheimer's, dementia and Parkinson's.

00:06:42:06 - 00:06:47:04
And indeed, researchers have found a significantly negative correlation between

00:06:47:04 - 00:06:50:19
l-theanine intake and risk for Parkinson's disease [42],

Table 1
Role of L-theanine in ameliorating the cardinal pathophysiological changes in Parkinson's disease.

Parkinson's disease pathophysiology	Beneficial impact of L-Theanine	Reference
Anti-oxidative effects	1) 100 and 200 mg of L-theanine administered 1 h before 3-nitropropionic acid results in an increase in antioxidant molecules, superoxide dismutase and glutathione as well as substantial up-regulation in catalase and succinate dehydrogenase activity.	Thangarajan et al. (2014)
	2) 500 μM of L-theanine efficiently diminishes the level of HO-1 and ERK1/2 phosphorylation.	Cho et al. (2008)
	3) Significant increase in glutathione level in both astrocytes and glial conditioned medium and striatum of mice at 4 mg/kg L-theanine dosage for 14 days.	Takeshima et al. (2016)
	4) Excessive dopamine induced quinoprotein formation is attenuated by L-theanine (500 μM) in mesencephalic neuron-rich cultures.	Takeshima et al. (2016)
	5) 10 mmol (1.74 g)/kg once a day of L-theanine intake induces the mRNA expression of PLC-β1 and γ1 anti-stress molecules in primary cultured rat cerebral cortical neurons.	Nishida et al. (2008)
	6) Oral administration of 200 mg/kg L-theanine increases the over-all status of antioxidants, decreases lipid peroxidase, TBARS and nitric oxide.	Nishida et al. (2008)
	7) L-theanine prevents polychlorinated biphenyl induced oxidative damage in brain.	Nishida et al. (2008)
Anti-inflammatory effects	1) High dose of L-theanine (400 mg/kg) reduces the expression of overall inflammatory cytokines.	Li et al. (2016)
	2) 100 & 200 mg/kg oral L-theanine intake improves immunity by altering T_H2/T_H1 cytokine balance and their expression.	Thangarajan et al. (2014)
Restoration of altered neurotransmitter level	1) L-theanine increases dopamine concentration in striatum, hippocampus and hypothalamus.	Yokogoshi and Terashima (2000)
	2) Administration of L-theanine elevates GABA level by influencing $GABA_A$ receptors.	Shinozaki and Ishida (1978)
	3) Improvement in tryptophan and glycine concentration and alteration in serotonin synthesis and metabolism is also visualized following L-theanine treatment.	Yokogoshi and Terashima (2000)
	4) 0.1–10 mM L-theanine stabilizes the glutamate-glutamine neurotransmitter pool and influences long-term potentiation in cultured neurons.	Kakuda et al. (2008)
	5) L-theanine perfusion prevents aspartic acid release.	Yamada et al. (2009)
Motor behavioral improvement	1) L-theanine (100 & 200 mg/kg) treatment successfully reduces motor behavioral symptoms as observed in Morris water maze, open field test, and forced-swim test and rotarod activities in Huntington's disease model.	Thangarajan et al. (2014)
	2) Rearing behavior can be significantly improved in 0.3% L-theanine-administered rats.	Takeda et al. (2011)
	3) Exploratory activity is influenced by L-theanine intake, which indicates neurogenesis in hippocampus leading to improved memory and cognition.	Ogawa et al. (2018)
Other potential anti-Parkinsonian properties	1) L-theanine is structurally similar to glutamate because of which it serves as a glutamate receptor antagonist. It can thus protect neuronal damage against excessive glutamate-induced cellular excitotoxicity, which is one of the major pathophysiological changes associated with Parkinson's disease.	Hypothesis needs to be tested
	2) Changes in glutamate receptor activity are also involved in L-DOPA induced dyskinesia. L-theanine holds an ability to attenuate the complicacy associated with dyskinesia and may prove to be a useful alternative to amantadine.	Hypothesis needs to be tested

Figure 6 Table of 1 of the review article of Deb et al. discussing the observed lower risks for Parkinson's Disease among regular L-theanine consumers [42]. This table summarizes various previous studies in which L-theanine intake was found to reduce Parkinson's pathophysiology through various mechanistic pathways.

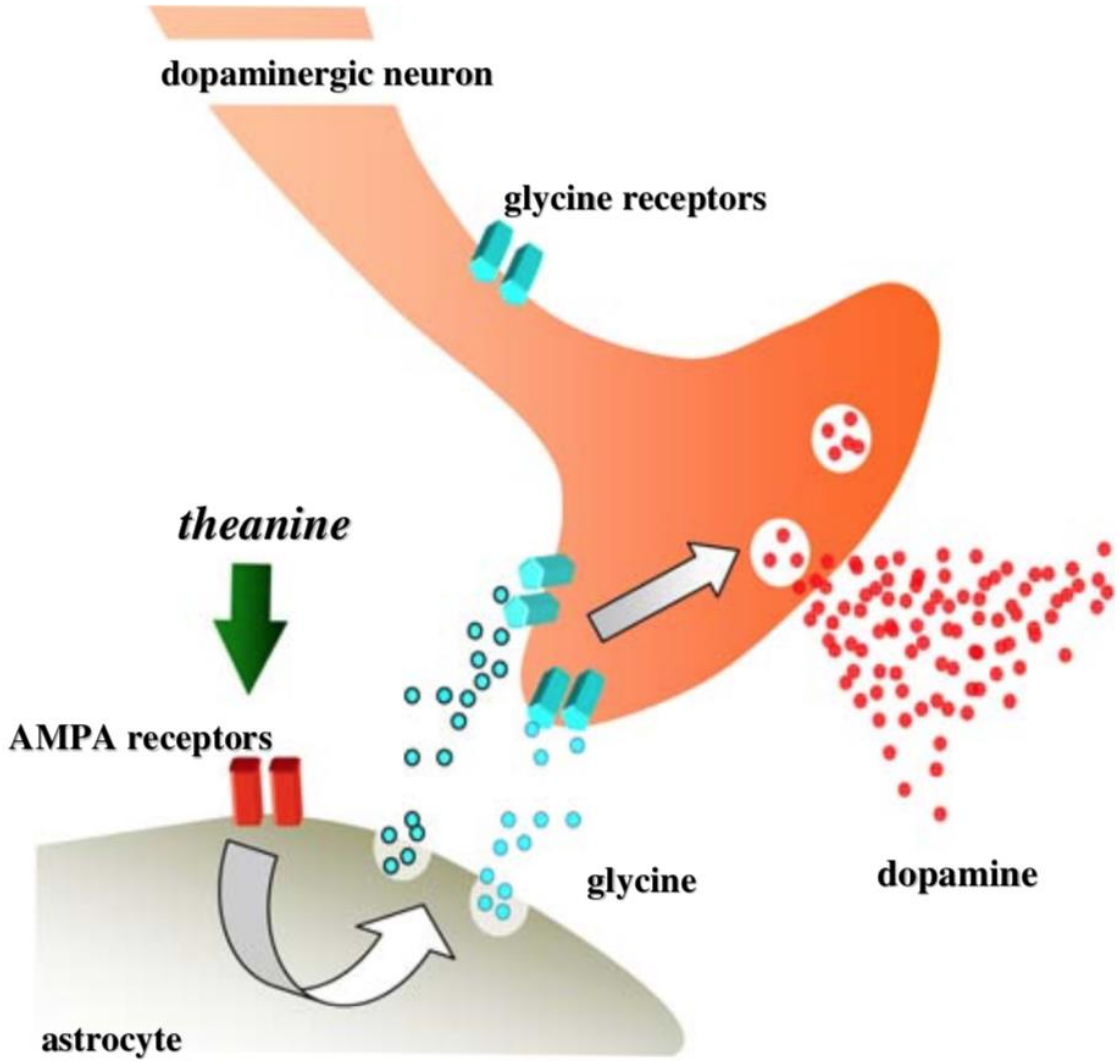

Figure 7 A mechanism proposed by Yamada et al. in 2009 of how theanine acts on Dopamine neurons. The article is titled "Theanine, γ-glutamylethylamide, a unique amino acid in tea leaves, modulates neurotransmitter concentrations in the brain striatum interstitium in conscious rats." We didn't cite this article in the original YouTube video but you can find it with the following DOI link: https://doi.org/10.1007/s00726-007-0020-7 This article by Yamada was foundational in understanding the effects of theanine on dopaminergic activity, and is cited in the table above this figure that discusses how theanine can play a role in Parkinson's Disease pathogenesis. In my later 2019 work [7], I built off of this model by Yamada to propose the 'AMPA Hypothesis', which explained how EGCG was found in some cases to counteract the anti-stress effects of theanine. Both molecules appear to act on dopaminergic AMPA receptors, and therefore may be in competition with one another for AMPA receptor site access.

00:06:50:19 - 00:06:56:14
And you also see significantly improved cognitive function in middle and older aged individuals [6,41,43].

00:06:56:14 - 00:07:01:14
So another effect of regular daily l-theanine intake over time is

00:07:01:14 - 00:07:03:08
increased neurogenesis [44-46],

00:07:03:08 - 00:07:07:16
if you have a human brain cell in a petri dish and you squirt l-theanine on it [45],

00:07:07:16 - 00:07:09:12

then it grows

00:07:09:12 - 00:07:10:21
thicker and bigger

00:07:10:21 - 00:07:12:21
it grows more neurites

00:07:12:21 - 00:07:18:14
These are the branches of the neuron cell that connect and form connections with other neurons in the brain.

00:07:18:14 - 00:07:23:05
So exposed to l-theanine human brain cells grow [47]

00:07:23:05 - 00:07:24:14
which is pretty incredible.

00:07:24:14 - 00:07:26:10
the mechanism is still being worked out, but

00:07:26:10 - 00:07:28:12
one article I found by Yoneda

00:07:28:12 - 00:07:36:20
showed one potential pathway of L-theanine induced neurogenesis, which you can check out here [45], and his more recent article is here [48].

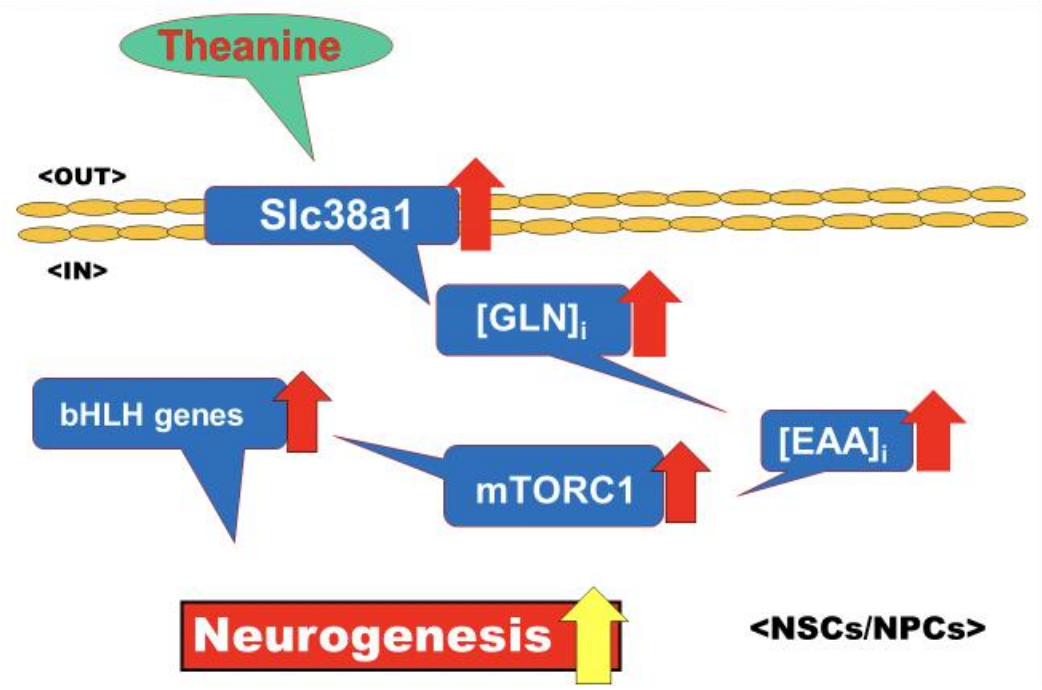

Figure 8 Signaling pathway from theanine to neurogenesis proposed by Yoneda et al. in 2020 [48]. Sustained exposure to theanine selectively up-regulates the expression of an isoform of glutamine transporter (GLNT), Slc38a1, among different adherent and trophic molecules endowed to modulate the properties of neural stem cells (NSCs) toward an increase in the intracellular glutamine (GLN) level in primitive NSCs/neural progenitor cells (NPCs) only, but not in daughter cells such as neurons and astrocytes. In exchange of intracellular GLN, the incorporation of extracellular essential amino acids (EAAs) is facilitated to activate mTORC1 phosphorylation signaling and upregulation of several basic helix-loop-helix (bHLH) transcription factors capable of promoting neurogenesis in NSCs/NPCs. In neurons and astrocytes, by contrast, theanine is unable to up-regulate the expression of Slc38a1, which is absolutely required for triggering the proposed signaling cascade.

00:07:36:20 - 00:07:40:11
These are both working models for how L-theanine

00:07:40:11 - 00:07:45:10
works through a number of receptors and signaling molecules

00:07:45:10 - 00:07:49:04
to activate neurogenesis in human neurons.

00:07:49:04 - 00:07:55:11
a final thing on L-theanine is if you've seen chapter two of the MasterClass on Tea, you'll remember that

00:07:55:11 - 00:08:00:08
L-theanine varies a lot with growing conditions of the tea plant

00:08:00:08 - 00:08:06:07
And it's usually the case that with green tea it is the more high grade

00:08:06:07 - 00:08:10:10
teas that have more l-theanine levels [49-51],

00:08:10:10 - 00:08:14:13
Now, let me test the levels in your organic house blend.

00:08:14:13 - 00:08:25:12
if you want to maximize the effects of green tea on the brain and specifically the l-theanine mediated effects on the brain, then you want to go for the top shelf shit,

00:08:25:12 - 00:08:26:21
That's good shit.

00:08:26:21 - 00:08:38:14
Now on to our third and probably actually most important, neuroactive compound in green tea. That's right, folks. I saved the best for last. We are talking about green tea Catechins [3,8,52-62].

00:08:38:14 - 00:08:48:02
green tea Catechins is actually a little family of eight catechins in the most famous and most abundant in green tea is called EGCG [63].

00:08:48:02 - 00:08:52:01
So what is the function of these green tea catechins in the brain? [54]

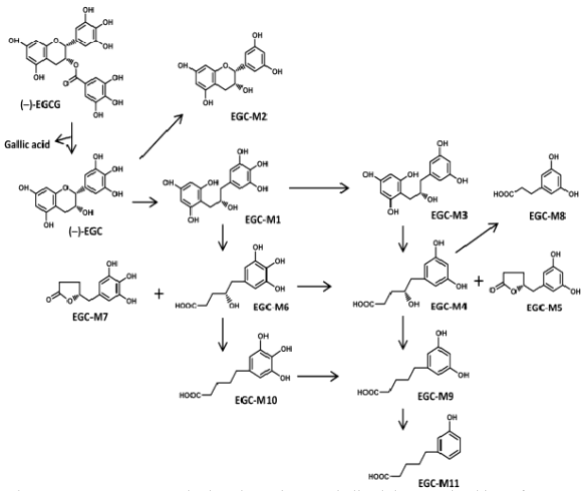

Figure 9 – How EGCG gets broken down (i.e. metabolized) by gut microbiota after consumption. These break down products, called catechin metabolites, appear to share many similar neuroactive and neuroprotective effects with the parent EGCG molecule [54].

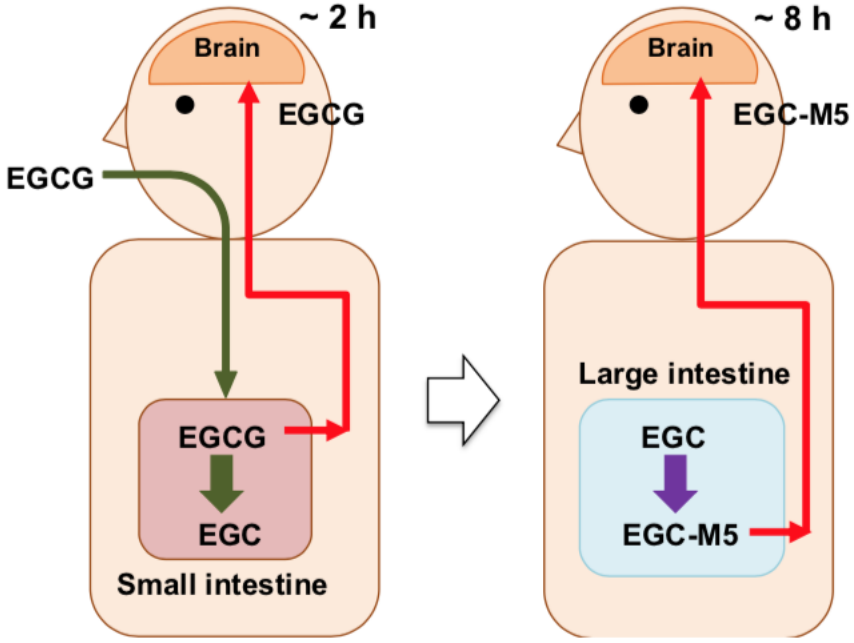

Figure 10 A hypothesis by Unno and Nakamura that EGCG and its degradation products act on the brain with a time lag [3].

00:08:52:01 - 00:08:52:14
Well,

00:08:52:14 - 00:08:53:17
in the acute

00:08:53:17 - 00:08:54:12
time window,

00:08:54:12 - 00:08:57:07
you don't see much effect of catechins [8]

00:08:57:07 - 00:08:57:21

when it comes to

00:08:57:21 - 00:09:01:24
the changes in mood and alertness and cognitive performance in the short run.

00:09:02:03 - 00:09:06:23
Green tea catechins are not really the stars of the show. That is more caffeine and l-theanine.

00:09:06:23 - 00:09:07:15
However,

00:09:07:15 - 00:09:10:09
when we take things long term and we go chronic

00:09:10:09 - 00:09:12:00
they are

00:09:12:00 - 00:09:13:20
doing the lion's share of the work.

00:09:13:20 - 00:09:16:04
there's two hugely important

00:09:16:04 - 00:09:20:13
ways that these green tea catechins are affecting the brain in the long term.

00:09:20:13 - 00:09:22:01
And so the first way

00:09:22:01 - 00:09:27:04
is that these green tea catechins are directly acting as free radical scavengers [64-69].

00:09:27:04 - 00:09:29:10
what is a free radical in the brain? (also known as Reactive Oxygen Species/ROS)

00:09:29:10 - 00:09:31:19
these are basically tiny little,

00:09:31:19 - 00:09:37:13
asshole molecules that bounce around the cells of your body and destroy things.

00:09:37:13 - 00:09:43:00
when they touch the lipids or proteins or DNA of your cells, they

00:09:43:00 - 00:09:45:05
rip electrons off of them and

00:09:45:05 - 00:09:46:10
make them ineffective,

00:09:46:10 - 00:09:50:02
when it happens to your DNA, it can cause mutations that can lead to cancer [70].

00:09:50:02 - 00:09:52:21
When it happens to proteins and cell membranes it can cause

00:09:52:21 - 00:09:55:23
leakage of things and things just not working properly.

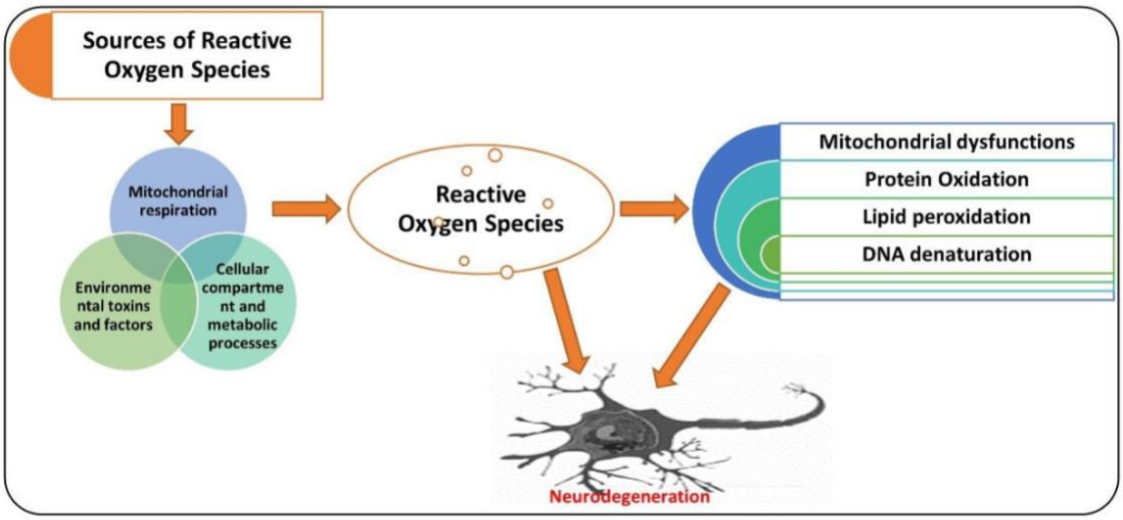

Figure 11 depiction of how free radicals (also known as Reactive Oxygen Species) create and accelerate neurodegenerative disease [26]

00:09:55:23 - 00:09:59:08
green tea catechins are great at neutralizing these free radicals

00:09:59:08 - 00:10:04:04
making it so that they can't destroy the molecules in your cells [64-69].

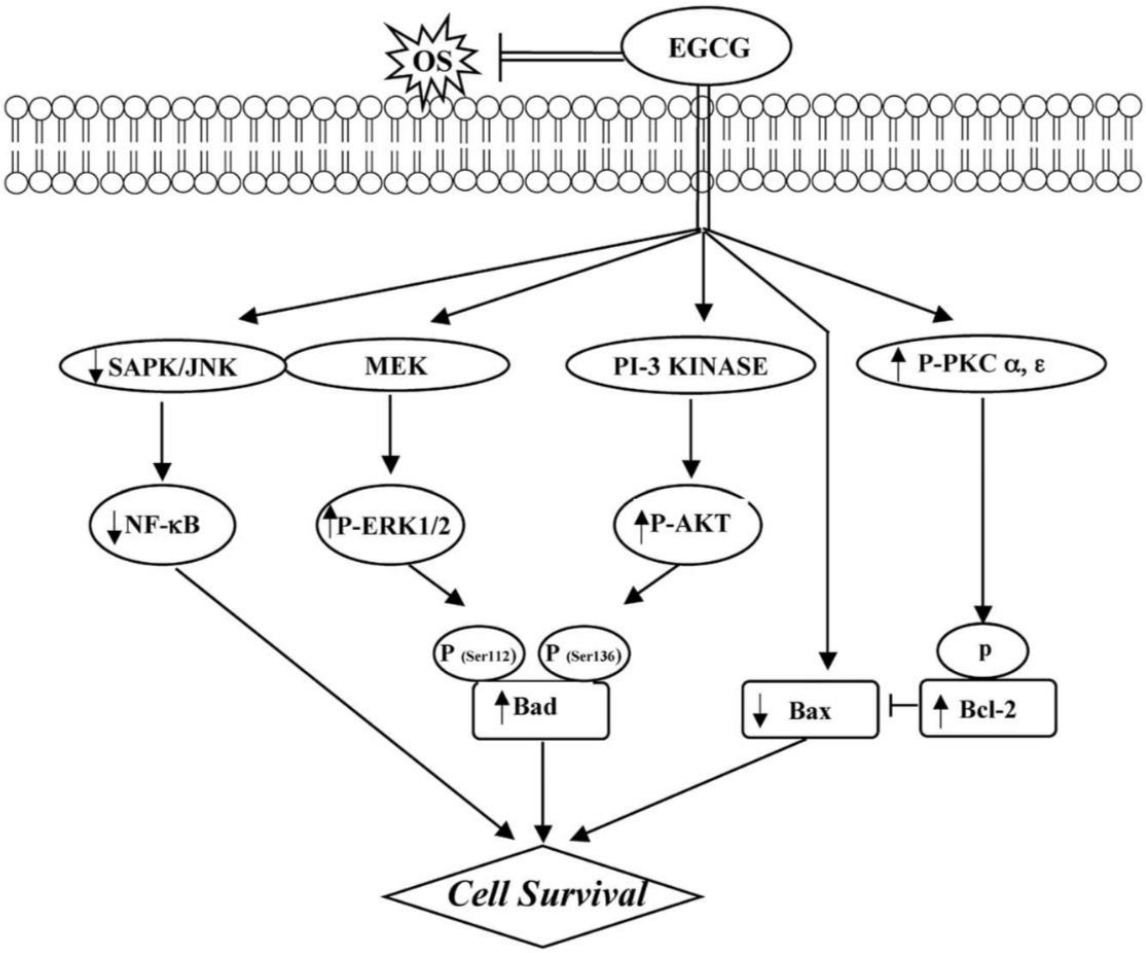

Figure 12 Generally speaking, we know that EGCG is working through MULTIPLE pathways simultaneously to exert neuroprotective effects on brain cells. The above figure is from an OLD article (2004 ;)) by Weinreb et al. [66] that was among the earliest to propose that in ADDITION to neutralizing free radicals (the Reactive Oxygen Species 'OS' on top), EGCG also significantly affects various **signalling pathways** in the brain that ultimately protects neuron viability.

00:10:04:04 - 00:10:07:09
Nice. Nice,

00:10:07:09 - 00:10:08:05
nice.

00:10:08:05 - 00:10:10:10
The second big way that green tea catechins

00:10:10:10 - 00:10:13:12
are improving brain health and functioning in the brain

00:10:13:12 - 00:10:14:20
is

00:10:14:20 - 00:10:25:00
green tea catechins are significantly affecting gene expression, the turning on and turning off of key important brain health modulating genes [7,62,65,71,72]

00:10:25:00 - 00:10:26:09
in your brain cells.

00:10:26:09 - 00:10:27:22
the first one actually

00:10:27:22 - 00:10:29:08
relates back to

00:10:29:08 - 00:10:30:20
antioxidant activity

00:10:30:20 - 00:10:35:06
and something I didn't mention about these free radicals is that aside from being

00:10:35:06 - 00:10:36:10
created by

00:10:36:10 - 00:10:43:01
toxin exposure, by smoking and drinking and etc. fun activities, they

00:10:43:01 - 00:10:45:07
are also created

00:10:45:07 - 00:10:46:01
naturally

00:10:46:01 - 00:10:51:19
when we use oxygen to create ATP, we are also generating a small

00:10:51:19 - 00:10:54:03
baseline level of free radicals.

00:10:54:04 - 00:11:02:16
So, basically we've evolved systems inherently in our body to neutralize these free radicals. So we ourselves have our own antioxidant

00:11:02:16 - 00:11:06:11
machinery built into our cells and

00:11:06:11 - 00:11:13:17
green tea turns up the expression, turns up the genes that create these antioxidant

00:11:13:17 - 00:11:22:02
Enzymes [73]. One of the most famous ones is called Nrf2 And basically exposure to green tea catechins

00:11:22:02 - 00:11:23:12
increases the expression

00:11:23:12 - 00:11:24:11
of Nrf2 [74-76]

00:11:24:13 - 00:11:27:04
that is enhancing our own innate

00:11:27:04 - 00:11:31:10
internal capacity for antioxidant function [73,77].

00:11:31:10 - 00:11:35:01
which I might say is pretty… **radical**,

00:11:35:01 - 00:11:36:20
Smack the lip, Whapow

00:11:36:20 - 00:11:38:21
ride the barrell and get pitted.

00:11:38:21 - 00:11:40:06
you knew the radical pun was coming.

00:11:40:06 - 00:11:48:23
So another key gene pathway that's being turned down by green tea catechins is the inflammatory pathway [78-81].

00:11:48:23 - 00:12:00:13
green tea catechins are down regulating the expression of inflammation genes so that is keeping us from getting inflamed chronically [82], which is great.

00:12:00:13 - 00:12:05:01
we mentioned that inflammation is kind of that bridge in between toxin exposure

00:12:05:01 - 00:12:06:13
and disease [83]

00:12:06:13 - 00:12:07:04
in the long run.

00:12:07:04 - 00:12:19:00
it's the exposure to these toxins that creates chronic inflammation. And that, what, you know, a lot of people think, is what causes the disease of the brain, such as Alzheimer's, Parkinson's, dementia. So

00:12:19:00 - 00:12:23:19
green tea catechins down regulate the inflammation genes and the inflammation response [62].

00:12:23:21 - 00:12:33:15
So the next gene that green tea catechins are changing the levels of and changing the expression of is called CREB [7,82,84,85]. CREB is a really cool gene that

00:12:33:15 - 00:12:36:19
Upregulates mitochondrial biogenesis

00:12:36:19 - 00:12:39:13
basically increasing the amount of energy

00:12:39:13 - 00:12:42:13
and ATP that your brain cells can produce,

00:12:42:13 - 00:12:43:02
CREB

00:12:43:02 - 00:12:43:18
also

00:12:43:18 - 00:12:45:14
turns up the expression

00:12:45:14 - 00:12:45:19
of

00:12:45:19 - 00:12:49:24
BDNF [86], and so CREB and BDNF are in one pathway.

00:12:50:03 - 00:12:53:08

It's called the CREB/BDNF pathway. And

00:12:53:08 - 00:12:54:11
both of those

00:12:54:11 - 00:13:04:11
genes are getting activated by green tea Catechins [56,82,85,87-89]. and BDNF is huge, brain derived neurotrophic factor, that induces neurogenesis [88].

00:13:04:11 - 00:13:10:09
that is another thing that's causing the growth and the out branching of your neurons in your brain [90].

00:13:10:09 - 00:13:13:12
and CREB has also been associated with

00:13:13:12 - 00:13:15:15
healthy, normal expression of

00:13:15:15 - 00:13:18:23
dopamine and neurotransmitter systems [91,92].

00:13:18:23 - 00:13:22:06
CREB is going to keep you from bouncing off the walls when you get down some.

00:13:22:08 - 00:13:40:06
So basically, this profile of gene expression that you get with green tea catechin exposure, we're having more antioxidant activity, we're having less inflammation activity, we're having more CREB/BDNF induced

00:13:40:06 - 00:13:41:09
neurogenesis,

00:13:41:09 - 00:13:42:05
more

00:13:42:05 - 00:13:45:03
growth and out branching of neurites

00:13:45:03 - 00:13:49:03
And we're having regulated neurotransmission in the brain,

00:13:49:03 - 00:13:50:11
you take those, you combine it with

00:13:50:11 - 00:13:51:02
direct

00:13:51:02 - 00:13:56:23
free radical neutralizing effects of green tea catechins and you can get a glimpse, a picture of why

00:13:56:23 - 00:13:58:00
a brain

00:13:58:00 - 00:14:08:24
that has been consuming green tea for years and years and years looks so different [21]. The architecture of the brain, the physical structure of it, and the biochemistry of that brain is significantly [55,61,62,66]

00:14:08:24 - 00:14:10:09
less likely

00:14:10:09 - 00:14:11:15
to develop disease

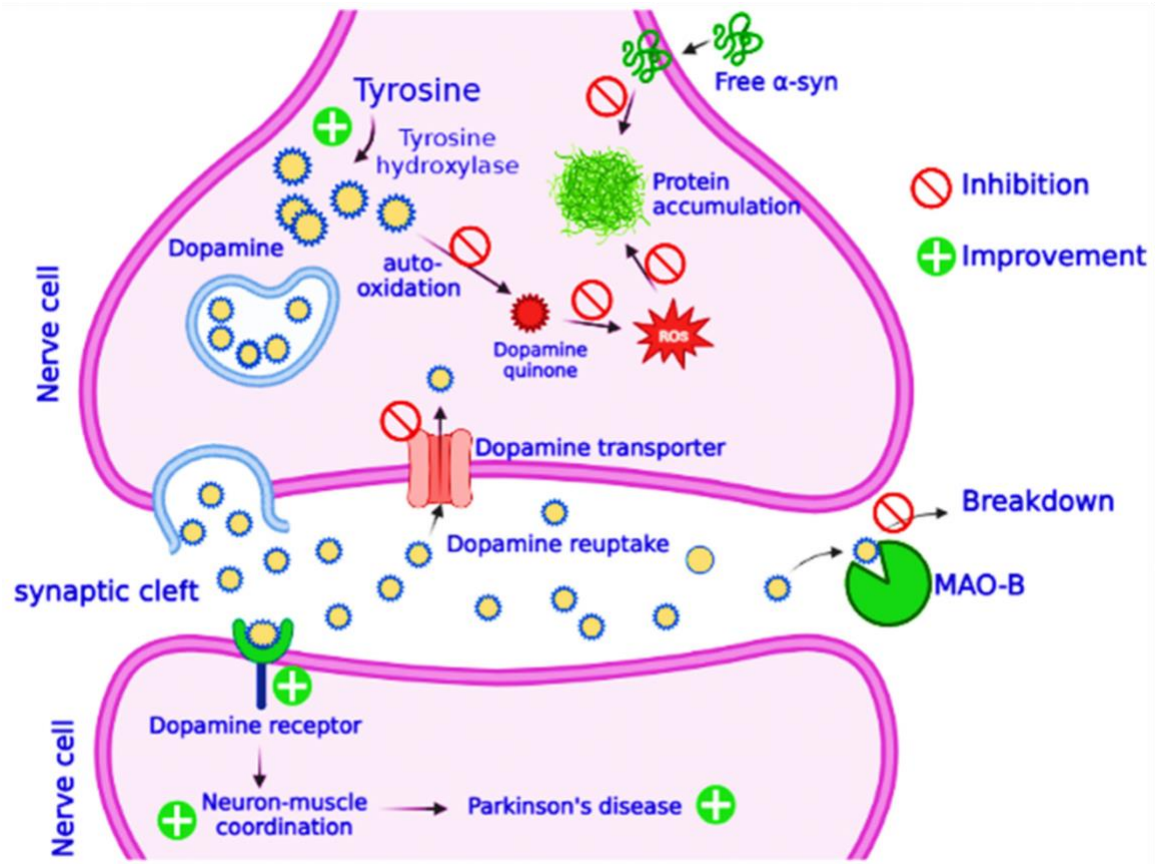

Figure 13 Above are potential mechanisms by which green tea catechins alleviate Parkinson's Disease pathogenesis, proposed by Afzal et al. 2022 [62]. Green plus signs indicate supportive effects, while red cancel signs indicate inhibitory effects. Importantly, Parkinson's disease is characterized by dopamine deficiency, and treatment measures are aimed at preservation of the overall dopamine signaling system, as well as the introduction of dopamine as a medicine. The figure illustrates several key features of the dopamine system, including conversion of tyrosine to dopamine by the action of the enzyme tyrosine hydroxylase. Newly synthesized dopamine is packed into vesicles and released into the synapse, where it binds to dopamine receptors. Normally, dopamine is reabsorbed into the nerve cells and reused, or it is broken down by the action of an enzyme monoamine oxidase B (MAO-B). Presence of green tea catechins inhibits MAO-B activity and promotes dopamine reutilization. Catechins also inhibit plaque formation by α-synuclein and autoxidation of dopamine.

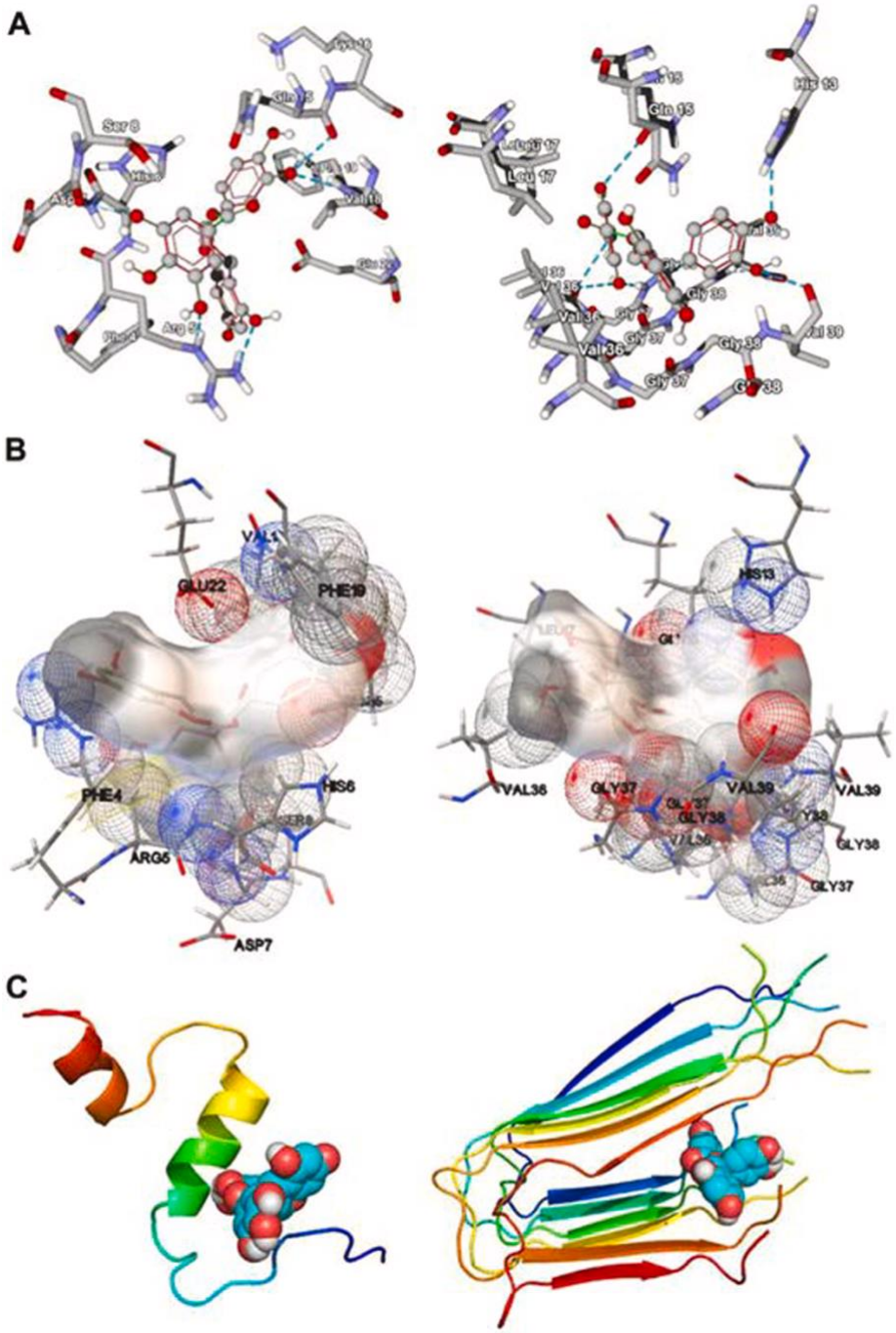

Figure 14 Above is a figure from the article titled "Inhibition of Aβ aggregates in Alzheimer's disease by epigallocatechin and epicatechin-3-gallate from green tea" by Chen et al. [61]. This figure uses computer software (*in silico*) modelling to predict how the green tea catechin, EGC, attaches to aggregate-forming amyloid-β (Aβ) proteins, thereby **reducing** the ability of this protein to aggregate in the brain and form the plaque that leads to Alzheimer's disease. Remember that this is only **one** proposed pathway of preventative action by Green Tea. There are other hypotheses about how Alzheimer's arises in the brain that involve glucose metabolism instead of protein aggregation (the type 3 diabetes model). In that model, the relevant preventative effects of Green Tea might include regulated blood sugar levels or enhanced insulin resistance, which has been demonstrated in other works. While the predominant mechanistic pathway remains uncertain, numerous longitudinal studies have now found that regular green tea drinkers do have significantly lower risks of developing Alzheimer's Disease, and scientists are now trying to study the various mechanisms at play. The model proposed in the figure above involves hydrogen bonding between ECG and amino acid residues in Aβ40 (A), amino acid residues around ECG (B), and calculated surroundings of ECG–Aβ40 monomer and fibrils (C).

00:14:12:02 - 00:14:26:03

So, folks, I wish I could leave the discussion here. Because we've covered the three molecules and we've covered the chronic and the acute effects, but I simply can't because there's one extra topic within green tea brain

00:14:26:03 - 00:14:38:19
effects that is so interesting and maybe could be possibly the most important of everything we've talked about so far. And it is something called the tea-brain-gut axis,

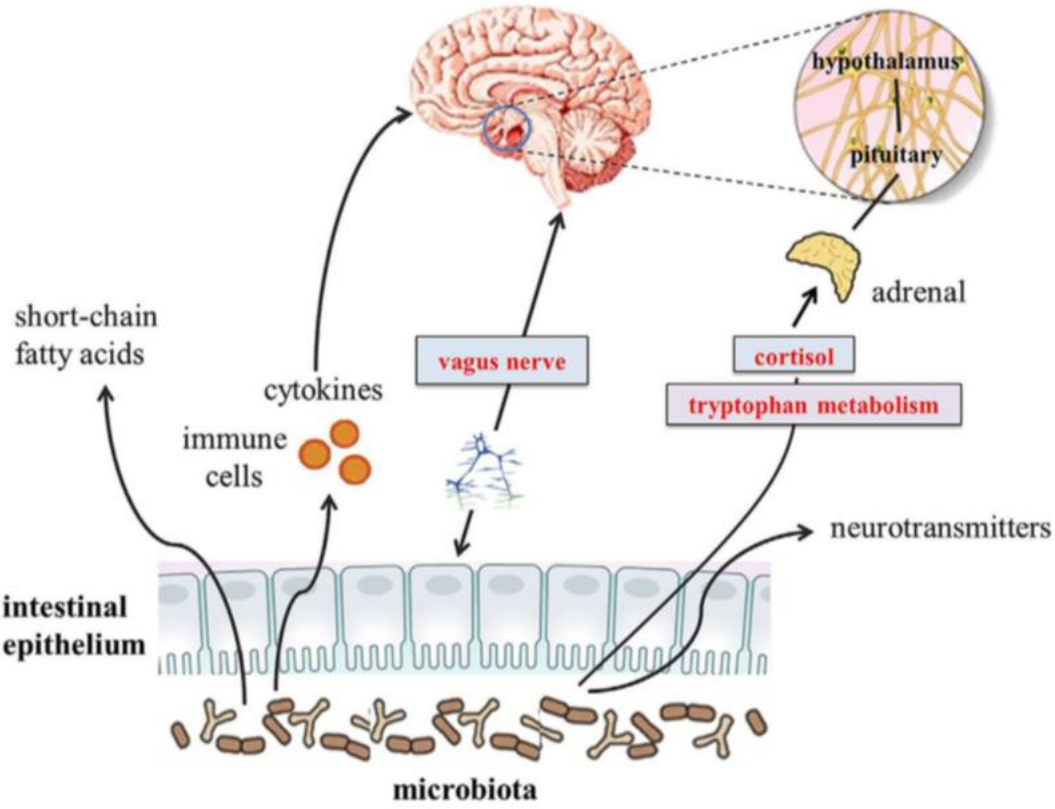

Figure 15 Pathways involved in bidirectional communication between the brain and gut microbiota [93]. You can imagine bioactive tea constituents (mostly tea polyphenols, it appears) forming the third node of a 'tridirectional' gut-brain-tea communication. Tea polyphenols appear to preferentially support the communities of 'psychobiotic' gut bacteria (lactobacillus and bifidobacterial) that promote mood and healthy neurotransmission in the brain.

00:14:38:19 - 00:14:52:01
research coming out since 2020, in the last couple of years in particular [93] have shown that green tea consumption increases the levels of brain-altering bacteria in our gut.

00:14:52:01 - 00:14:54:05
they're communities called Psychobiotics [94-97].

00:14:54:05 - 00:15:09:04
And green tea enhances improves the levels of some of these key bacteria like lactobacillus and bifidobacteria [98], that are actually increasing serotonin production and increasing the neurotransmitter levels in your gut and in your brain [99-103].

00:15:09:04 - 00:15:13:16
and one professor named Zhang Xin from Ningbo University has been leading the charge on

00:15:13:16 - 00:15:16:02
uncovering some of these really fascinating ways that

00:15:16:02 - 00:15:20:13
tea polyphenols are working through the microbiome to

00:15:20:13 - 00:15:21:07
alleviate

00:15:21:07 - 00:15:24:05
psychiatric and neurological disorders [104].

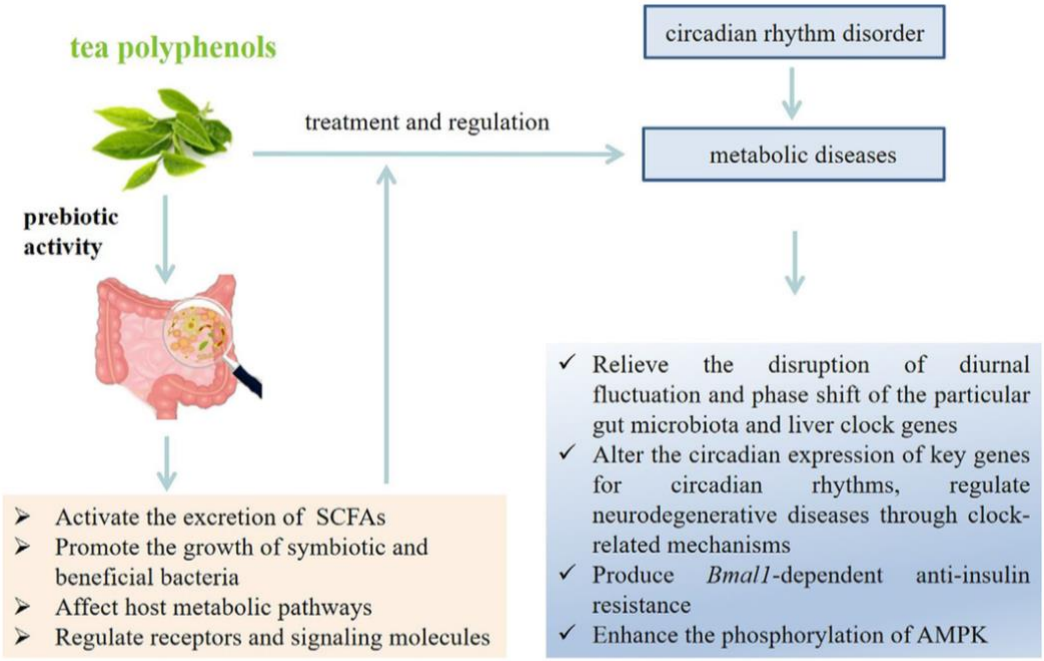

Figure 16 Figure from Xin et al. [93] indicating how tea polyphenols function THROUGH their prebiotic effects to ameliorate metabolic diseases. Pretty gut boggling stuff!

00:15:24:05 - 00:15:30:03
His research is honestly mind boggling, or should I say, gut boggling.

00:15:30:03 - 00:15:40:12
And what else boggles my gut is the notion that you might not have seen the MasterClass on Tea, which is an eight-chapter, eight video Masterclass right here on the YouTube

00:15:40:12 - 00:15:42:15
Chapter one putting that right there (hyperlink in pdf here)

00:15:42:15 - 00:15:45:23
that explores the universe of the six major tea types

00:15:45:23 - 00:15:50:21
learning about these tea types is going to be instrumental to learning more about the world of tea

00:15:50:21 - 00:15:51:09
and

00:15:51:09 - 00:15:52:06
the health effects

00:15:52:06 - 00:15:52:19
of tea

00:15:52:19 - 00:15:53:16

on the human body.

00:15:53:16 - 00:15:56:23
So check out this video and check out the master class as a whole

00:15:56:23 - 00:16:00:15
and I will see you in the next video.

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