Unlocking Coffee's Secrets: Friend, Foe, or Something in Between

Acknowledgement

We would like to express our sincere gratitude to everyone who contributed to this presentation. Special thanks to the faculty of the Chemistry Department for their invaluable guidance and support. We also appreciate the contributions and insights from our colleagues and peers, which greatly enriched this work. Lastly, thank you to the professors and students for their time and attention.

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And

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Introduction to Coffee: The Bitter Sweet World of Coffee

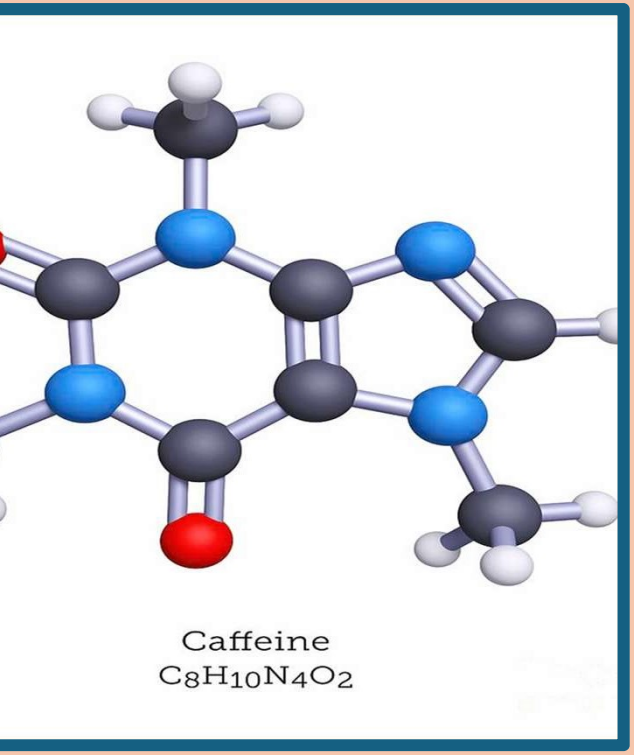
Welcome to “The Bitter Sweet World of Coffee,” where we explore the complex chemistry behind this beloved beverage. Coffee, enjoyed by millions worldwide, offers a rich tapestry of flavours and aromas, thanks to its diverse chemical compounds. The bitterness primarily comes from caffeine and chlorogenic acids, which are naturally present in coffee beans and become more pronounced during the roasting process. The sweetness is attributed to naturally occurring sugars, such as sucrose, which also caramelize during roasting and enhancing. It provides benefits like enhanced alertness and antioxidants, but also has potential downsides such as anxiety and stomach irritation.

This presentation delves into the science of coffee, examining its health impacts, cultural significance, and the fine balance required to enjoy its perks while minimizing adverse effects. Join us on this journey to better understand the multifaceted nature of coffee.

Historical Perspective : Coffee’s Journey

ffee’s journey began in Ethiopia, where a goat herder ed Kaldi discovered the energizing effects of the red es from a certain tree. From there, it spread to the ian Peninsula, becoming a popular beverage in the nic world and eventually spreading to Persia, Egypt, the Ottoman Empire. By the 17th century, coffee ned Europe, sparking a coffeehouse culture that spread ss the continent. The Americas soon followed, with ee plantations emerging in the Caribbean, Central and h America, and Brazil becoming a major producer. In nodern era, technological advancements and vations in coffee production and consumption have led e rise of specialty coffee and the third wave coffee ement Today, coffee is a global phenomenon with rse traditions and practices. From the bustling cafes of s and New York to the serene tea gardens of Japan, ee culture varies widely. The beverage continues to ve, with innovations

e Science behind the buzz :- Caffeine Jo



The "buzz" we experience from coffee primarily comes from caffe a natural stimulant found in coffee beans. Here's a look at the science behind it:

1.Caffeine and the Brain Adenosine Receptor Blockage: Caffeine blocks adenosine receptors, reducing drowsiness and increasing alertness.

2.Physiological Effects Enhanced Physical Performance: Increases adrenaline, boosting physical performance and alertness.

3.Metabolic Effects :Increased Metabolism: Boosts metabolic rate, increasing energy expenditure. Diuretic Effect: Mildly increases urination frequency.

4.Tolerance and Dependence Tolerance: Regular use leads to nee higher doses for the same effect.

5.Withdrawal: Stopping can cause headaches, fatigue, and irritab

The buzz from coffee is a result of complex interactions between caffeine and the body's neurological and physiological systems. T immediate effects include increased alertness and improved moo

The Chemistry of Coffee : Friend or Foe

The chemistry of coffee is both friend and foe. Its beneficial compounds, such as antioxidants and caffeine, enhance alertness, improve mood, and may reduce the risk of certain diseases. However, excessive consumption can lead to negative effects like anxiety, insomnia, and increased heart rate. Additionally, coffee's acidity may irritate the stomach lining in some individuals. Therefore, while moderate coffee consumption can offer various health benefits, overindulgence can trigger adverse reactions. Balancing intake is crucial to enjoy its positive effects while minimizing potential harms.

Benefits of Moderate Coffee Consumption

oderate coffee consumption offers numerous health benefits, beginning with its positive effects on gnitive function and mood.

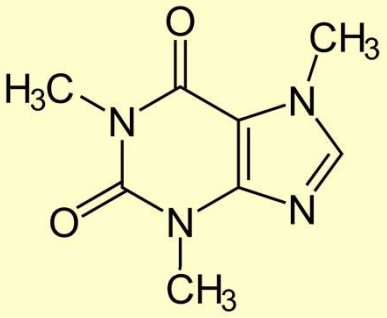
loderate coffee consumption enhances cognitive function nd boosts mood by increasing alertness and releasing opamine and norepinephrine.

offee is rich in antioxidants, which reduce cell damage nd inflammation.

lowers the risk of diseases such as Parkinson's, lzheimer's, and certain cancers, and improves physical erformance by increasing adrenaline and fat breakdown.

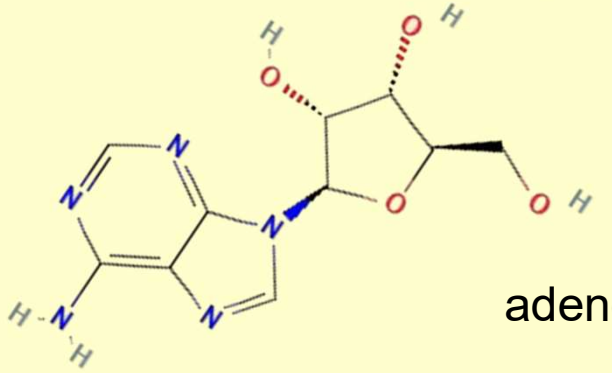
dditionally, coffee supports liver health by reducing the sk of liver diseases and may lower the risk of developing ype 2 diabetes.

Overall, enjoying coffee in moderation offers numerous ealth benefits for both mental and physical well-being.



caffeine

dopamine



adenosine

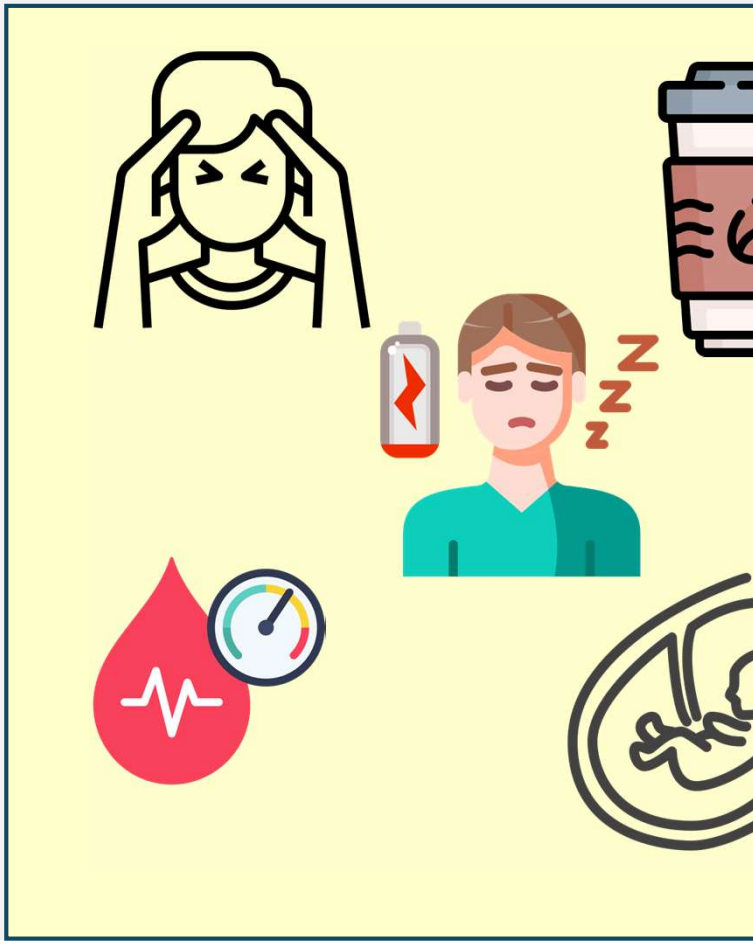
The Bad: Potential Health Risks Associated with Coffee

While coffee has many benefits, it's important to be aware of its potential health risks when consu in excess. High caffeine intake can cause anxiety, nervousness, and insomnia, especially in sensitive individuals.

Regular coffee consumption may lead to caffeine dependence, with withdrawal symptoms like headaches, irritability, and fatigue if intake is suddenly reduced.

Additionally, excessive coffee can temporarily raise blood pressure and, in rare cases, trigger irregular heart rhythms. Its acidic nature might cause digestive issues such as acid reflux and stomach discomfort.

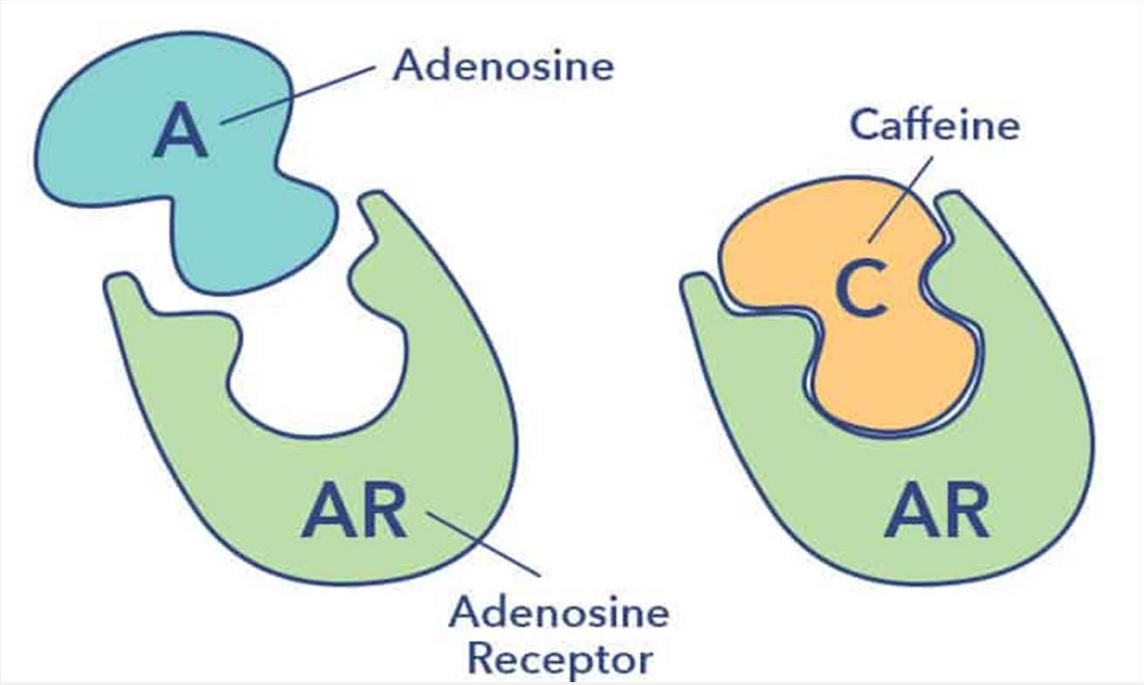
For pregnant women, consuming too much coffee may increase the risk of miscarriage.

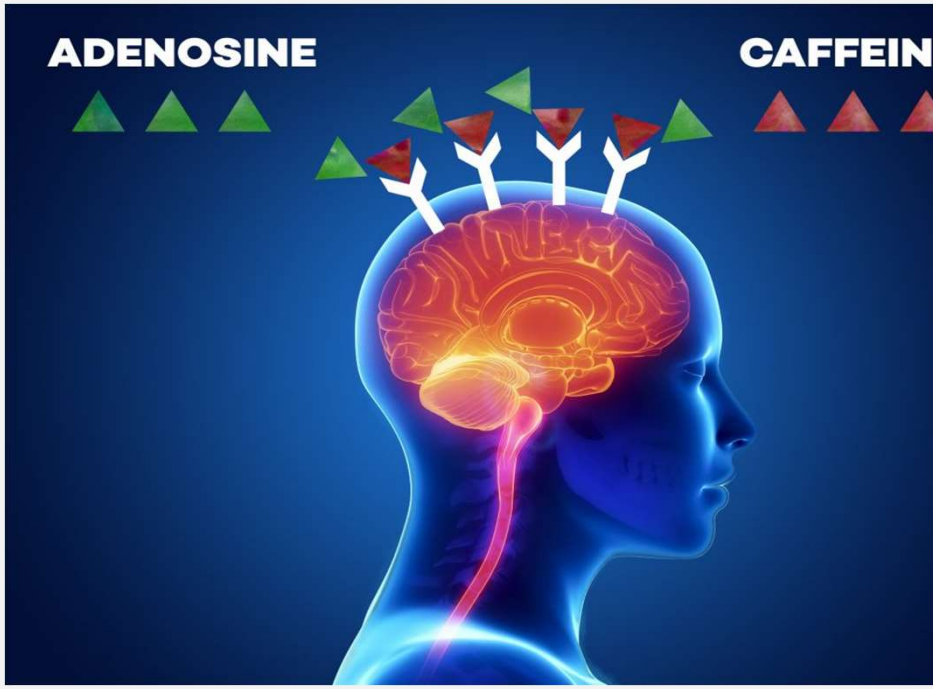


Coffee and Mental Health: Does it Lift or Burden

ort-Term Benefits:

Caffeine, coffee's main active ingredient blocks adenosine receptors, preventing drowsiness and promoting alertness.





Coffee and Mental Health: Does it Lift or Burden

ort-Term Benefits:

Caffeine, coffee's main active ingredient blocks adenosine receptors, preventing drowsiness and promoting alertness.

Low to moderate doses of coffee can boost mood and feelings of well beings.

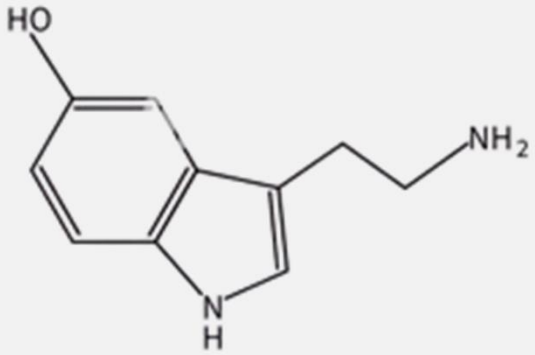
Coffee may improve psychomotor performance and energy levels.

offee and Mental Health: Does it Lift or Burden

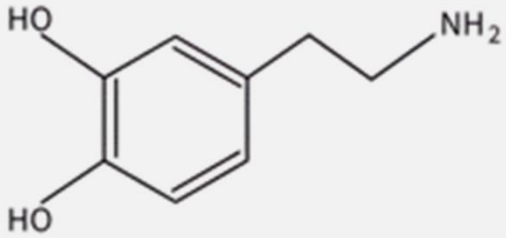
ng-Term Effects:

coffee intake is linked to a lower risk of depression. Heavy coffee drinkers had a reduced risk compared to non-drinkers .

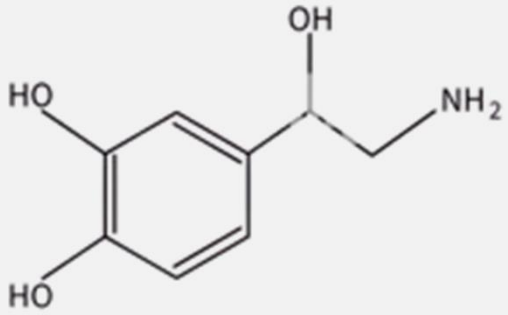
Caffeine increases turnover of neurotransmitters like serotonin, dopamine, and noradrenaline, which are involved in depression. Some studies even suggest that caffeine intake could reduce the incidence of suicide.



serotonin



dopamine



norepinephrine

offee and Mental Health: Does it Lift or Burden

e Flip side where coffee can be burden

- Withdrawal Symptoms: Regular coffee drinkers may experience headaches and irritability during caffeine withdrawal. These symptoms are usually short-lived but can be unpleasant.
- Blood Pressure: Caffeine can temporarily raise blood pressure, so caution is necessary for those with hypertension.

IOTE :- Remember that individual esponses to caffeine vary, and noderation is key

Coffee and Energy: Boost or Bust

Coffee's energy kick is a double-edged sword like a borrowed sugar rush

BOOST

- The caffeine blocks adenosine receptors in the brain, increasing wakefulness and alertness by making other neurotransmitters like dopamine and norepinephrine more active, a sleep-promoting brain chemical, making you feel more alert and focused. This feels fantastic as this results in improved mood and motivation, along with increased heart rate and blood flow, but it's temporary.

- Regular coffee drinkers build a tolerance, needing more and more coffee for the same initial boost.

offee and Energy: Boost or Bust

- **BUST**

But as caffeine wears off, adenosine floods back, leadi to an energy crash and potentially making you feel ever more tired than before.

Skip your cup, and you might experience withdrawal headaches and fatigue. The downside doesn't stop ther Coffee's acidity can irritate your stomach, and its laxativ effect might leave you feeling uncomfortable.

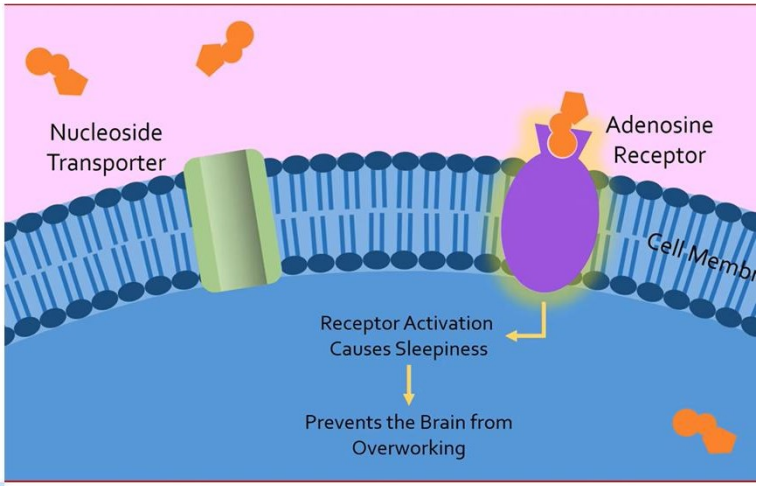
For people with high blood pressure, excessive coffee can be risky, potentially raising blood pressure further.

NOTE: Enjoy your coffee, but be mindful. Limit you intake, especially later in the day, to avoid these potential downsides and keep your energy levels steadier in the long run.

How does it work?

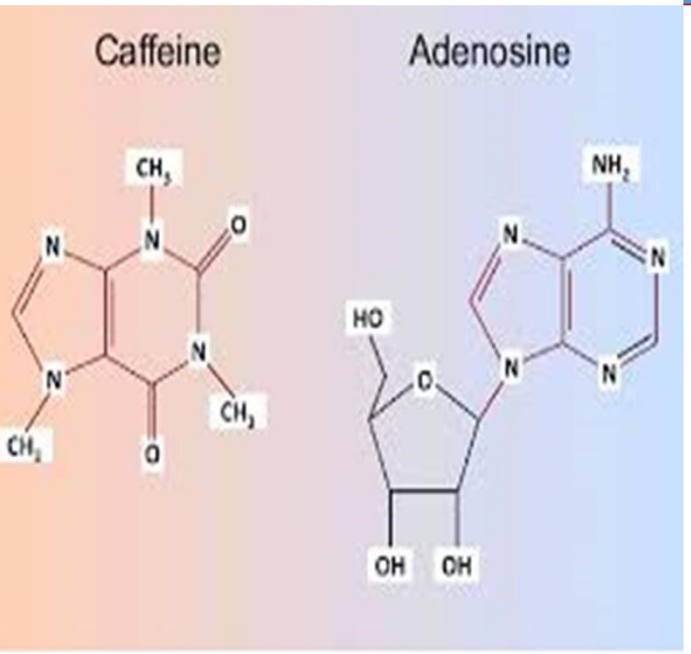
Adenosine

The Sleep Molecule: Our brain uses adenosine, a molecule, to signal sleepiness. As the day progresses, adenosine levels rise, making us drowsy.



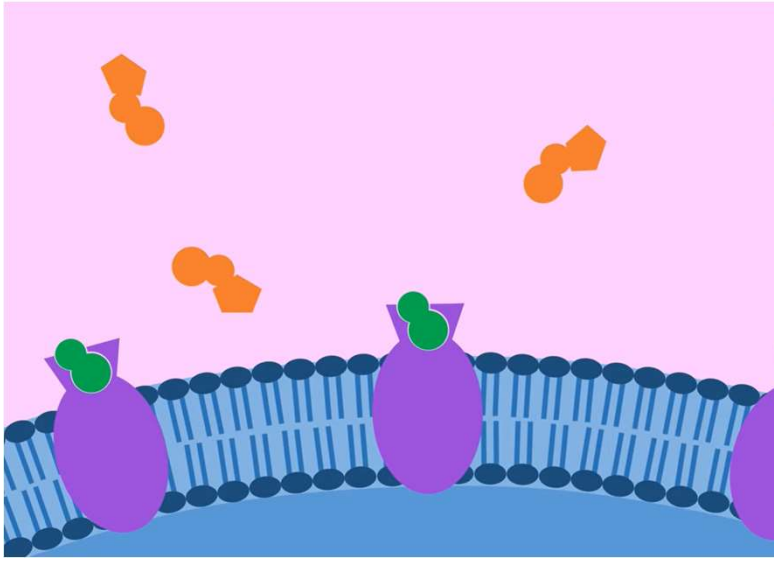
Caffeine

Caffeine, structurally similar to adenosine, can also dock onto these receptors. But unlike adenosine, caffeine doesn't activate the "sleepy" signal. It acts like a costume, blocking the real adenosine from binding.



Receptor Ruckus

Adenosine binds to special receptors on brain cells, like a key fitting into a lock. This binding triggers sleepiness.



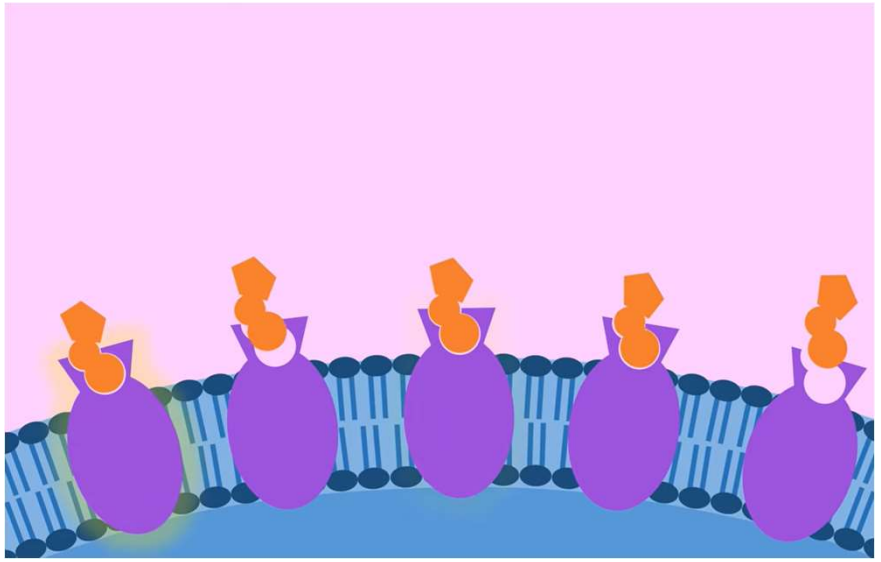
How does it work?

Alertness Activated

Without adenosine binding, the "sleepy" signal is blocked. Brain cells remain active, keeping you alert and focused.

Stopping Caffeine

When you stop consuming caffeine, there are excess adenosine receptors available to bind to. This leads to fatigue and tiredness, making you feel more tired than before.



Coffee and Sleep: Balancing Act

Coffee's Impact on Sleep

Coffee is a beloved beverage enjoyed worldwide, but its relationship with sleep is complex.

Caffeine Blockade :-

Coffee's a double-edged sword for sleep. While it boosts alertness, the caffeine blocks sleepiness, making it harder to fall asleep or stay asleep. .People vary in their sensitivity to caffeine. Some can manage a late afternoon coffee without issue, while others experience sleep disturbances .

Finding Your Balance:-

Most of the caffeine is eliminated from the body within 6 hours The key is finding your balance. Avoid coffee close to bedtime (4-6 hours before) and listen to your body. If sleep suffers, cut back or switch to calming teas before bed. For a pre-bedtime ritual, explore caffeine-free herbal teas like chamomile or lavender, known for their relaxing properties..

By understanding how coffee affects sleep and implementing these tips, we can find our personal balance and enjoy both our coffee and a good night's rest.

OFFEE AND SUSTAINABILITY: ENVIRONMENTAL CONCERNS

offee production as significant nvironmental pacts, raising veral stainability ncerns. Here are me environment ncern that we ust talk about:

Deforestation: Clearing land for coffee plantations can lead to habitat loss for wildlife and contribute to climate change.

Water Usage: Coffee plants require a lot of water to grow. This can put a strain on local water resources, especially in areas already facing water scarcity.

Processing and Waste: Coffee processing can generate wastewater that pollutes rivers and streams. Additionally, coffee cherry pulp (a byproduct) can be a source of environmental pollution if not managed properly

Decaffeinated Options: Finding a Middle Ground

Decaffeinated coffee, often referred to as “decaf,” is a ty
coffee that has had most of its caffeine content removed

- **Taste without Stimulant**: Retains coffee flavor with minimal caffeine content, suitable for those sensitive to caffeine.
- **Reduced Sleep Disruption**: Allows enjoyment withou interfering with sleep, ideal for evening consumption.
- **Health Benefits**: Contains antioxidants and nutrients present in regular coffee, supporting health without caffe stimulating effects.
- **Variety**: Available in various roasts and flavors, provid options for diverse preferences.
- **Moderation**: Enables coffee enjoyment without excee caffeine limits, promoting balanced consumption.

Incorporating decaffeinated coffee into your rou can satisfy coffee cravings while maintaining sleep qual and overall health.

ersonalizing Your Coffee Experience: Tips or Healthier Habit

Here are some tips for a healthy and personalized caffeine experience:

1

Hydrate: Caffeine can be dehydrating, so drink plenty of water throughout the day.

2

Quality matters: Choose high-quality ingredients, like loose leaf tea or whole coffee beans, to maximize flavor and minimize potential negative effects.

3

Mind the additives: Sugary syrups and cream can add unnecessary calories. Options for natural sweeteners like honey or stevia, and low-fat milk alternatives can be used .

CONCLUSION

Coffee: Friend or Foe? The Verdict

, is coffee a friend or foe? The answer depends on the individual and ir unique response to caffeine. For many, coffee can be a friend, ering a range of benefits like improved cognitive function, mood vation, and even potential health advantages. However, for some, it be a foe, causing anxiety, insomnia, or digestive issues.

conclusion, Moderate coffee intake can be enjoyed, but individuals uld be mindful of their tolerance and potential implications. The re may see a shift towards more conscious coffee choices.

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THANK YOU

PRESENTED BY

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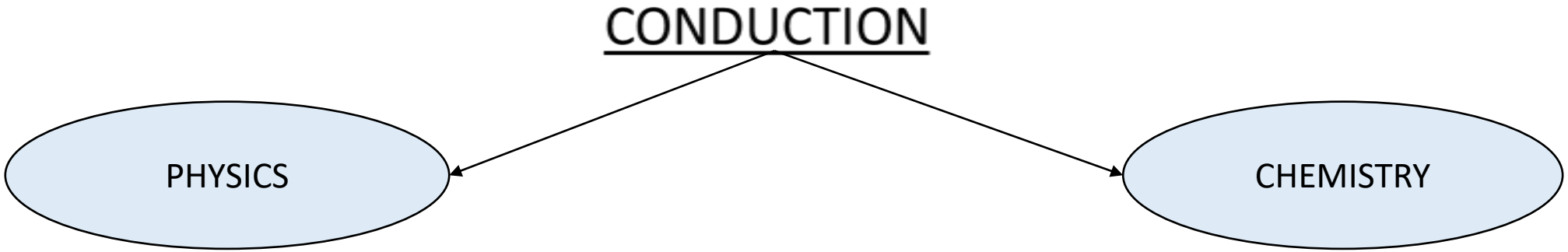
Conductance

CONDUCTANCE OF ELECTROLYTES

INTRODUCTION

- Resistance(R) : It is the property of conductor to resist the flow of charge.
- Conductance(G):It is defined as reciprocal of resistance .

$$G=\frac{1}{R}$$



Metallic conductors

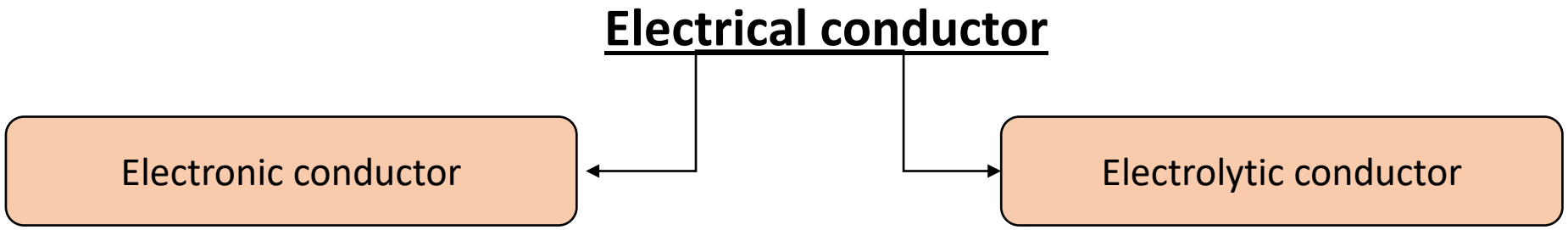
Electrolytes

- For metallic conductors, $G \propto \frac{1}{T}$ but for electrolytes in solution, $G \propto T$

BUT WHY??

- If the temp. of a metal conductor increases ,the ions of the metal vibrate more vigorously resulting the no of collisions increase between free electron and metal ions. Hence resistance increases with increasing temp and conductance decreases. Whereas for electrolytic solution ,with increasing temp. speed of the ions increases leading to increase in conduction.

- Electrical conductor: the substance which allow the flow of current



1. Conduction of electricity due to movement of electron.
2. From a higher negative potential to a lower one.

   Ex- metals

1. Flow of current due to the movement or migration of ions.
2. Movement of ions towards oppositely charged ions.

CONDUCTION OF ELECTROLYTES

- Like metallic conductor, solution also obeys ohm's law.

The expression for the corresponding conductance **G** is,

$$G = \frac{1}{R} = \frac{1}{\rho}\left(\frac{A}{l}\right) = k\left(\frac{A}{l}\right)$$

- Where k(kappa) is the specific conductance, whose SI unit is S m^{-1} . Can be also expressed as Ω^{-1} cm^{-1}
- l = length between two electrodes
- A= area of each electrodes
- If A=1,l=1 then G=k
- Both specific conductance and conductance of aq. Solution is an additive property.
- The ratio of l/A is known as cell conctant and used for measurement of conductance.

- **Specific conductance:** The specific conductance is a conductor having unit length and unit cross section area or having unit volume. For electrolytic solution the specific conductance is defined as the conductance of the unit volume solution.

- **Factors affecting k:**

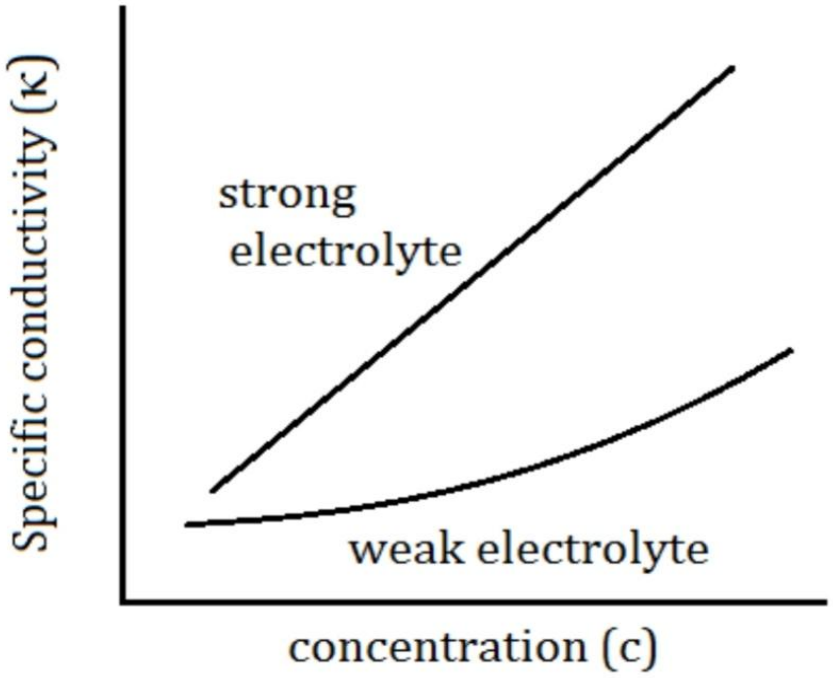
1. Effect of temperature

I. for strong electrolyte k increase with in crease in temperature.

II. For weak electrolyte with increase in temp. degree of dissociation also increases as well as speed of the ions will also increase resulting a more significant change of the k value compare to strong electrolyte.

2. Change of k with concentration of the electrolyte

- Specific conductance of an electrolyte solution increases with increasing concentration due to the an increase in no of ions/unit vol. of the solution.
- For strong electrolyte the increase is sharp but for weak electrolyte it is gradual.
- In case of strong electrolytes the increase of k is almost proportional to c because of complete dilution.
- But for weak electrolytes increase of k is not so rapid because of low ionization of the electrolytes.



Equivalent conductance

- It is the conductance of a volume of solution containing 1g equivalent of electrolyte placed between two parallel electrodes unit distance apart in such a way the entire electrolyte is placed within the electrodes.

- Equivalence conductance, $\Lambda = \frac{k}{c}$ where c= concentration of electrolytes

- The unit of eqv. Conductance is $\Omega^{-1}\ cm^2\ eqv^{-1}$

- If c is expressed in equivalent per litre or normality then the above relation is given by

$$\Lambda = \frac{1000k}{c}\ \Omega^{-1}\ cm^2\ eqv^{-1}$$

Molar conductance

- It is the conductance of a volume of a solution containing 1g mole of the electrolyte placed between two parallel electrons unit distance apart.

- Molar conductance , $\Lambda_m = \frac{k}{c_m}$ where c=concentration of electrolyte in mol/cm^3

Unit of molar conductance is Ω^{-1} cm^2 mol^{-1}

- If c_m is expressed in moles/litre or molarity then $\Lambda_m = \frac{1000k}{c_m}$ Ω^{-1} cm^2 mol^{-1}
- The relation between eqv. Conductance and molar conductance given by
- $$\Lambda = \frac{\Lambda_m}{V_+ Z_+ (or V\_Z\_)}$$

where V_+ and V_ are no of cations and anions produced from 1 mol of electrolyte and Z+ & Z_ are the charge of the cation and anion respectively.

Ex- $HCl \longrightarrow H^+ + Cl^-$ $V_+=1, Z_+=1$ $\Lambda = \frac{\Lambda m}{1}$

$MgCl_2 \longrightarrow Mg^{2+} + 2Cl^-$ $V_+=1$ V- $=2$, $Z_+=2$ Z-$=1$ $\Lambda = \frac{\Lambda m}{2}$

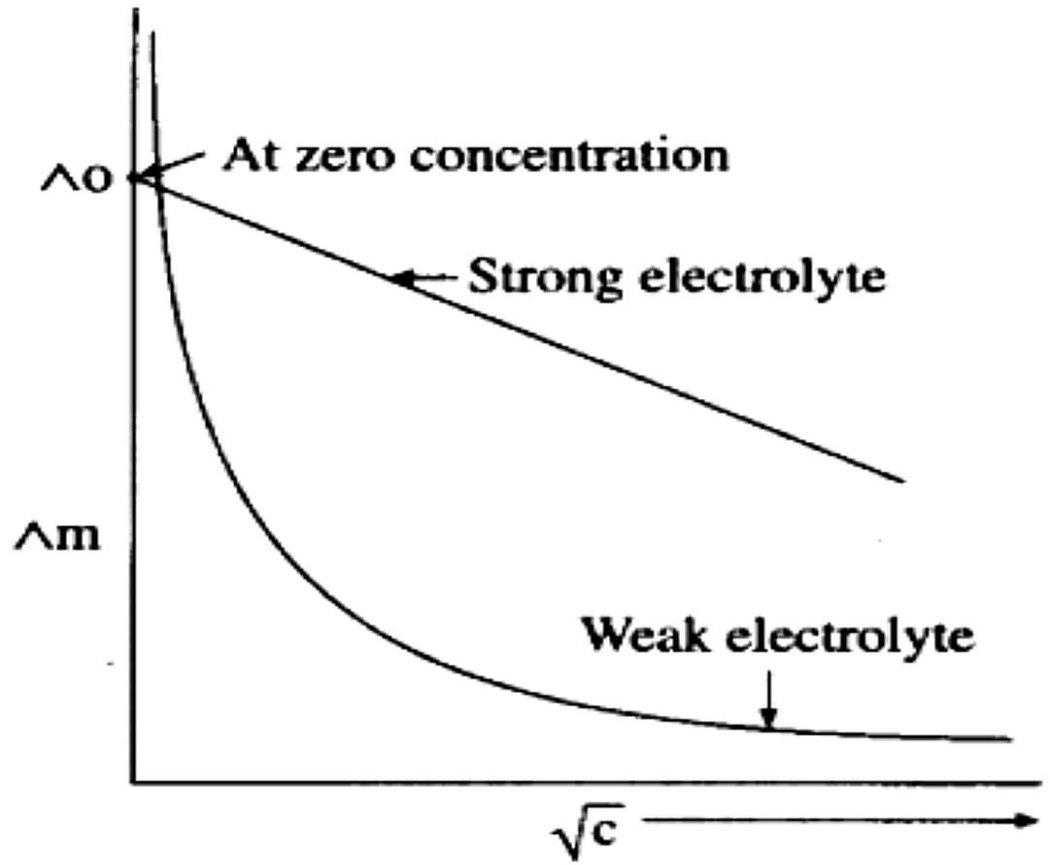
- ## Effect of temperature on Λ & Λ_m

- For strong electrolyte , with increasing temp no of ions remains same but speed of the ion increases thus both Λ & Λ_m will increase.
- For weak electrolyte, with increasing temp degree of dissociation will increase so no of ions per unit volume also increase moreover speed of the ion also increases resulting increase of both Λ & Λ_m .

- ## Effect of concentration on Λ & Λ_m

- For strong electrolyte, the no of ions remain same at any concentration because the solution contains 1 g-eq or 1g-mol og the electrolyte but with increasing concentration the inter ionic interaction between the oppositely charged ions increases resulting the inhibition of the speed of the corresponding ions leading to decrease in Λ & Λ_m value.

- Effect of concentration on Λ & Λ_m for strong and weak electrolytes

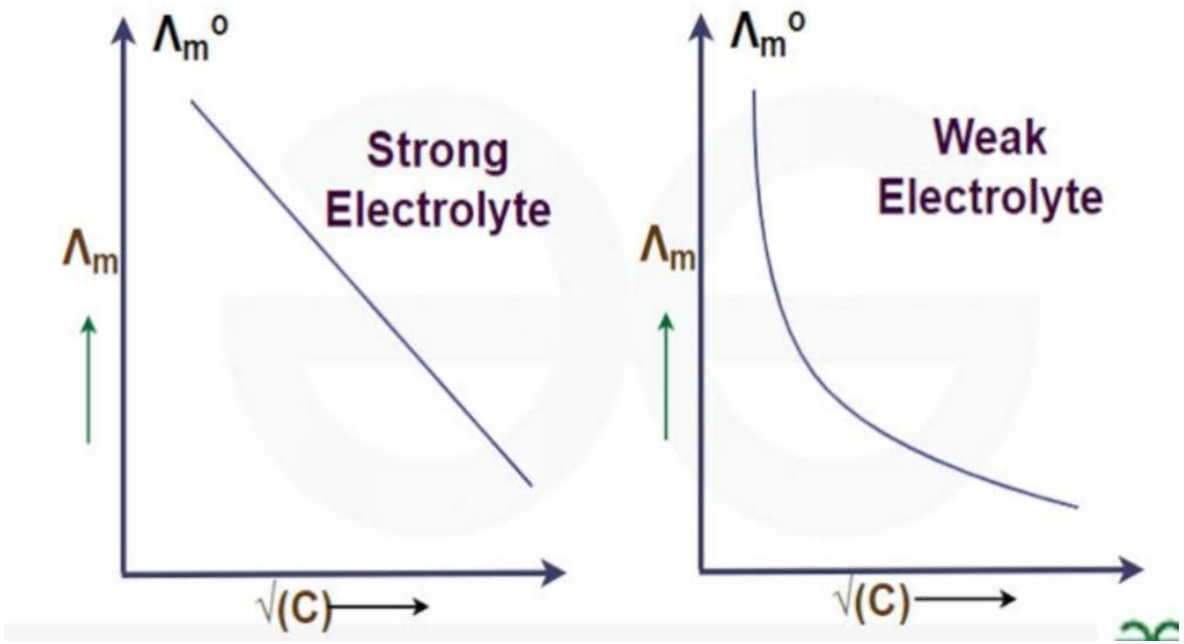


• Kohlrausch's law

- At infinite dilution where dissociation of all electrolytes is complete and where all interionic effect disappear and each ion migrates indepently with its counter ions and contributes a definite share to the total equivalent conductance of the electrolyte.
- Mathematically, $\Lambda^0 = \lambda^0_{+} + \lambda^0_{-}$
- Where Λ^0 is the equivalence conductance of the electrolyte at infinite dilution.
- If Λ^0_m is the molar conductance of the electrolyte at infinite dilution

$$\Lambda^0_m = V_+ \lambda^0_{+} + V_- \lambda^0_{-}$$

- Where V+ & V- are the no of cations and anions produced from the dissociation of 1 mol of electrolyte.



- Transport number or transference number

In an electrolytic solution current is carried by cations and anions ,the fraction of the total current carried by a particular ion is called its transport number.

- Transport number , $t_{+/-} = \frac{I_{\pm}}{I}$

where I_+ & I_- are current carried by cations and anions respectively.

- Total current $I = I_+ + I_-$
- t_+ & t_- can or cannot be same.
- $t_+ + t_- = 1$

• Ionic mobility

- Ionic mobility is the speed of ion with which it moves in an solution under under unit potential gradient. Thus
- Ionic mobility = $\frac{ionic\ speed(v)}{potential\ gradient(\frac{\Delta\phi}{l})}$
- Unit: SI=$m^2\,volt^{-1}\,sec^{-1}$

  CGS=$cm^2\,volt^{-1}\,sec^{-1}$
- Ionic speed (v) depends on

i. Concentration of the electrolytes

ii. Temperature

iii. Nature of the solvent

iv. Potential difference between the electrode

v. Distance between the electrode

- Transport number $\propto$ ionic speed, $t \propto v$

ACKNOWLEDGEMEMT

References:

i. Various internet websites
ii. Class notes of sir Dr. Biswajit Pal
iii. Study notes of Dr. Sayan Roy Chowdhury & Dr. Kaushik Bera
iv. Google stock images

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