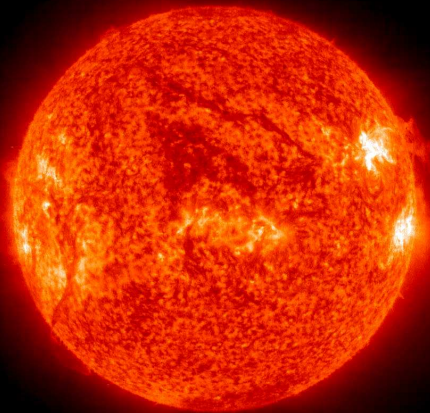


The

APOLLO-GAIA

Project





Complex Solutions for Complex Problems



**Mobilising Social Response to
Accelerating Climate Change in a
Post-Copenhagen Context**



Part 1:

An Introduction to the Dynamics of Climate Change



Part 2:

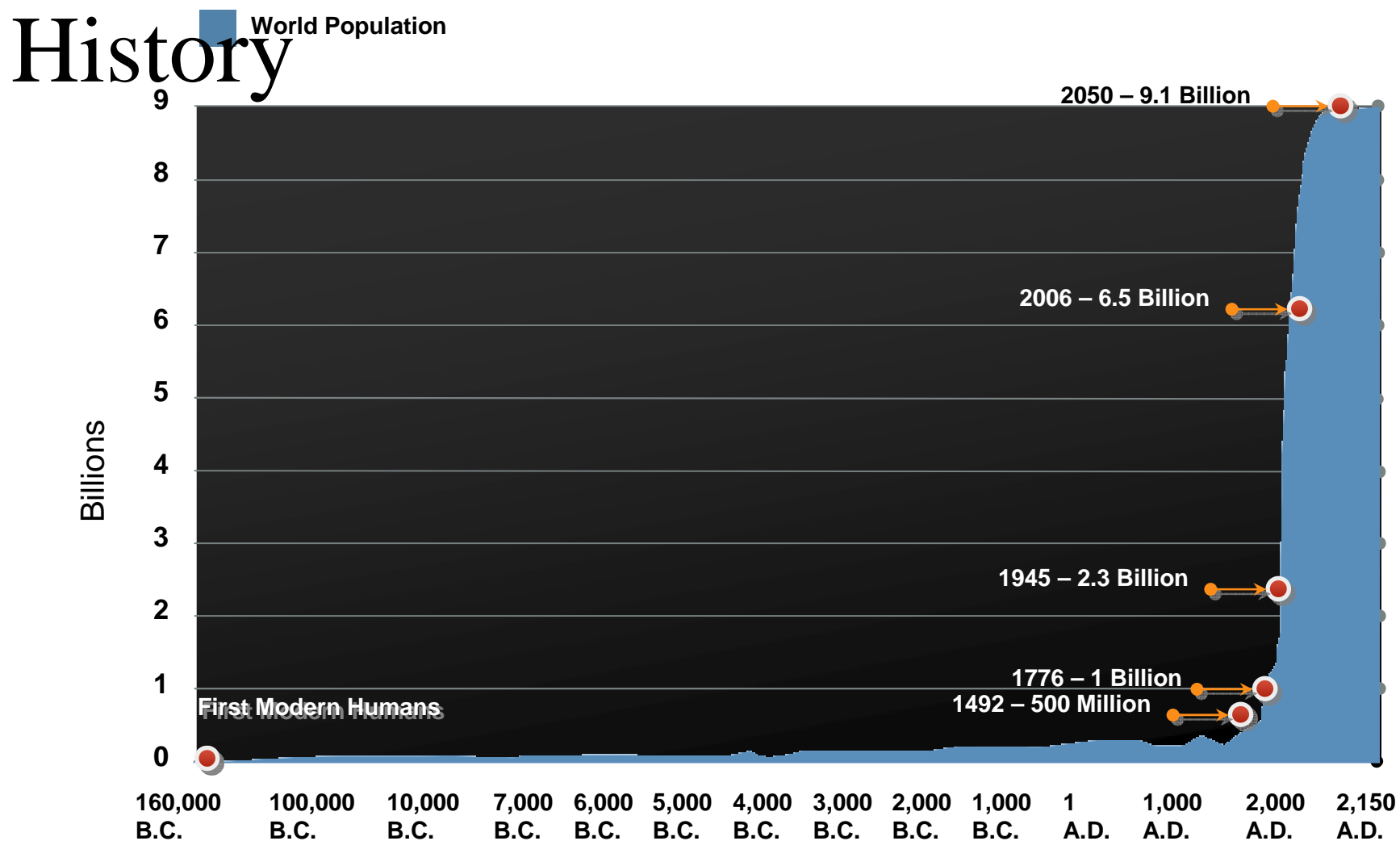
**Social Dynamics, Applied
Complexity & the Catalysis of
Transition**



Part 1:

An Introduction to the Dynamics of Climate Change

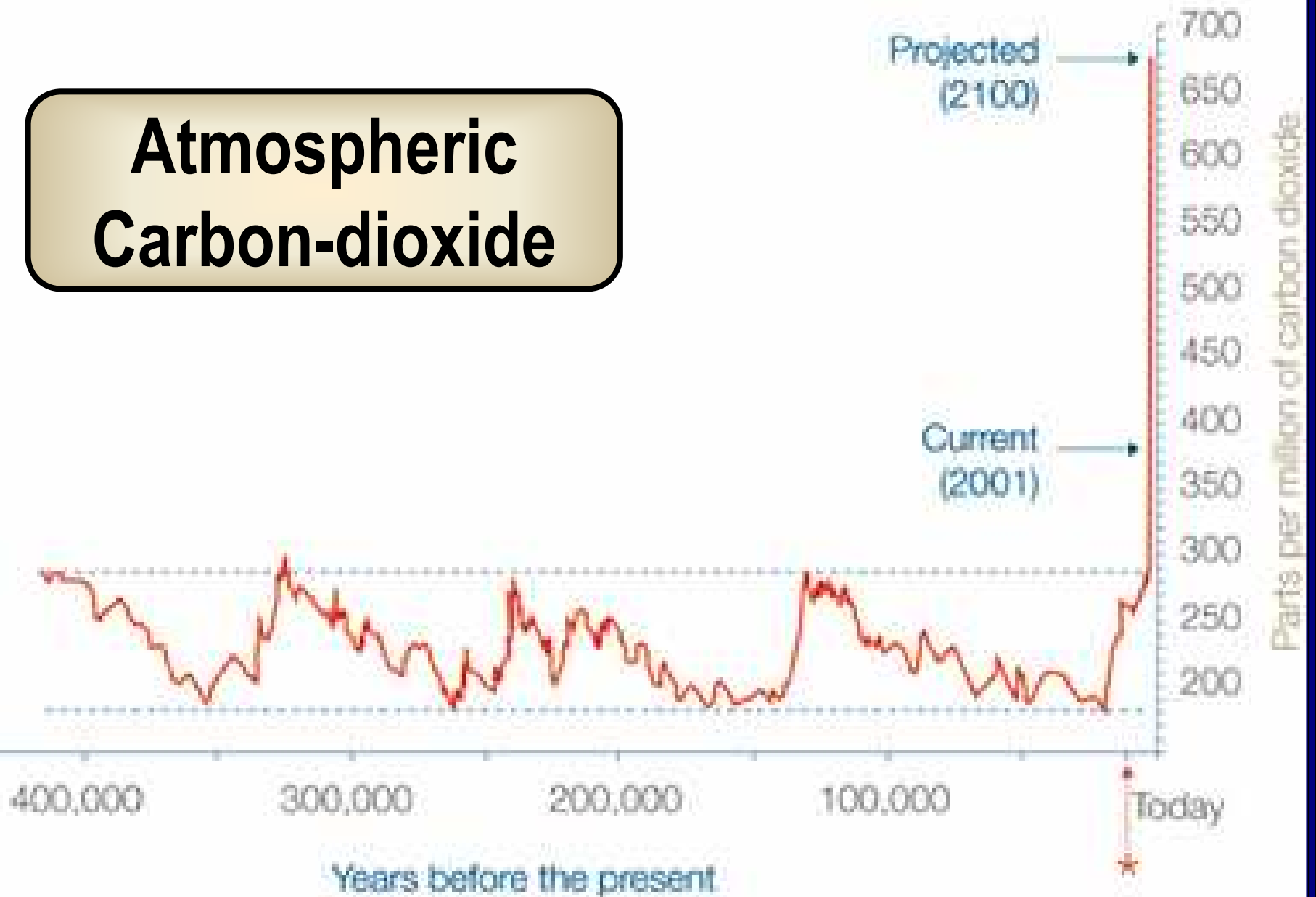
Population Growth Throughout History



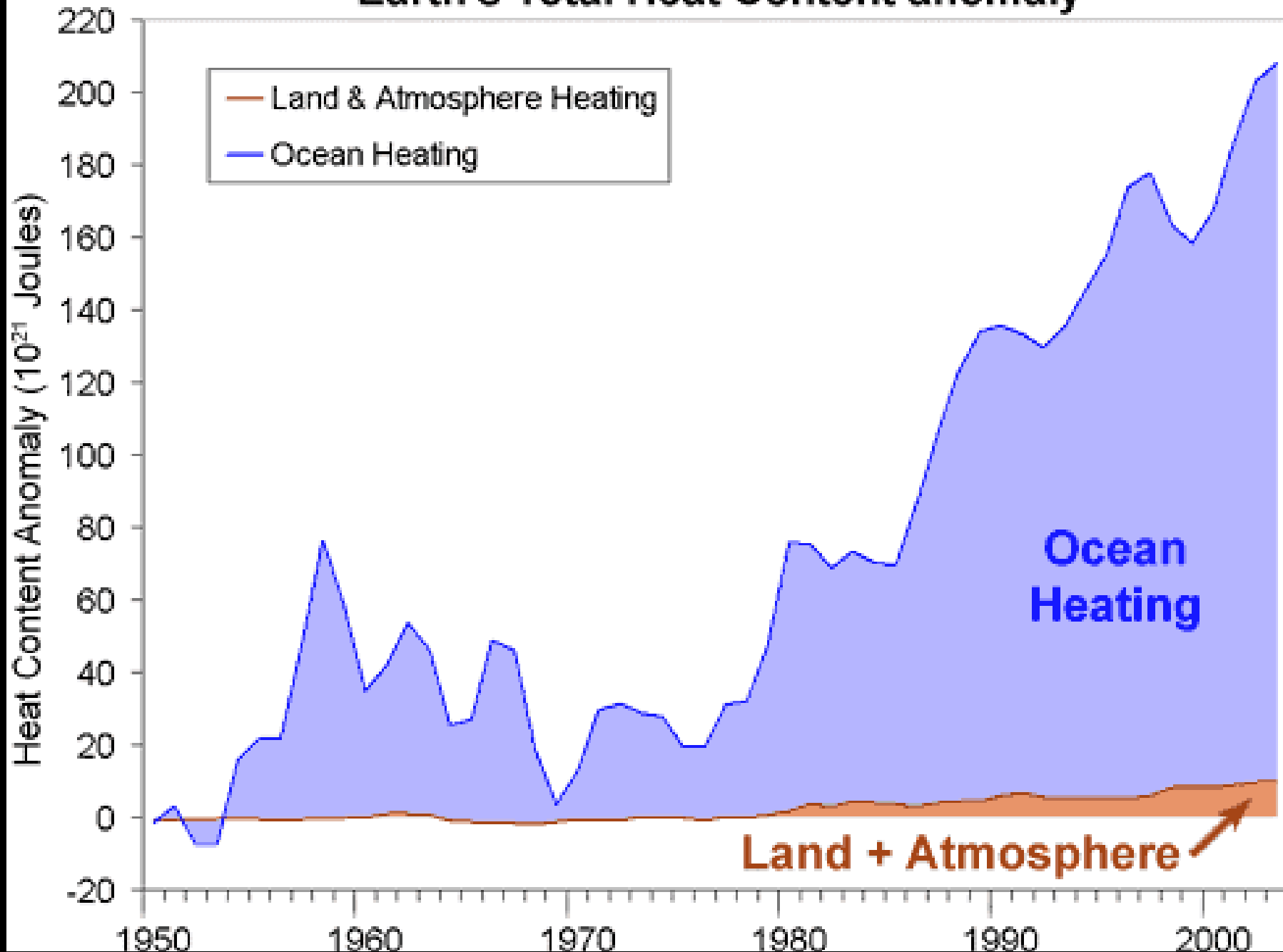
Source: United Nations

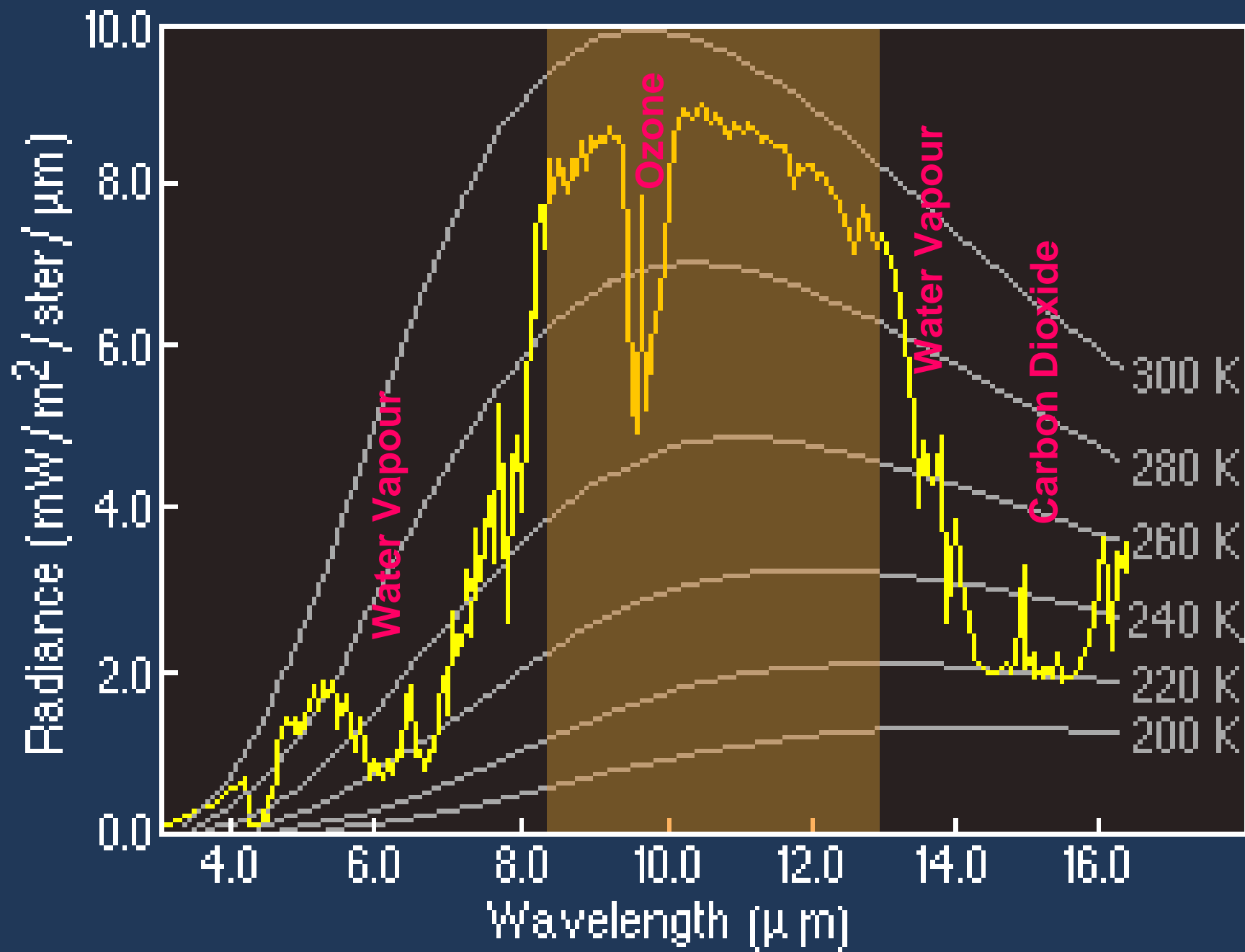


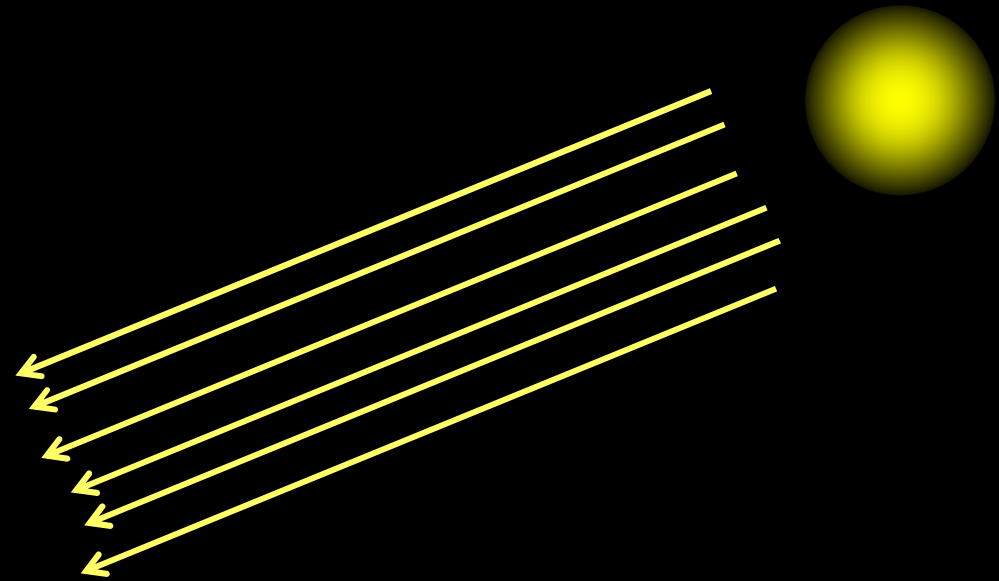
Atmospheric Carbon-dioxide



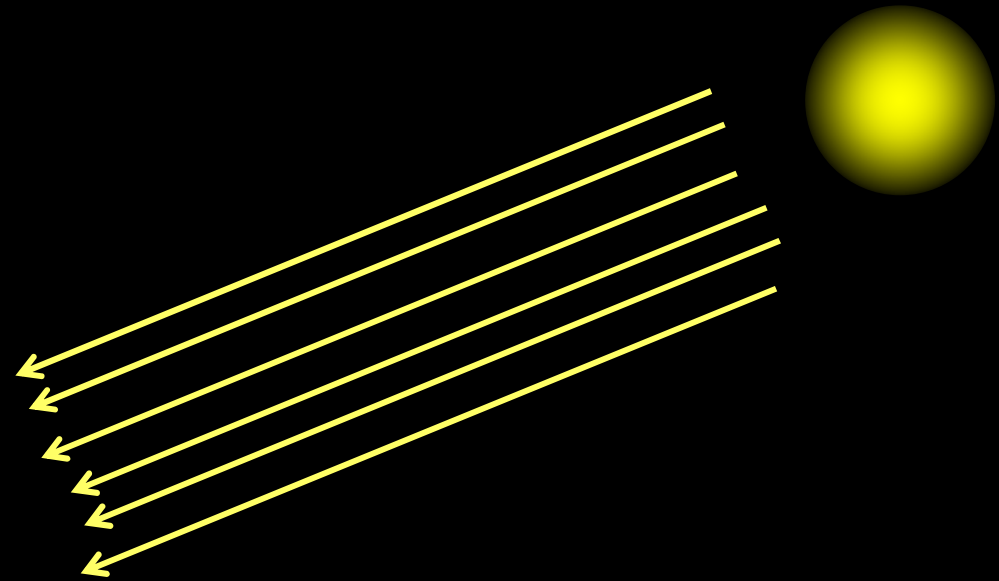
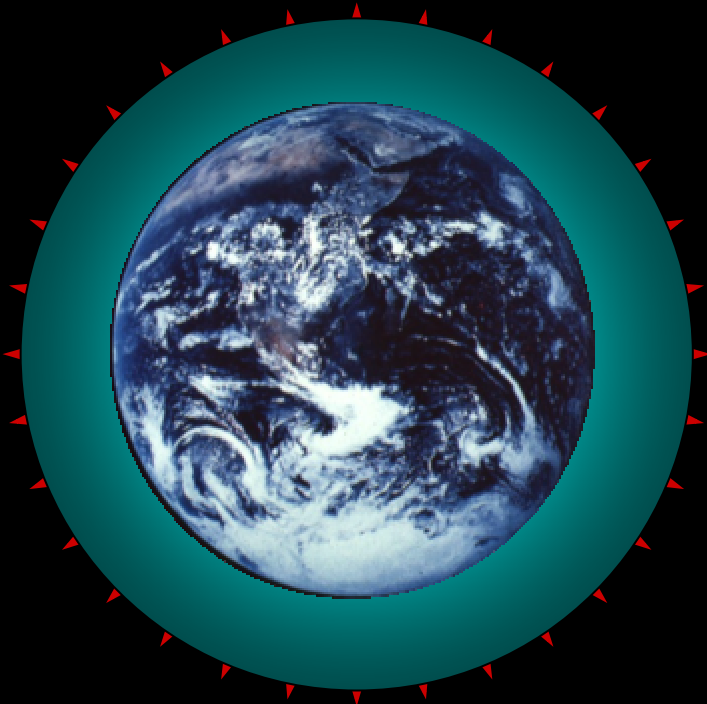
Earth's Total Heat Content anomaly



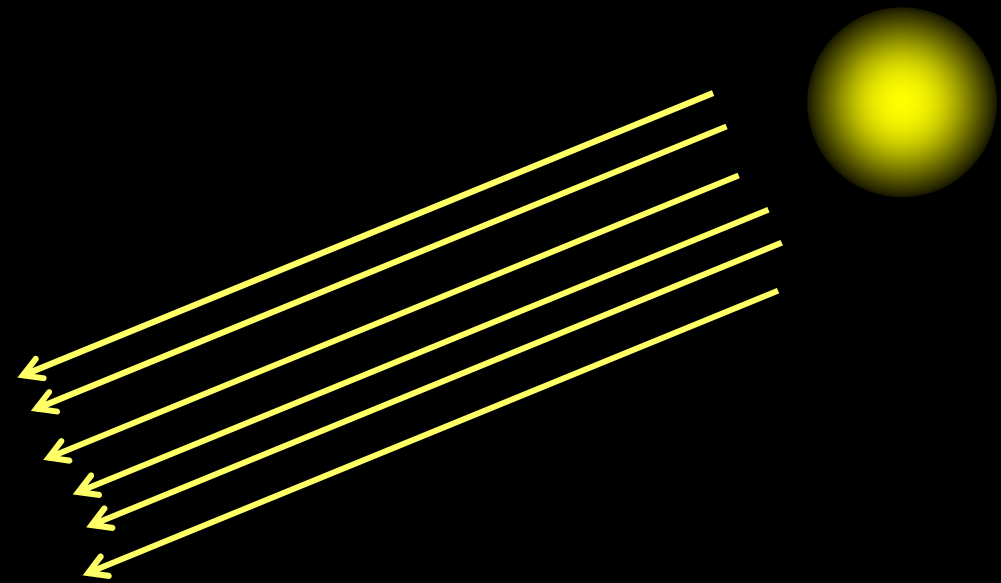




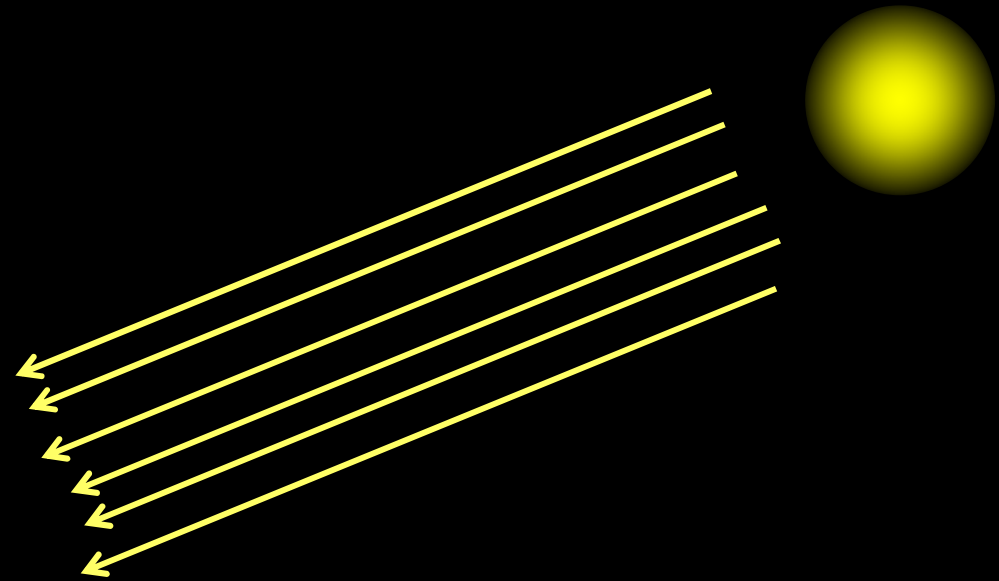
**Increase in GHG
concentration raises
efficiency of insulating envelope,
reducing net global radiation**



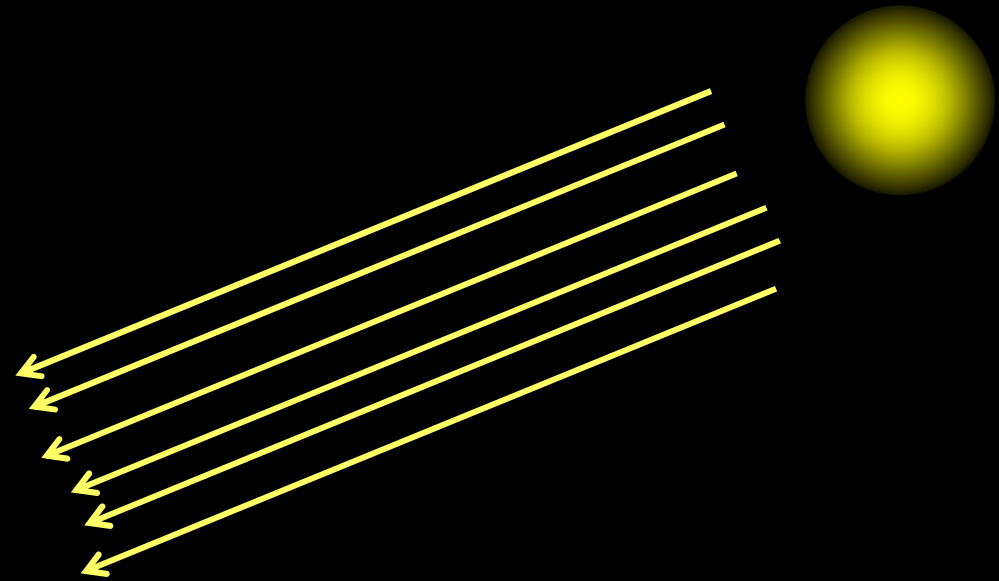
**Increase in GHG
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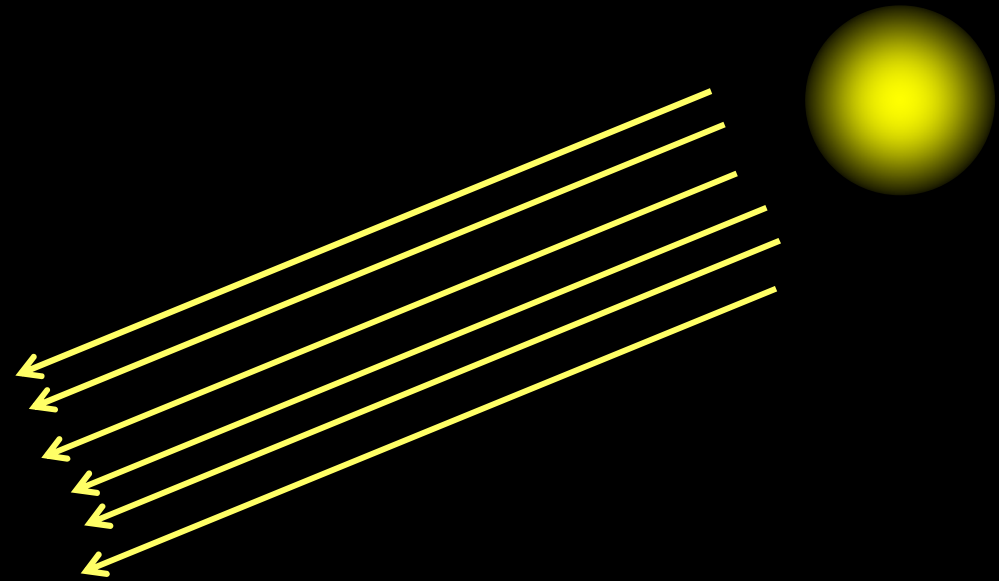
**Surface
temperature
rises, driven by
retained solar energy**



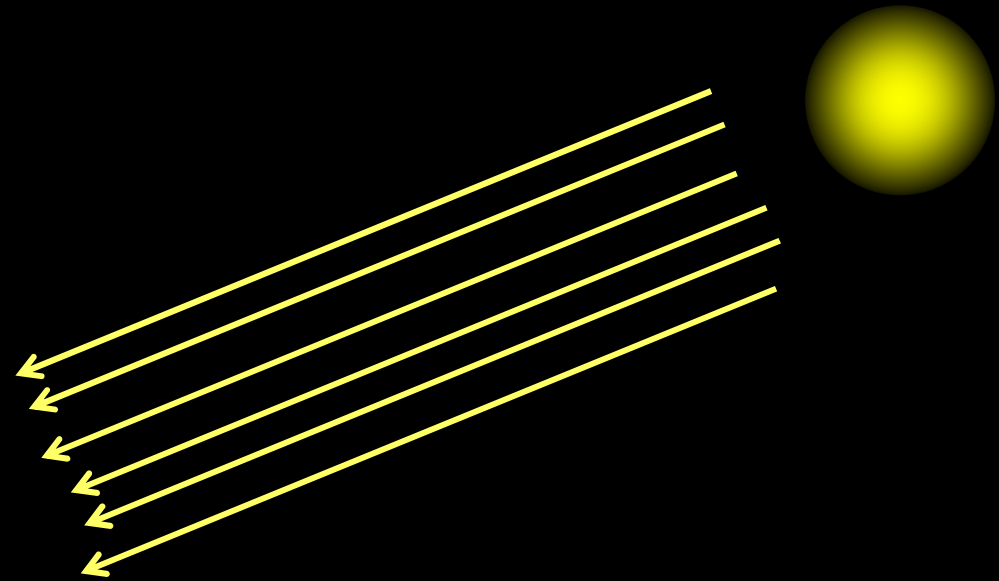
**until resultant
radiation recovers
to establish a new
thermal equilibrium**



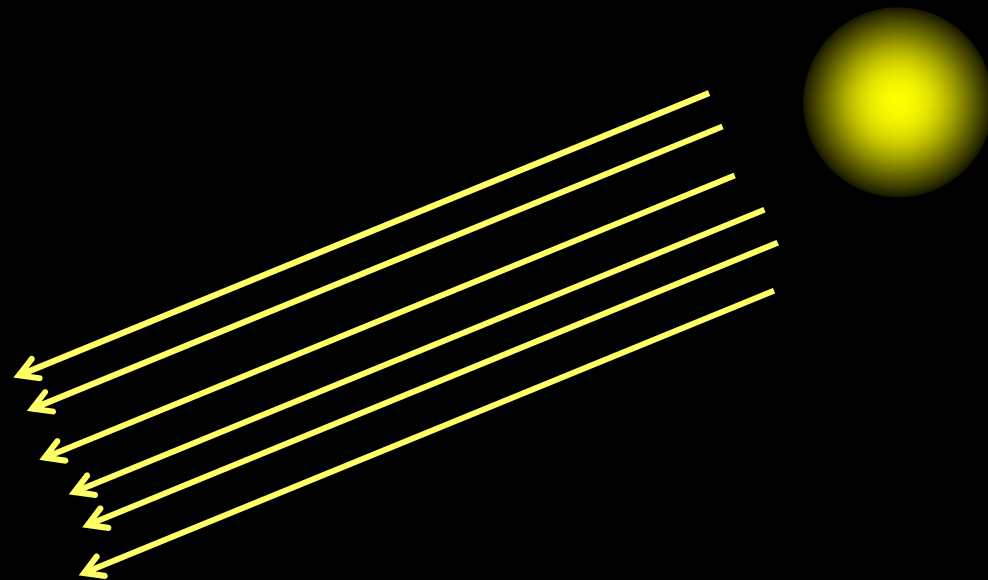
**Except that we
are accelerating the
accumulation of GHGs.**



**Except that we
are accelerating the
accumulation of GHGs.**



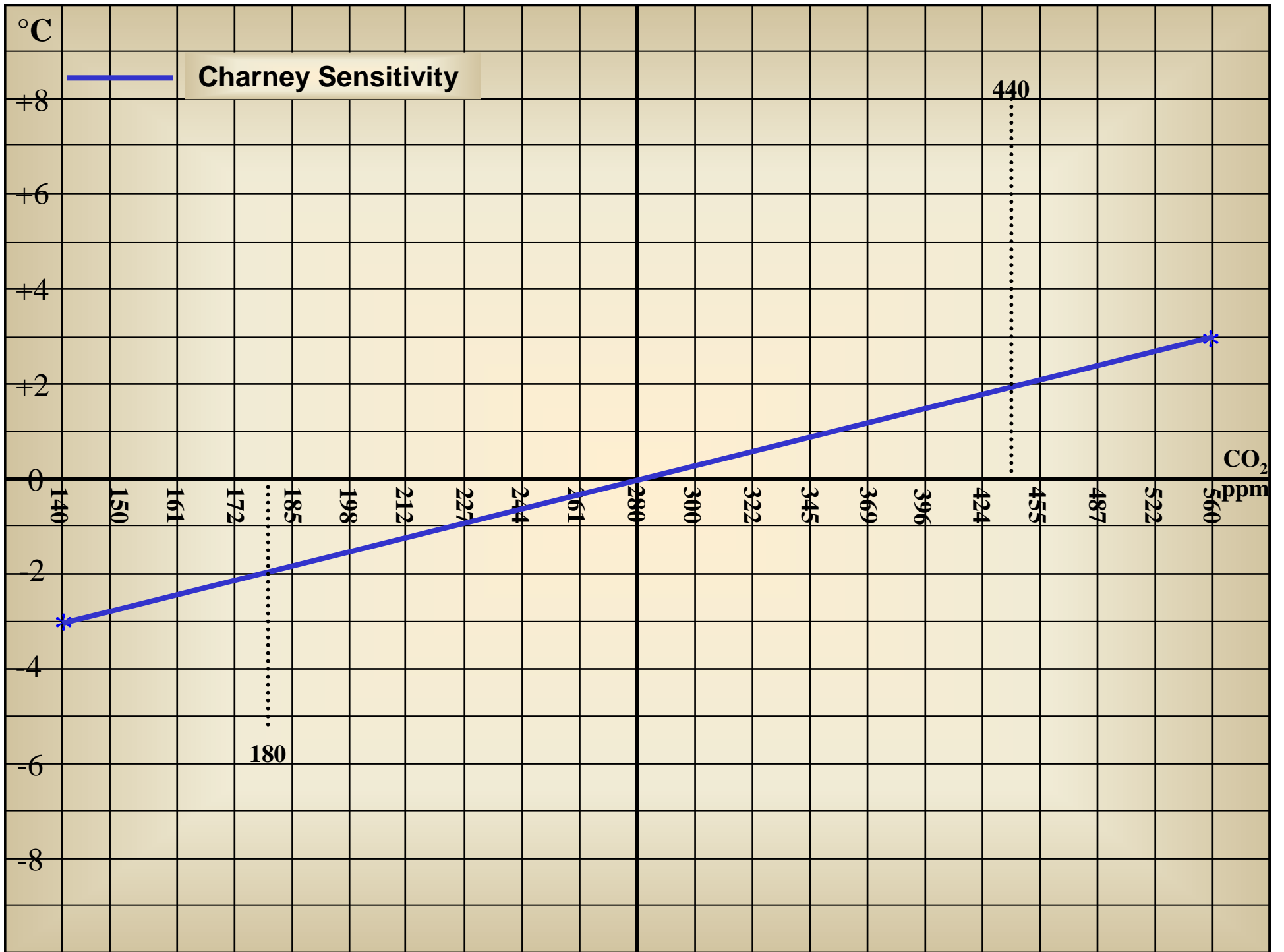
**Except that we
are accelerating the
accumulation of GHGs,
and feedbacks are also pushing
the system even further from balance**

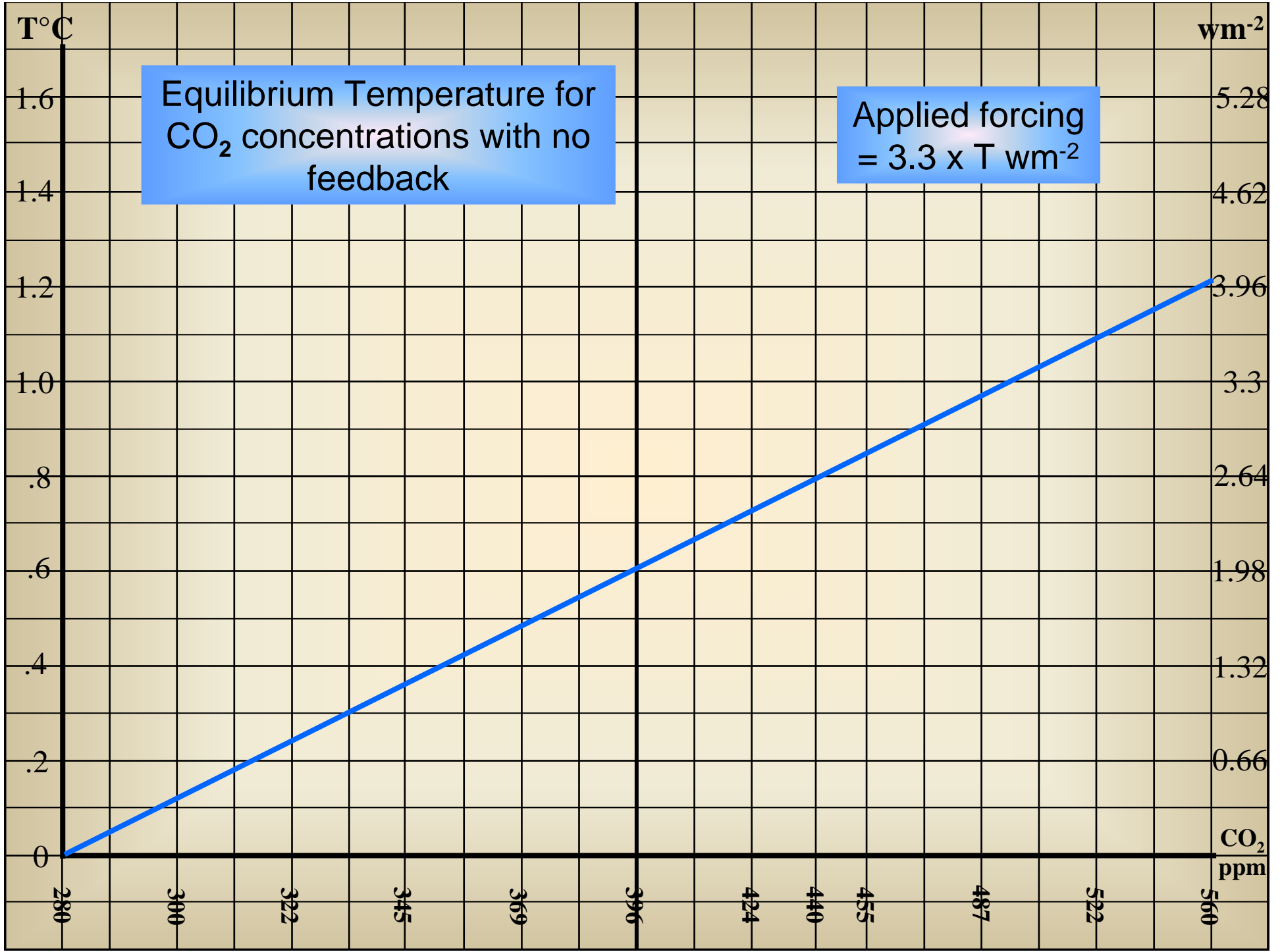


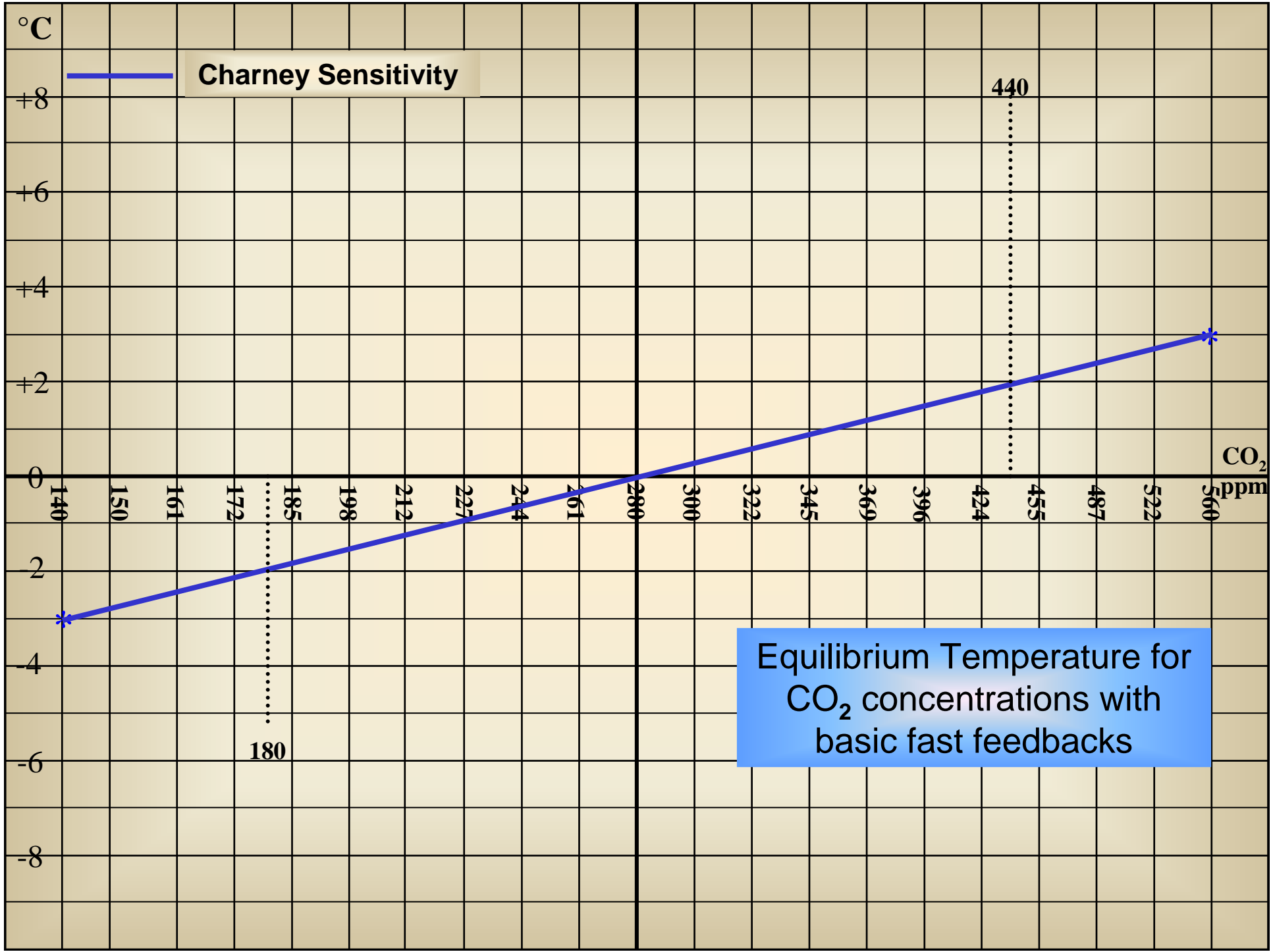
**Except that we
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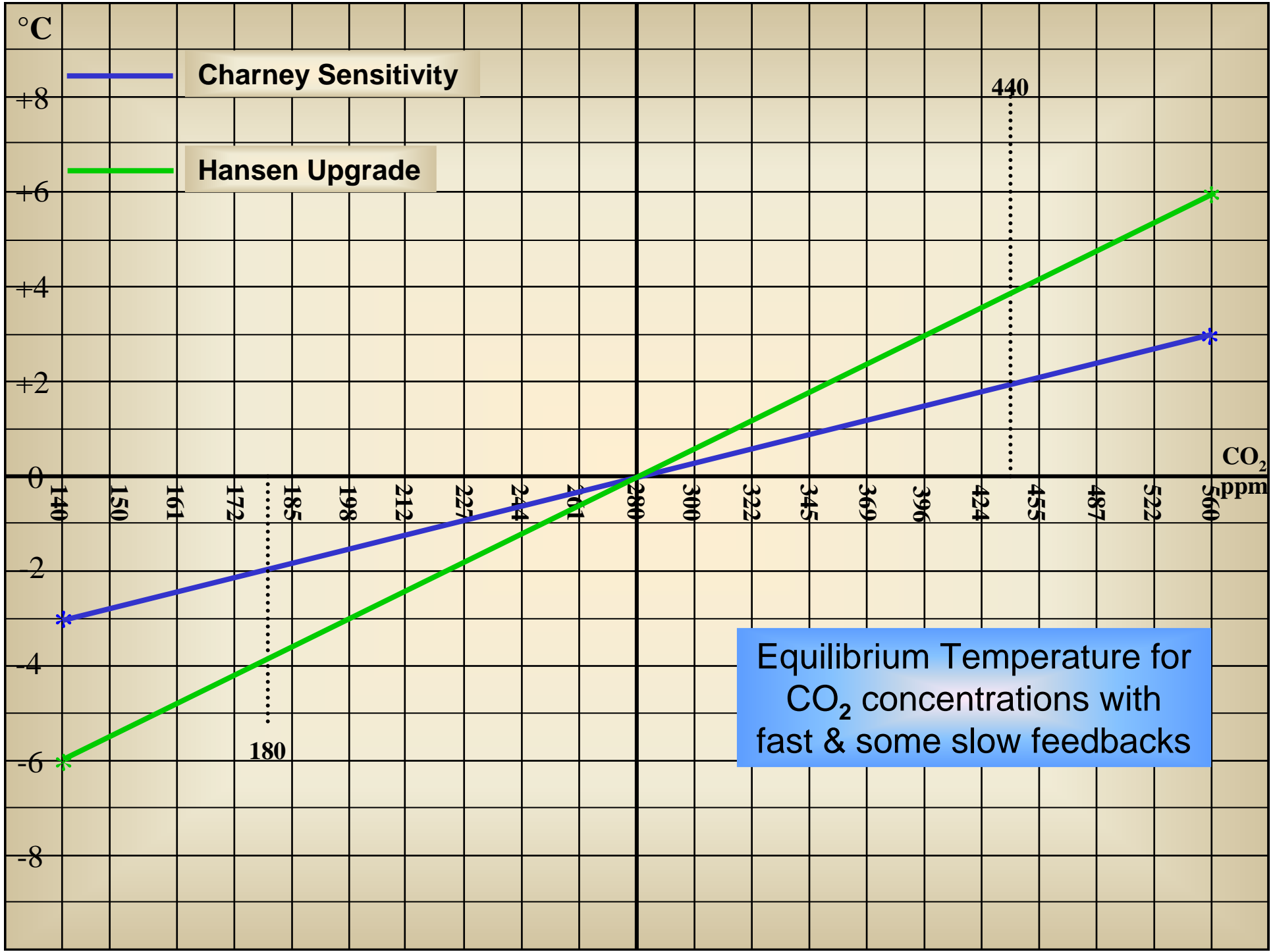
Climate Sensitivity

**Charney checked against
Paleo-records**

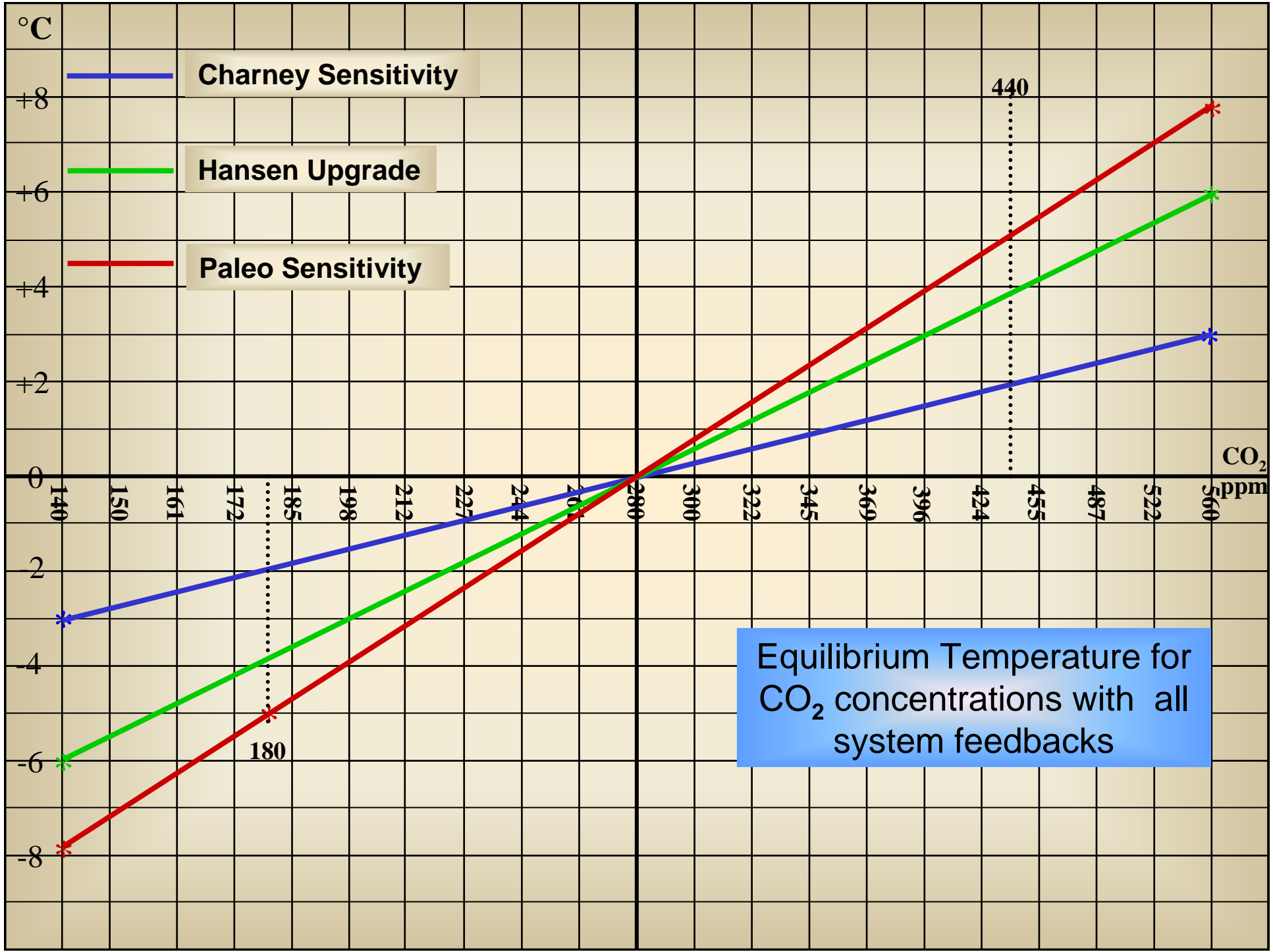




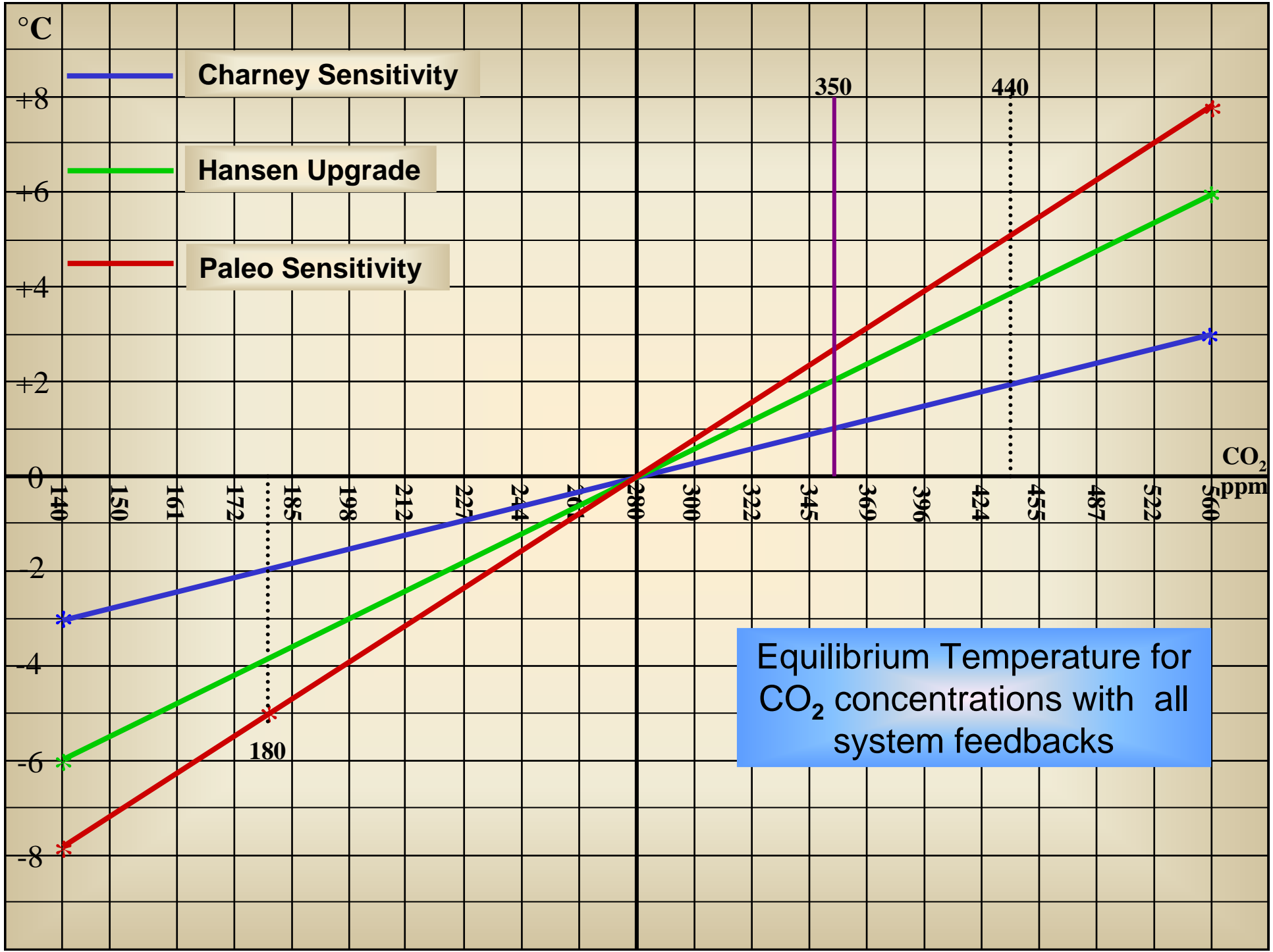




Equilibrium Temperature for CO₂ concentrations with fast & some slow feedbacks



Equilibrium Temperature for CO₂ concentrations with all system feedbacks



The “Feed-back” Simulator



The “Bath-Tub” Metaphor



The “Bath-Tub” Metaphor

**Meta for the
Planet**











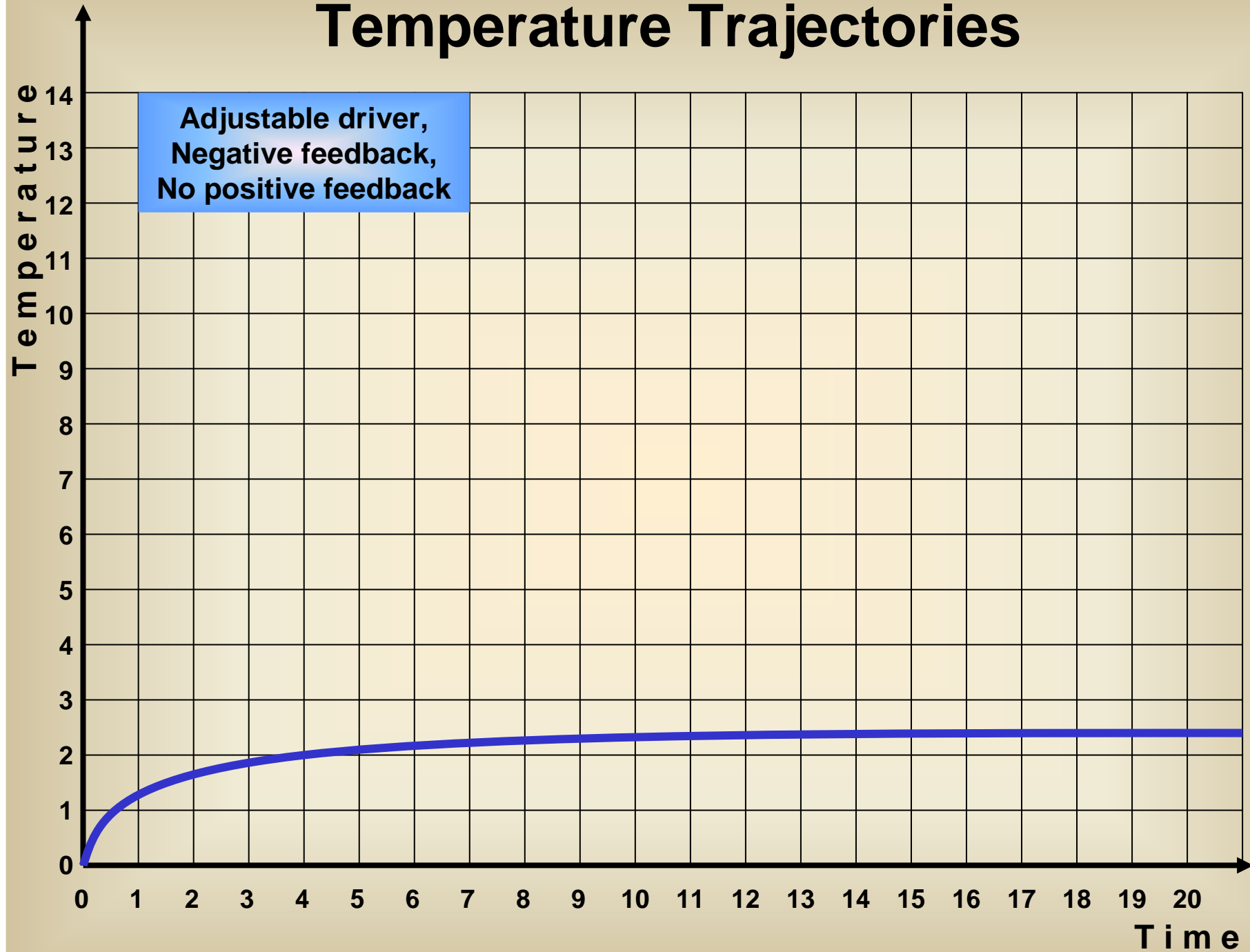








Temperature Trajectories













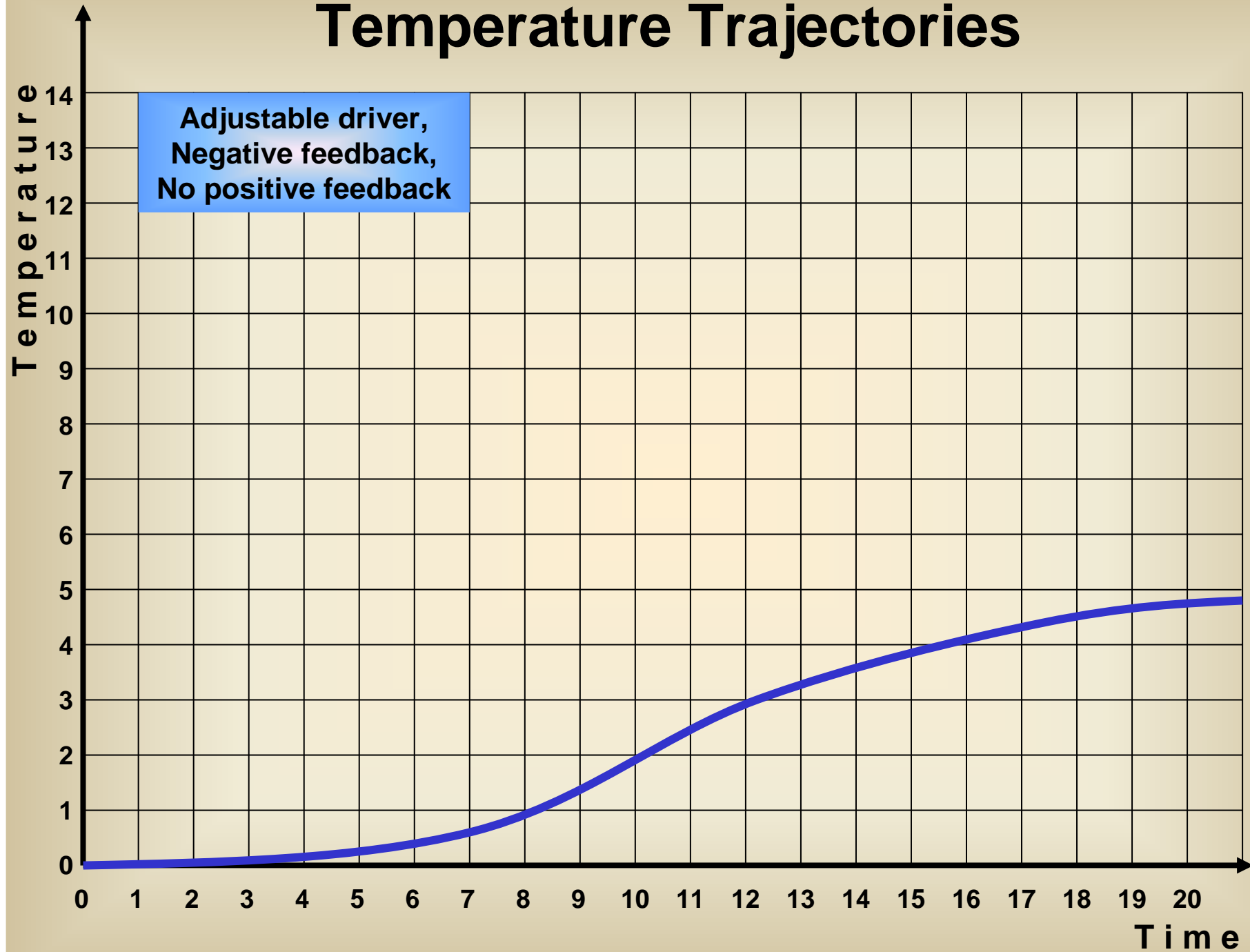








Temperature Trajectories





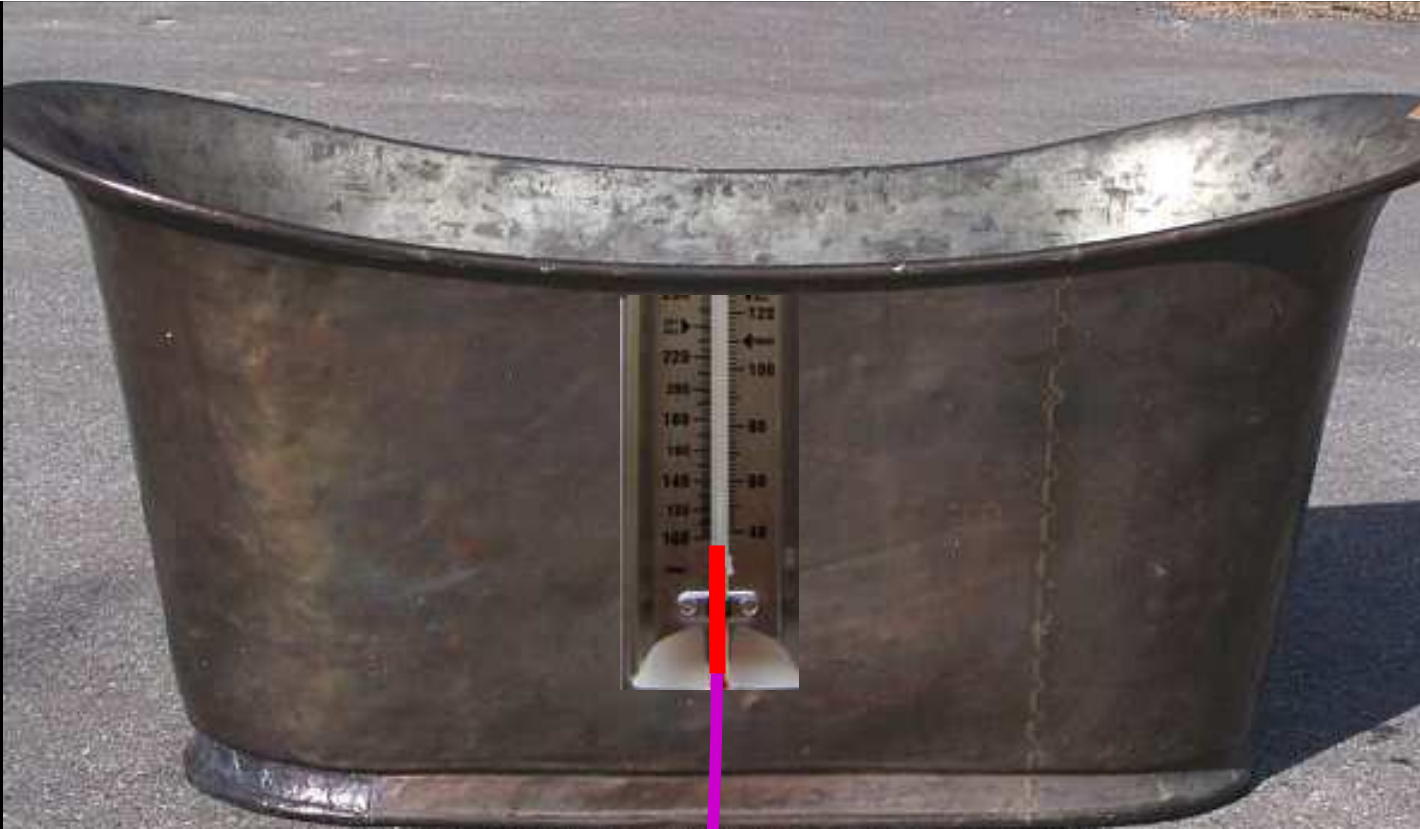
**Positive feedback
weaker than
Negative feedback**





**Positive feedback
weaker than
Negative feedback**





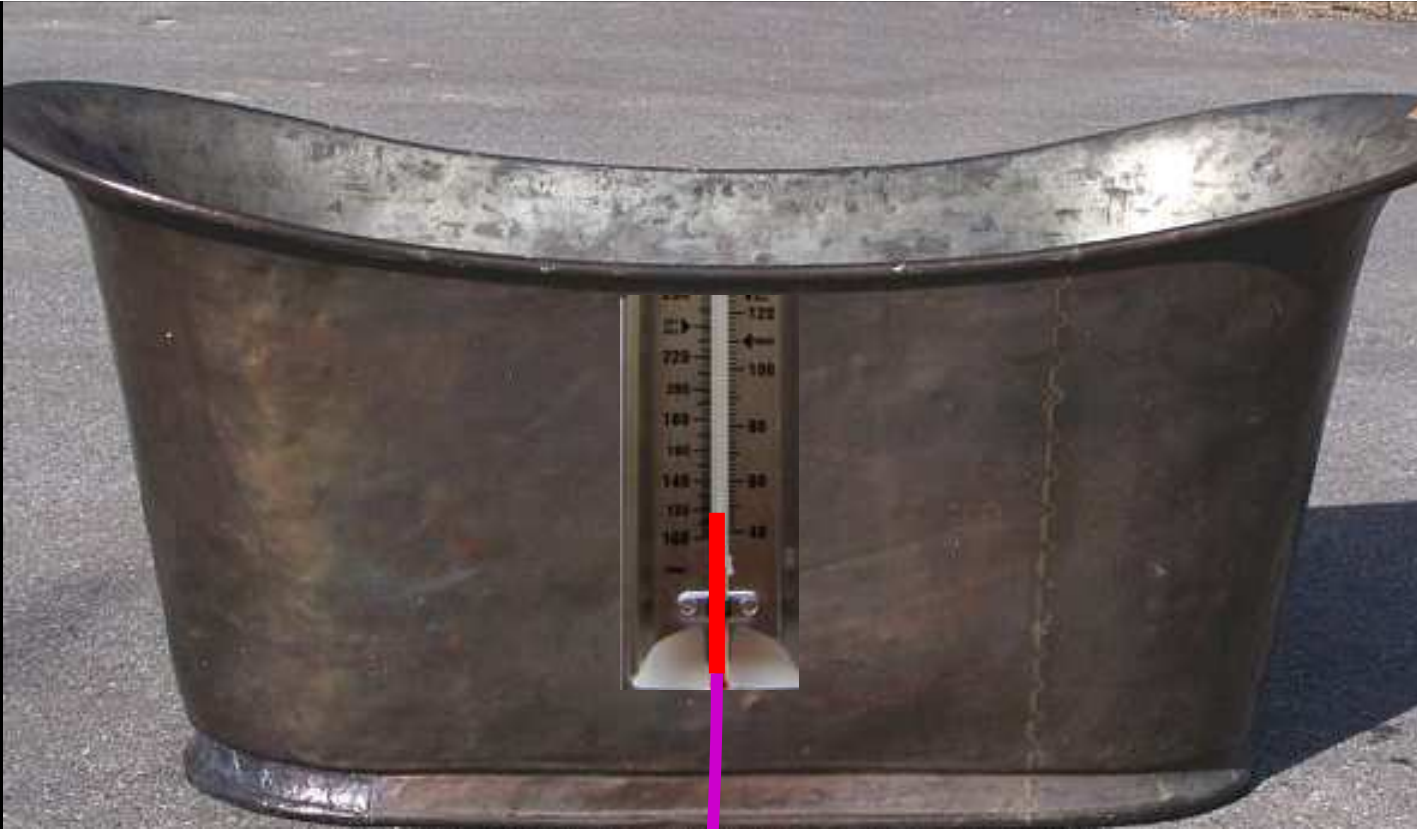
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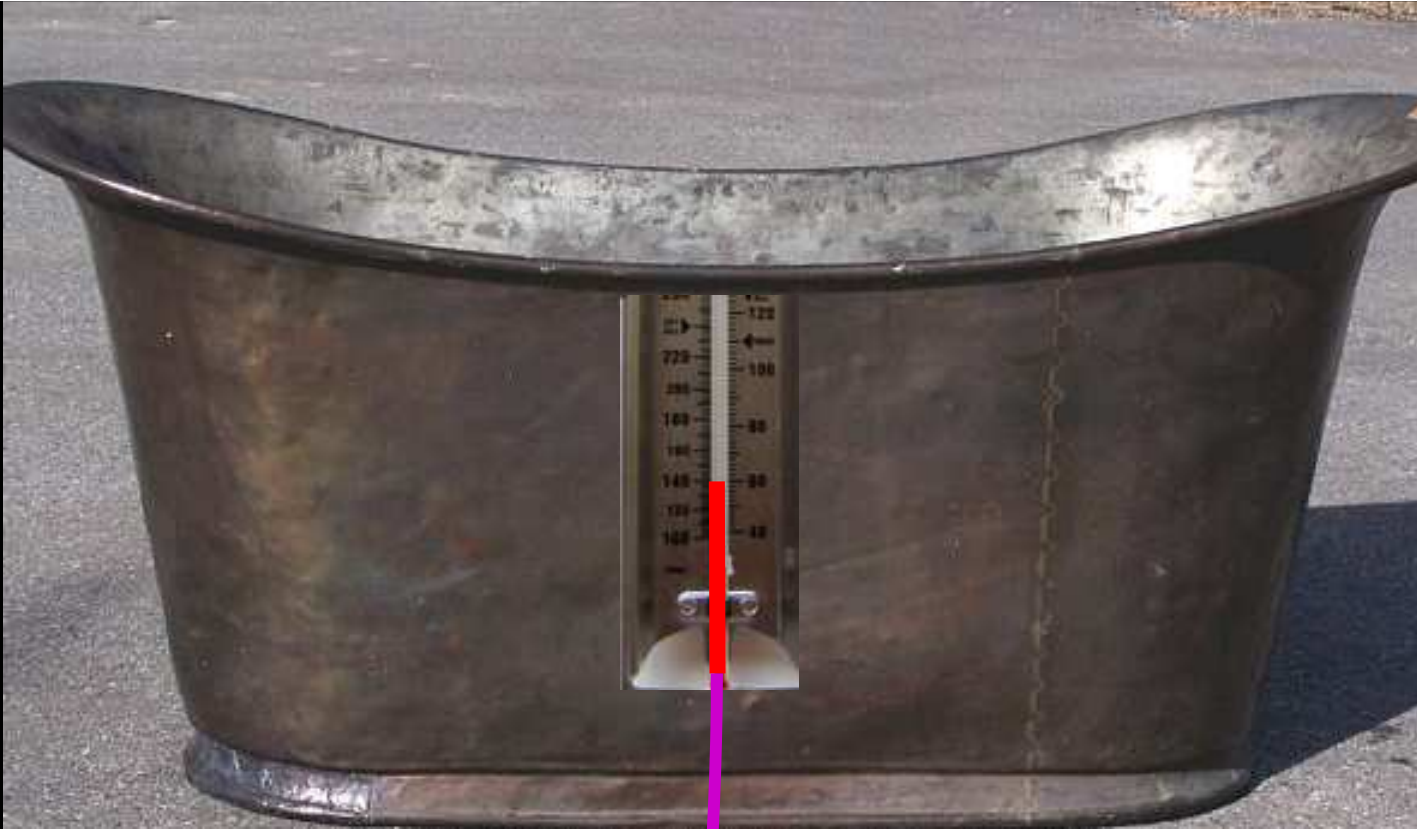
**Positive feedback
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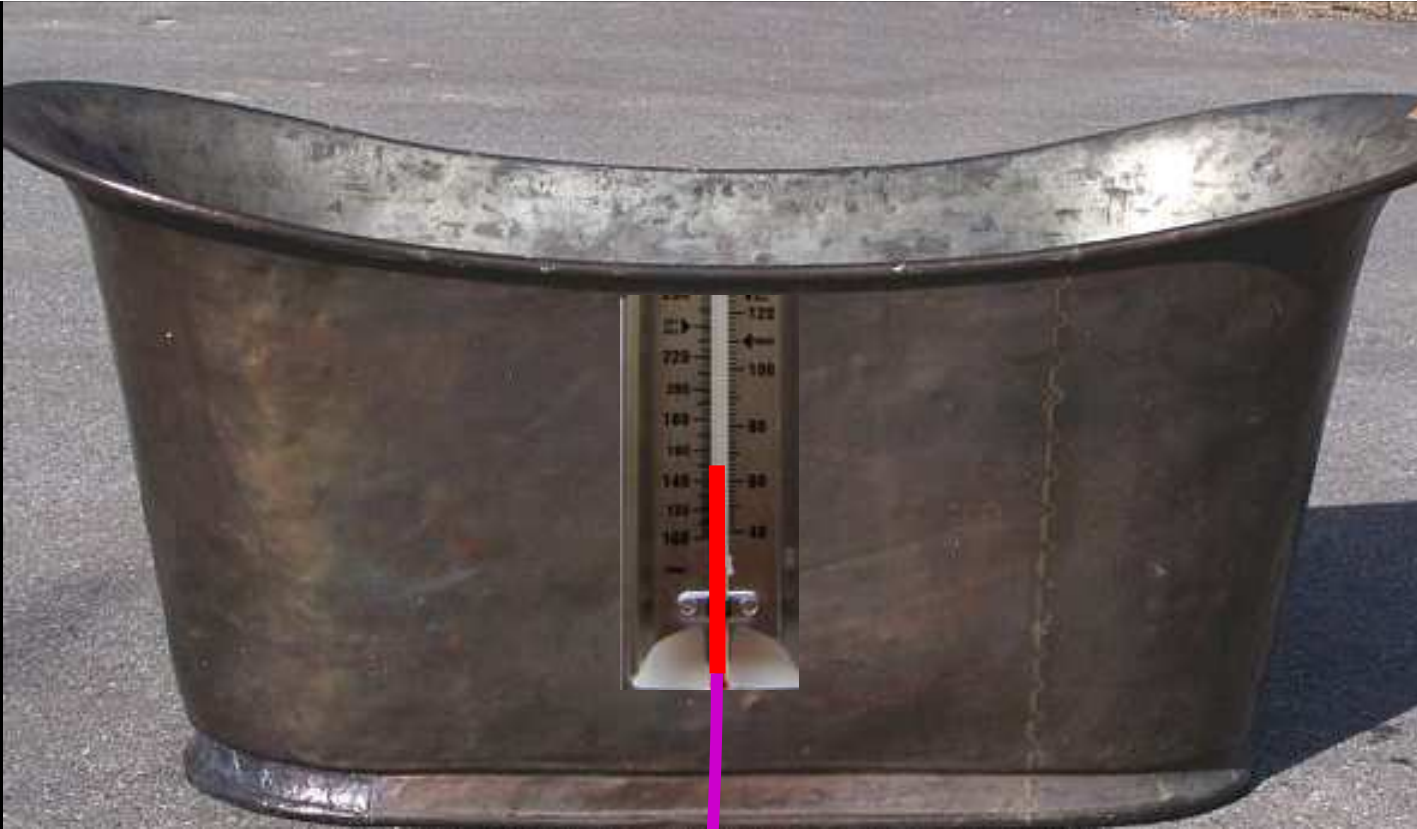
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Negative feedback**





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Negative feedback**





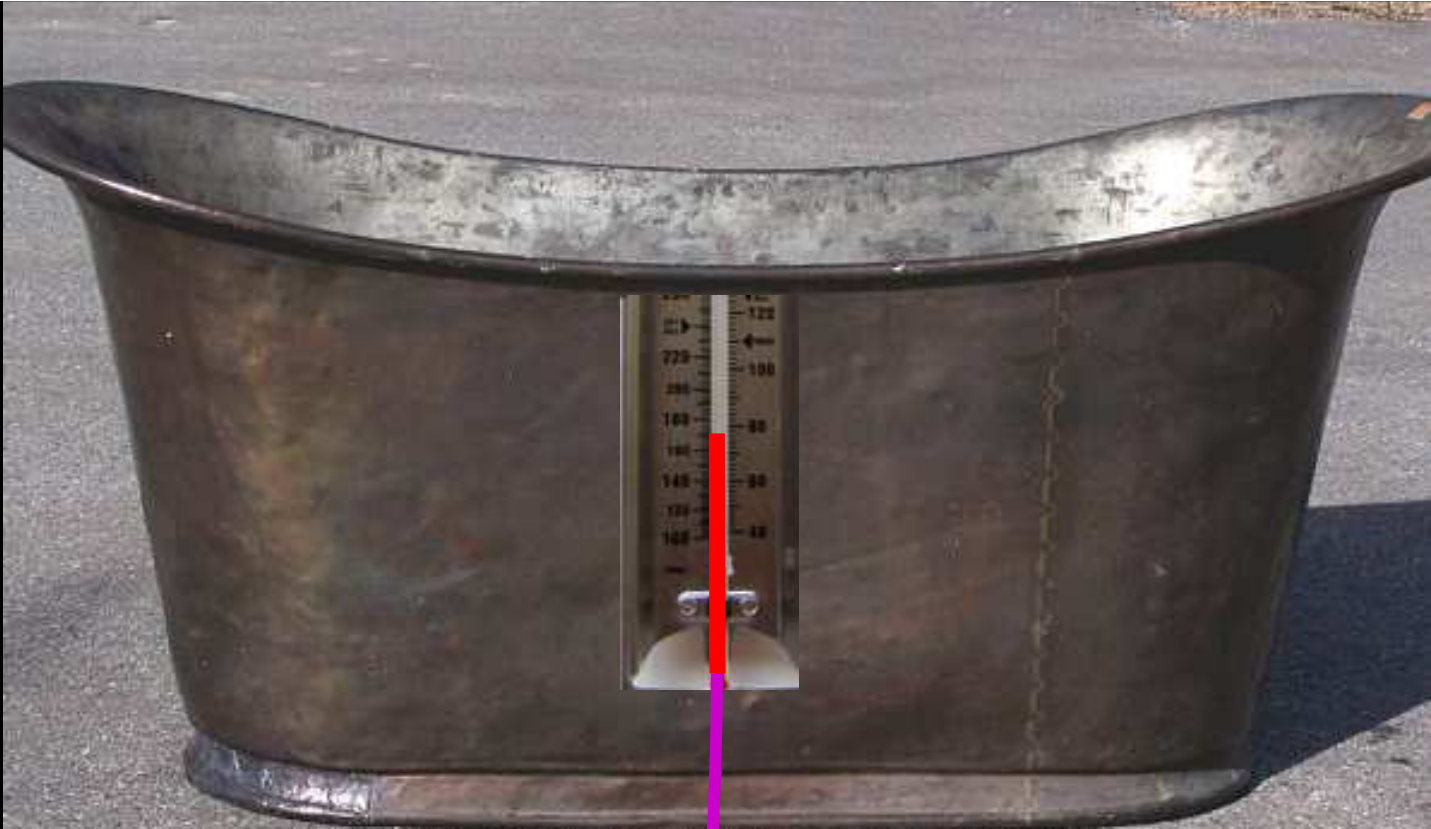
**Positive feedback
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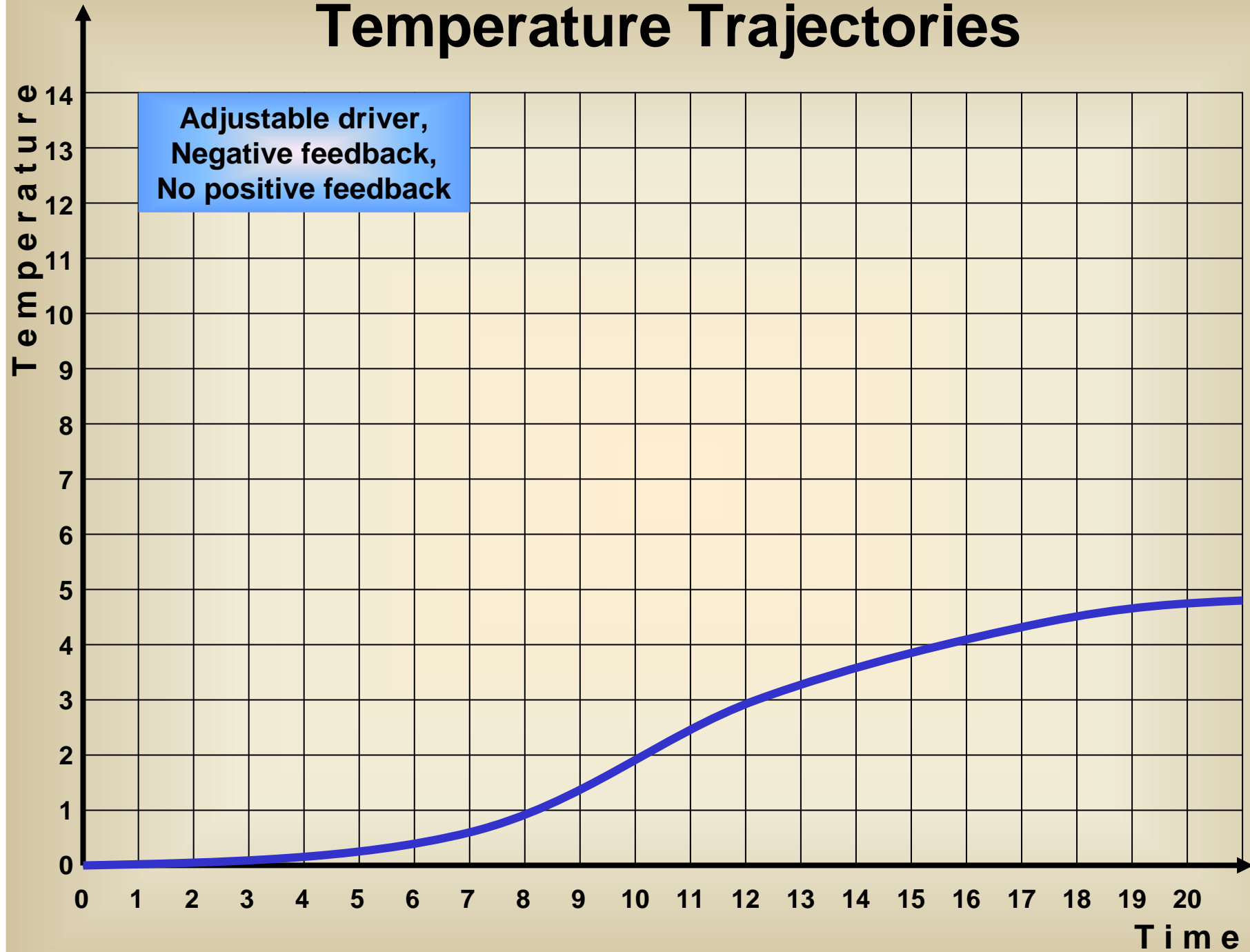
**Positive feedback
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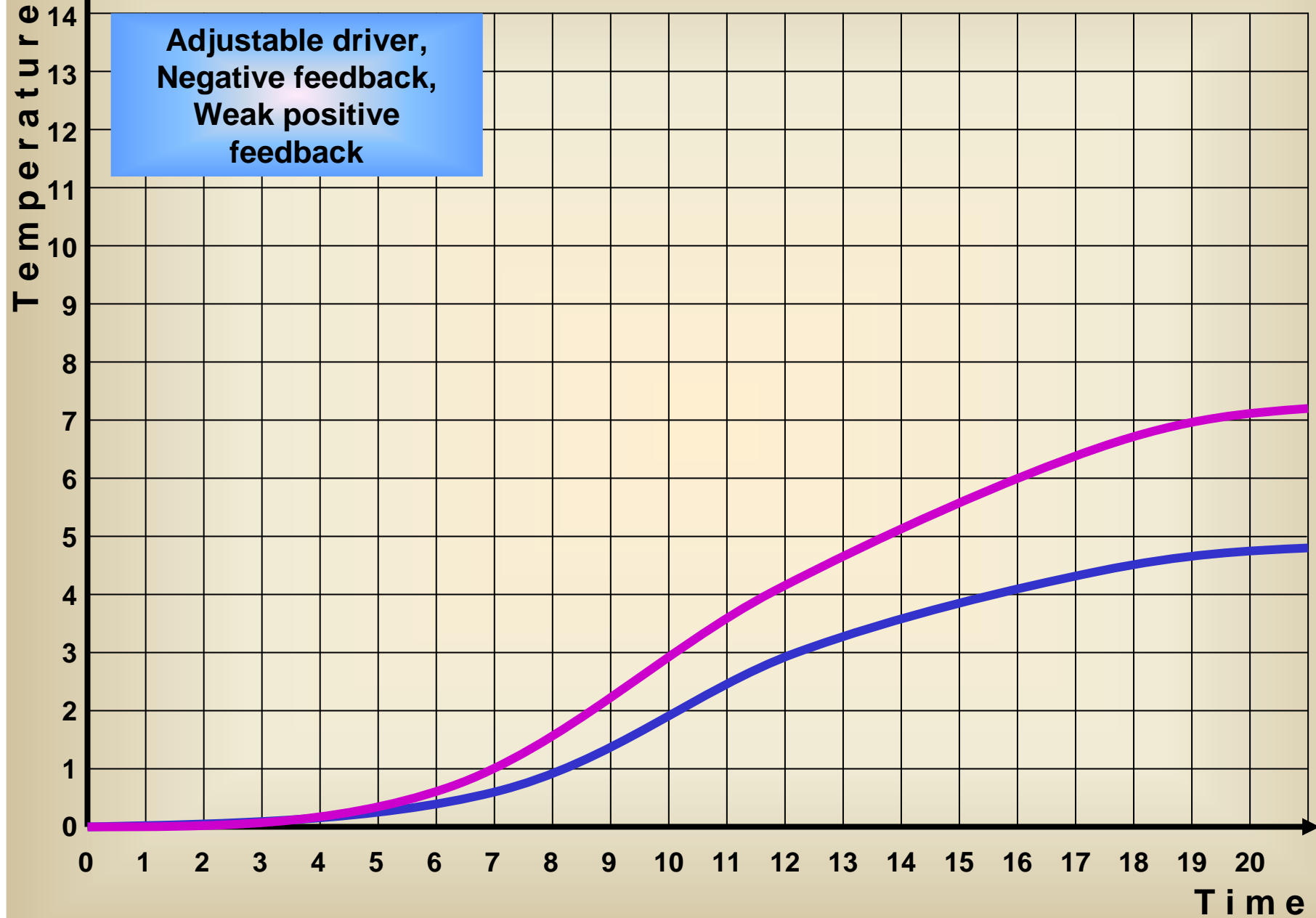


**Positive feedback
weaker than
Negative feedback**

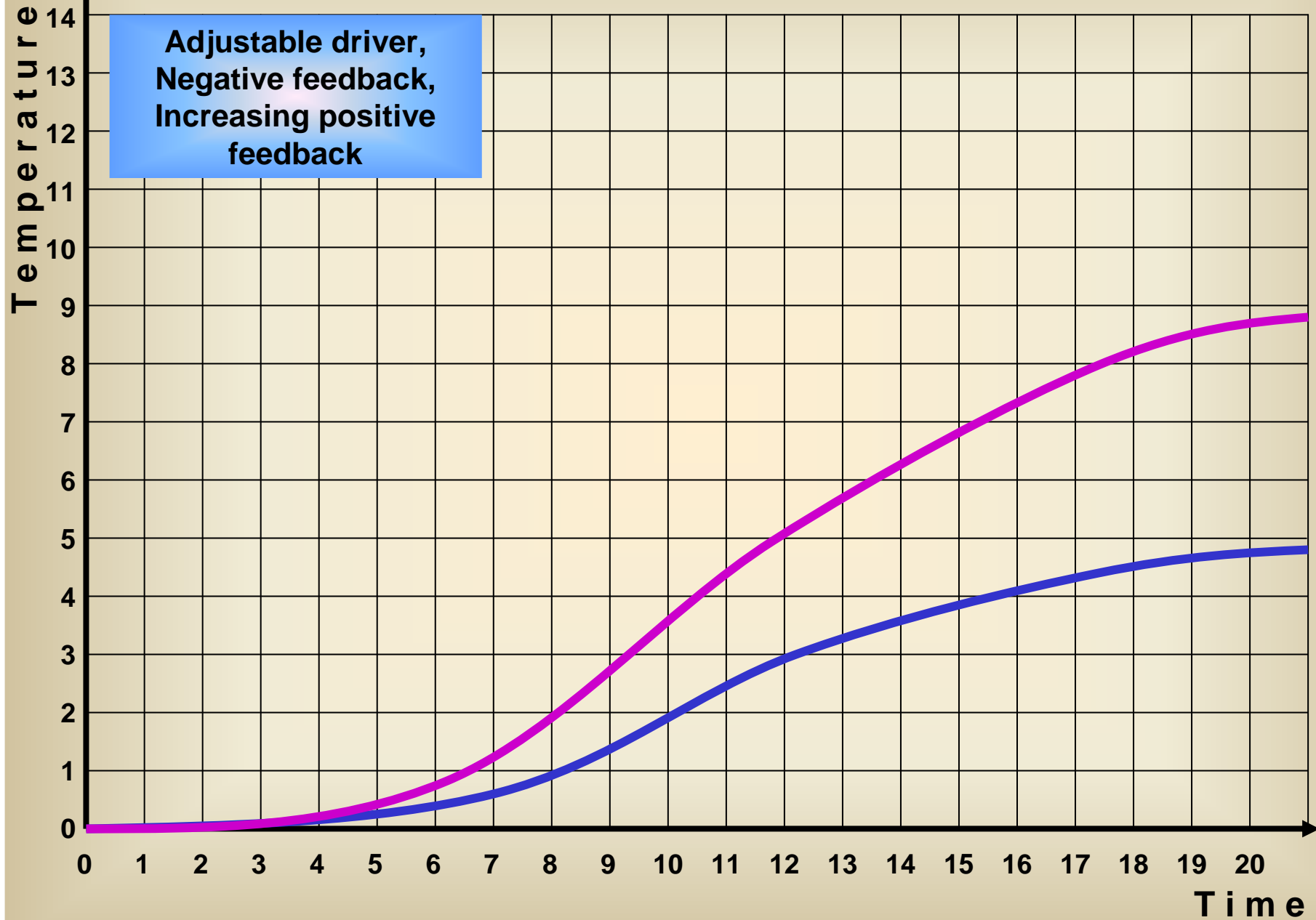
Temperature Trajectories



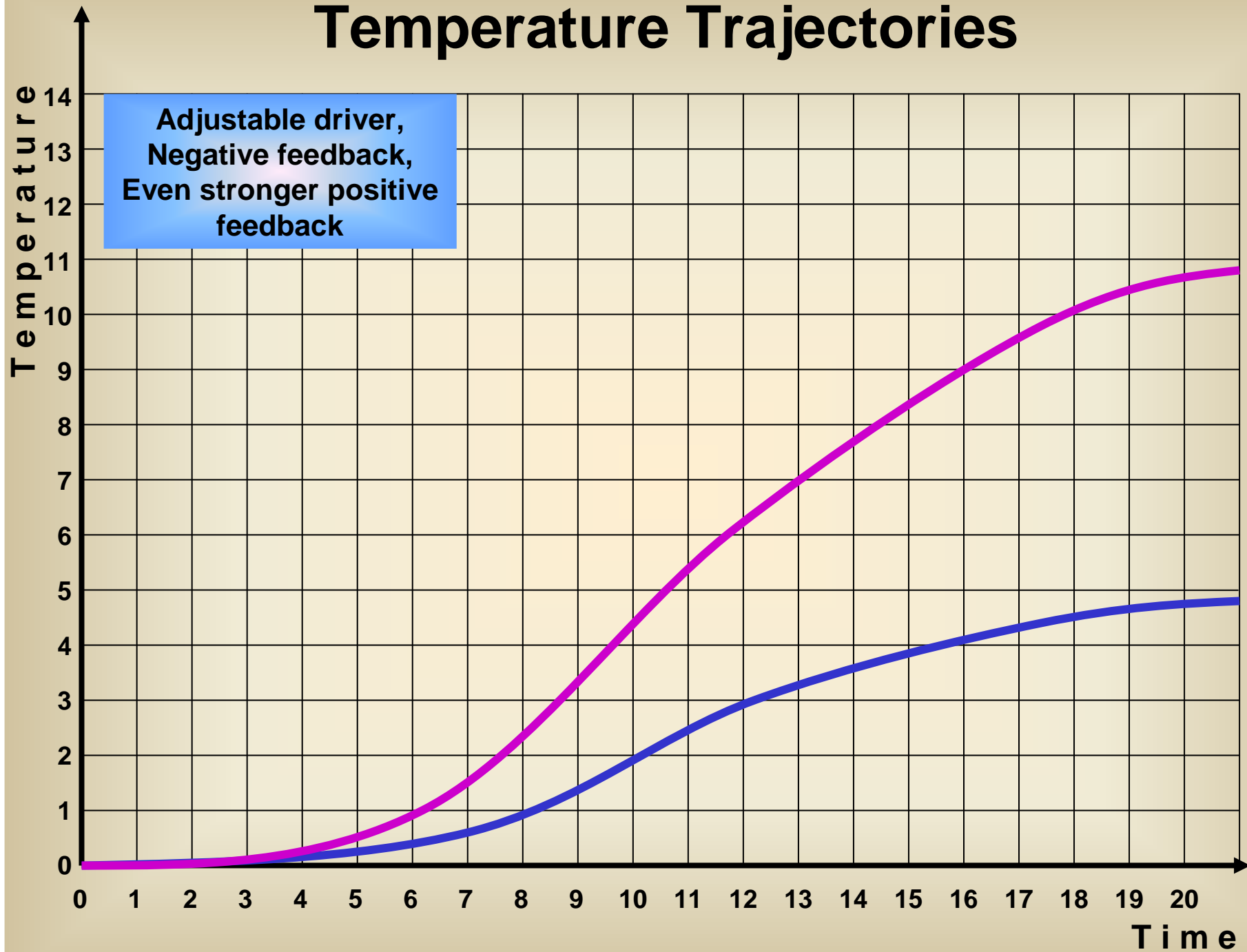
Temperature Trajectories



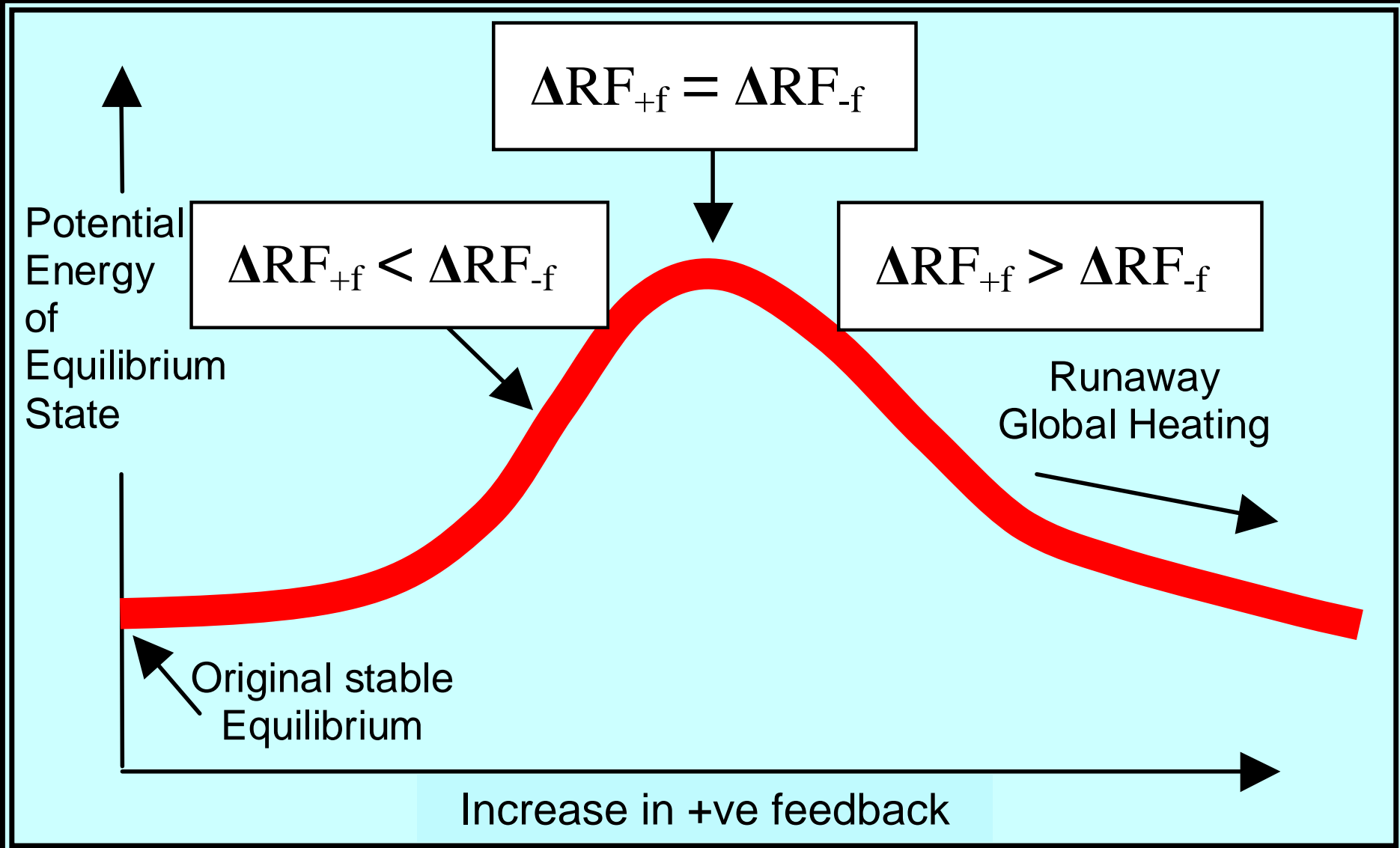
Temperature Trajectories



Temperature Trajectories



**Boundary conditions
for the onset of
runaway global heating**



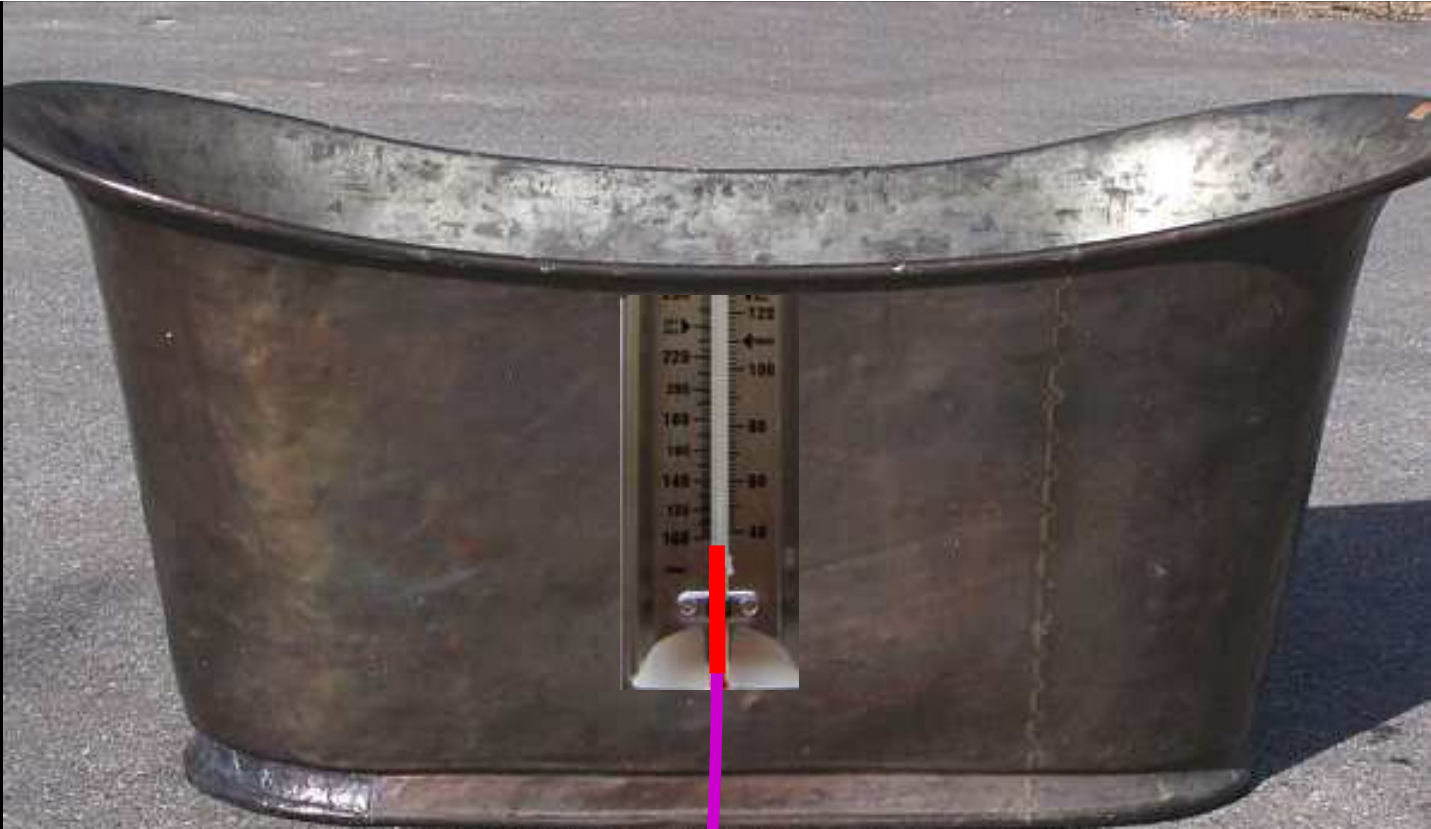


Beyond the Tipping Point

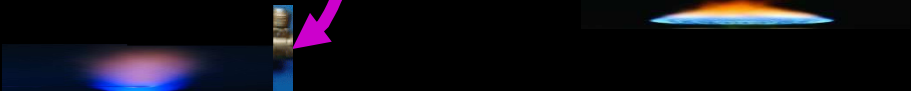


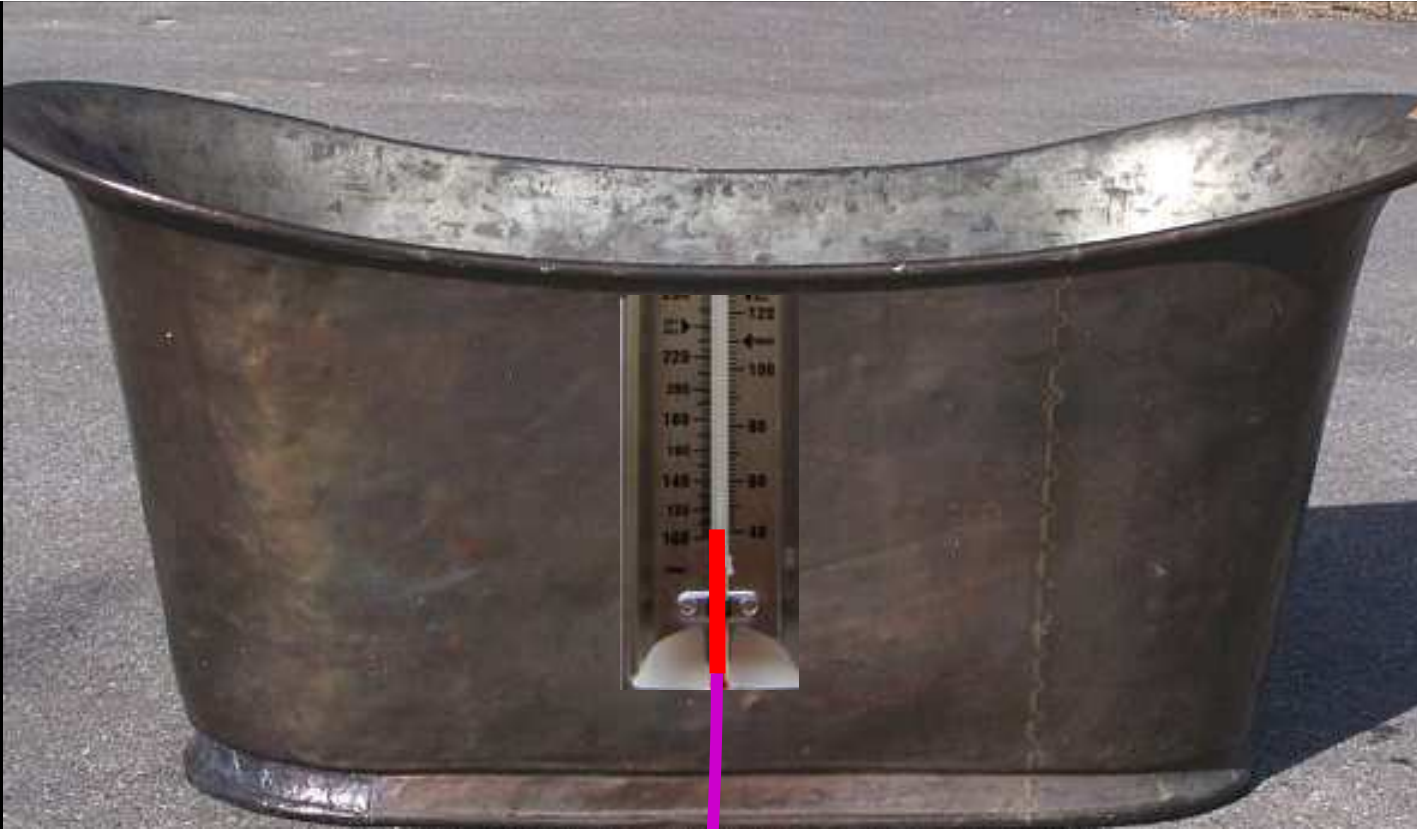
**Positive feedback
stronger than
Negative feedback**





**Positive feedback
stronger than
Negative feedback**





**Positive feedback
stronger than
Negative feedback**





**Positive feedback
stronger than
Negative feedback**





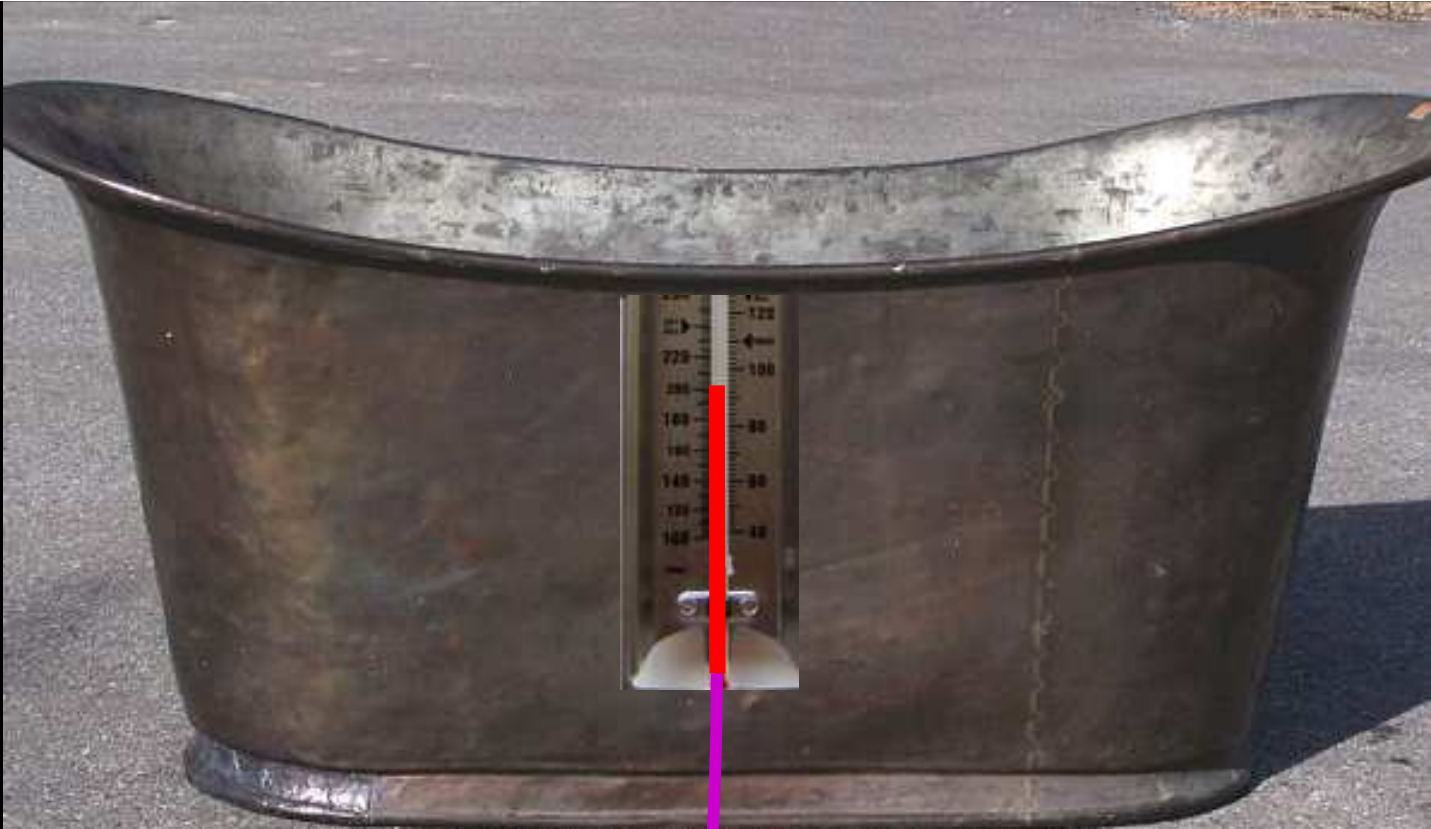
**Positive feedback
stronger than
Negative feedback**



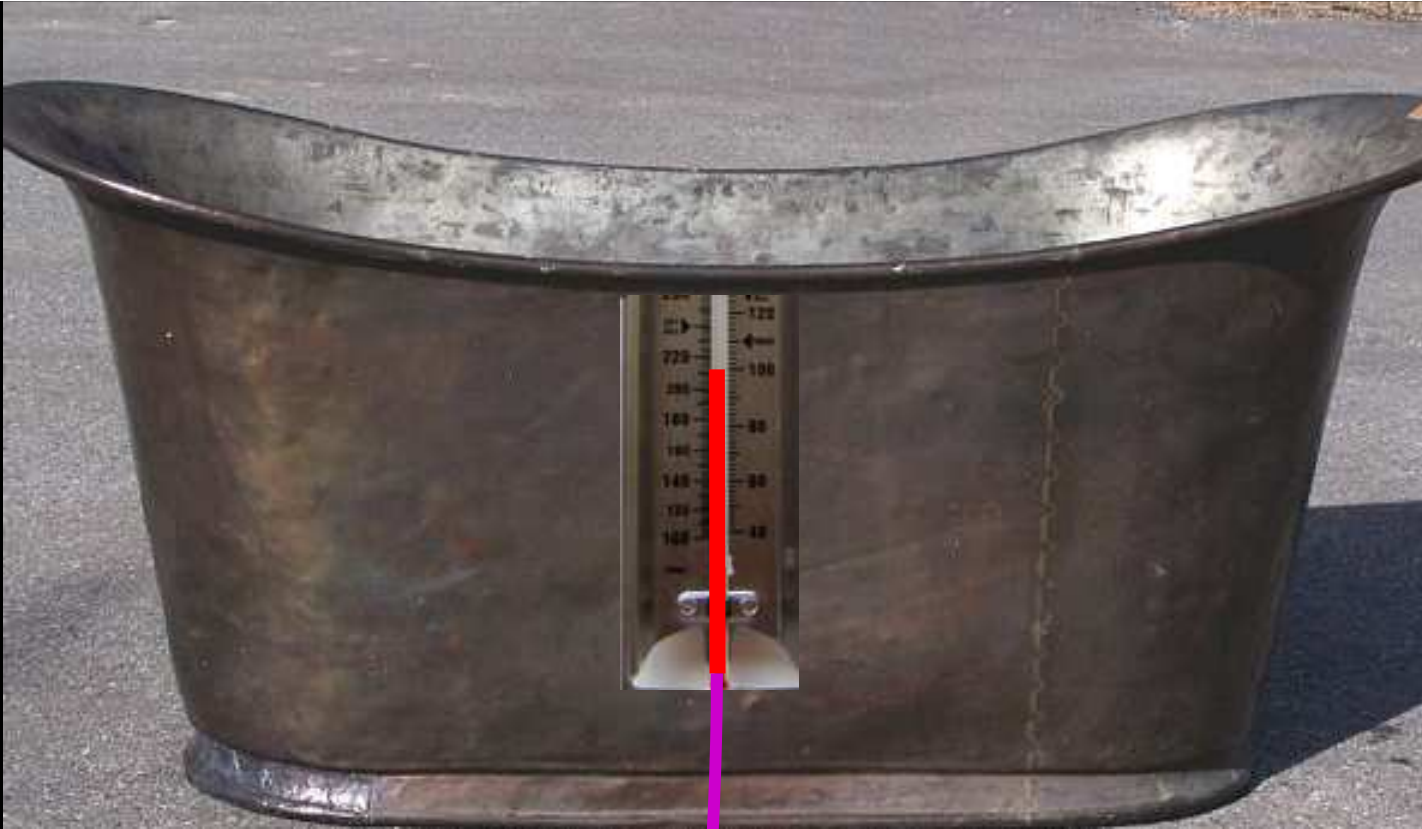


**Positive feedback
stronger than
Negative feedback**





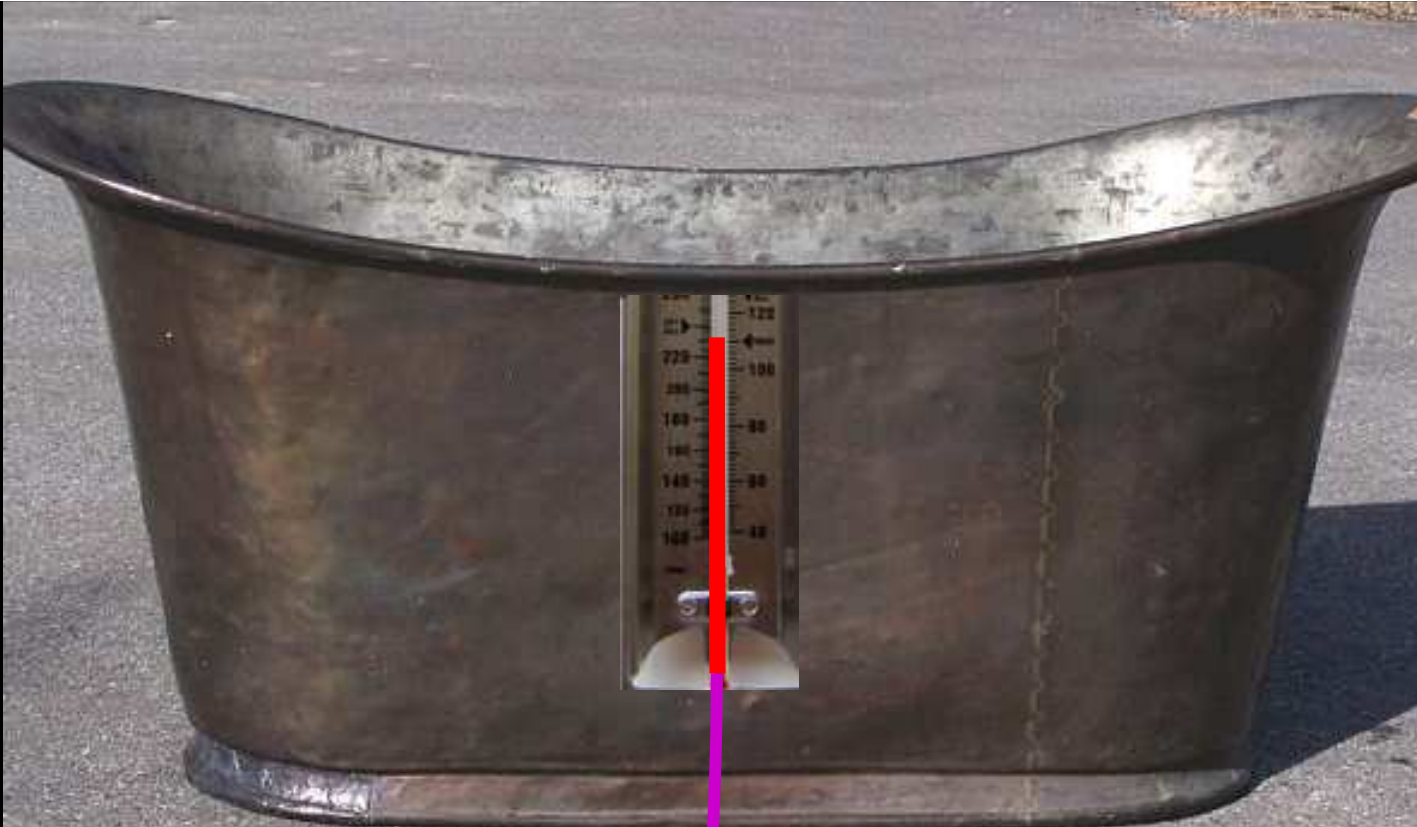
**Positive feedback
stronger than
Negative feedback**



**Positive feedback
stronger than
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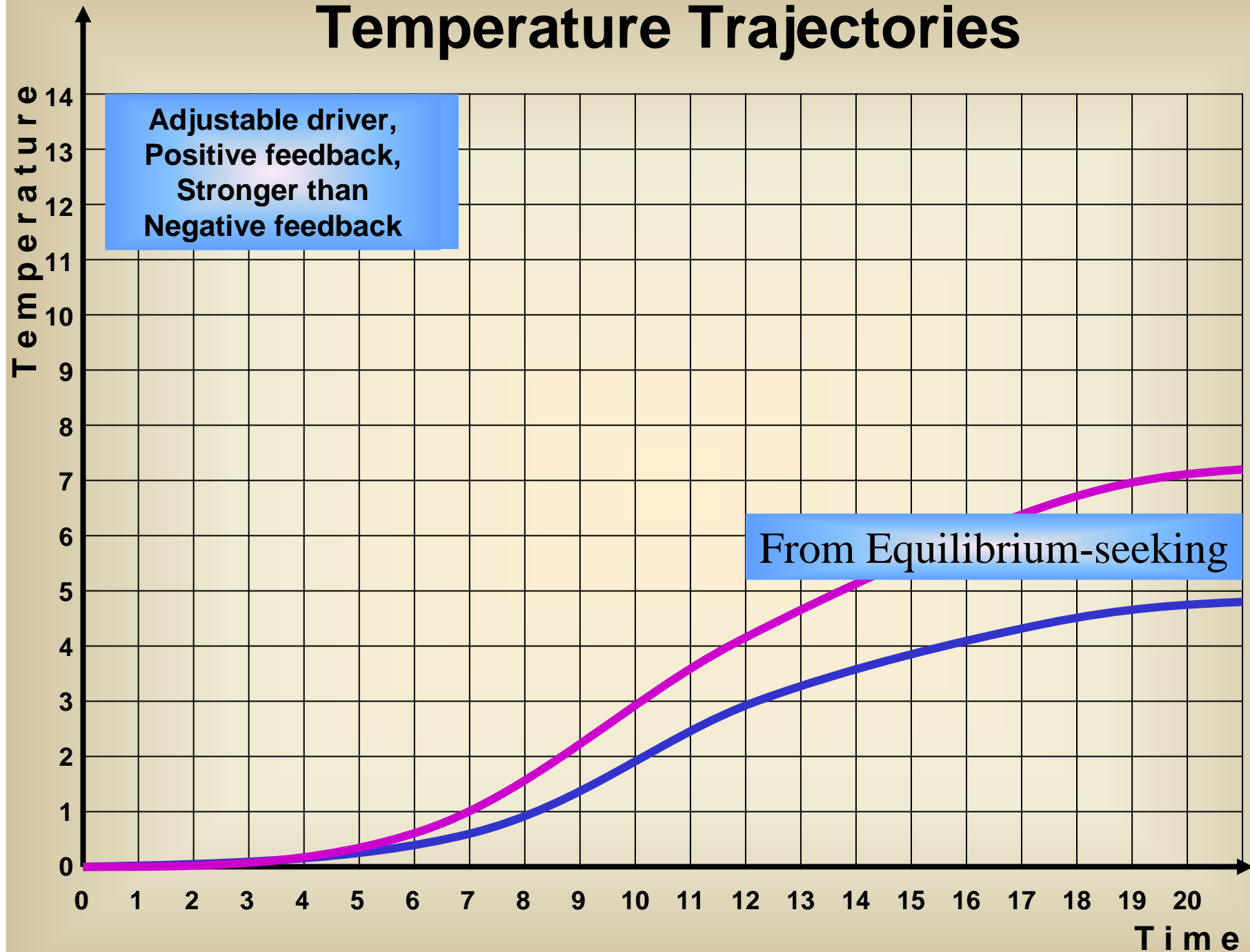


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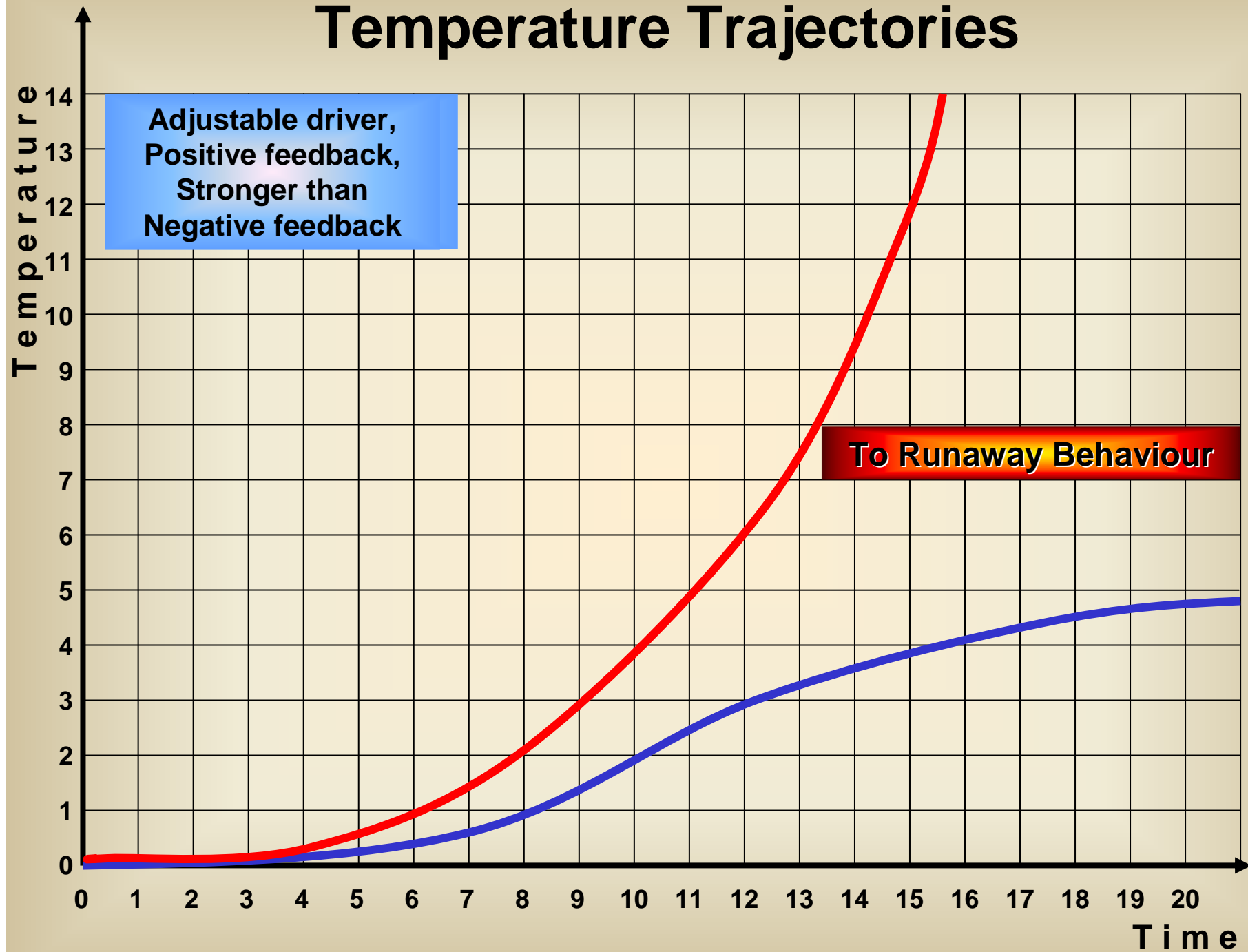


**Positive feedback
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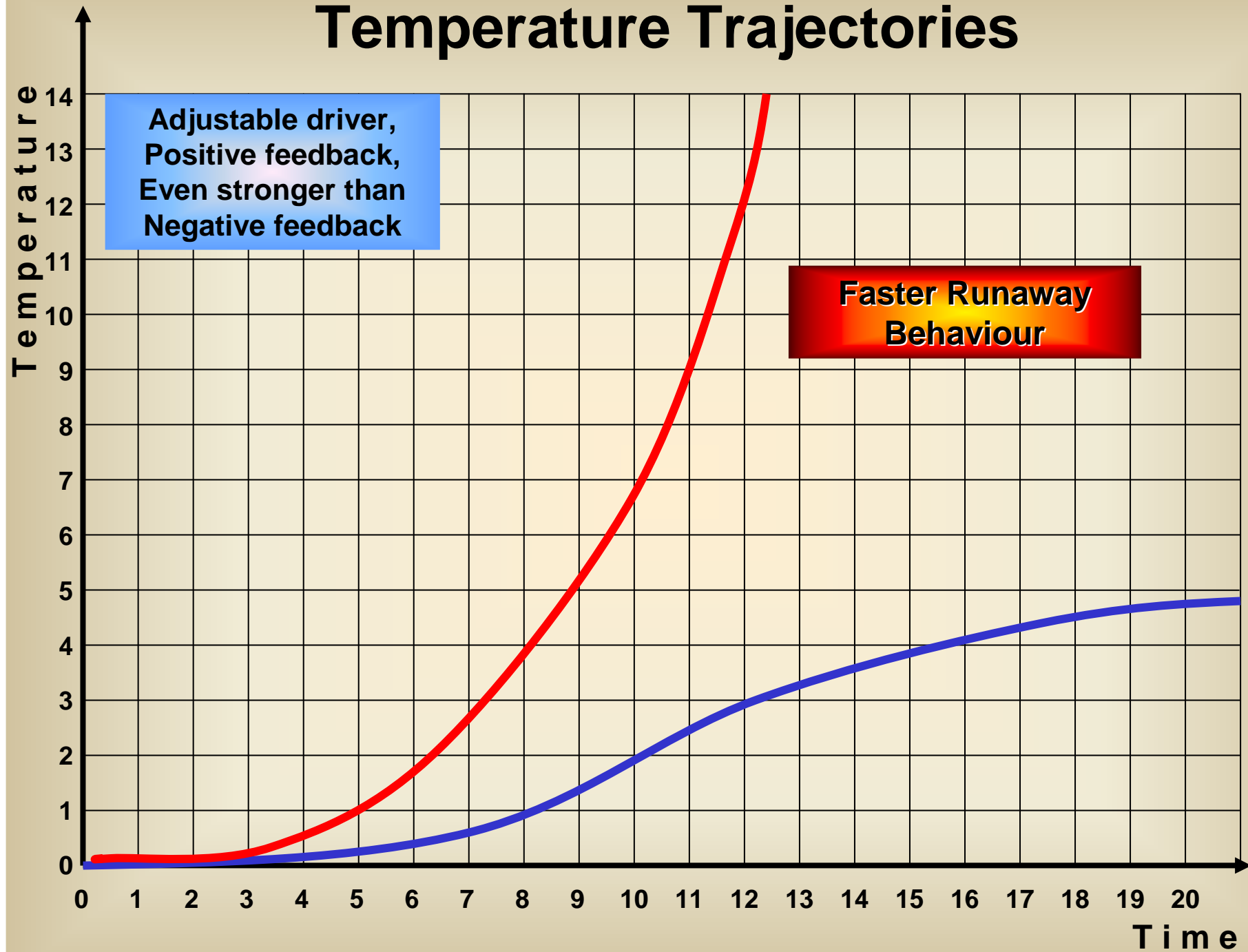
Temperature Trajectories

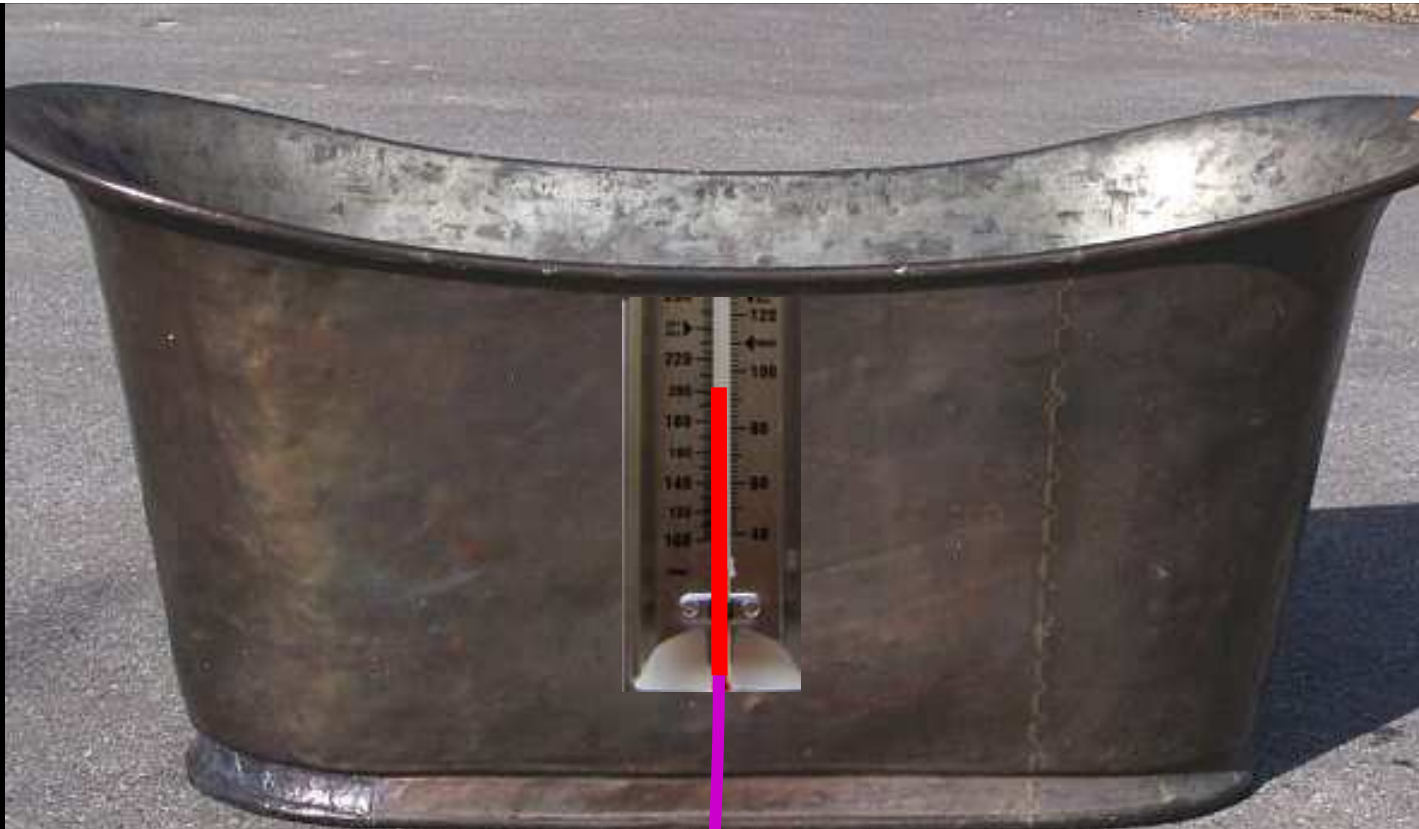


Temperature Trajectories



Temperature Trajectories





**Positive feedback
stronger than
Negative feedback**

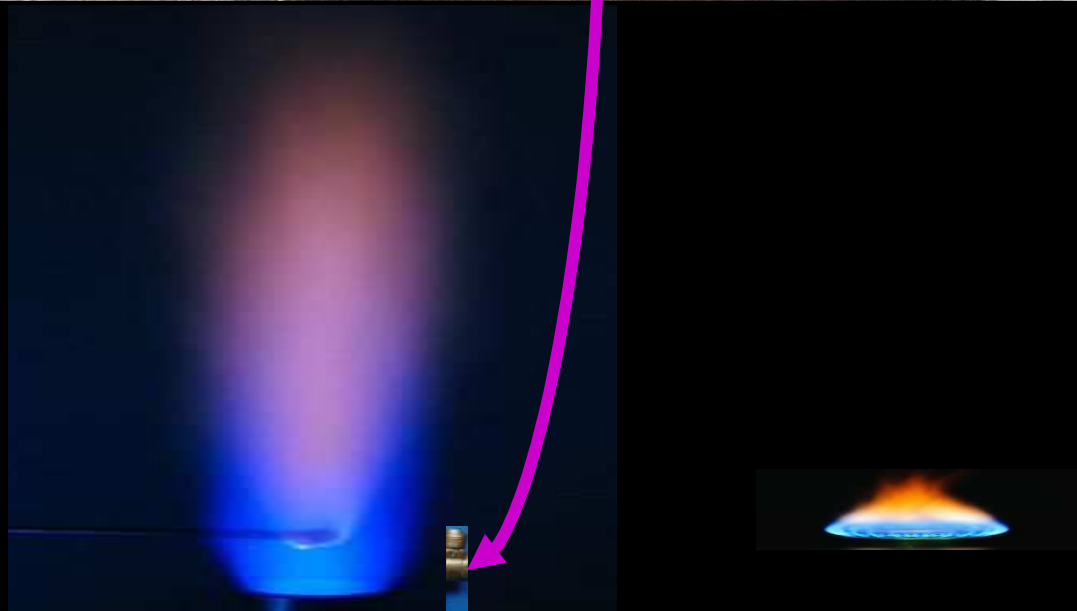
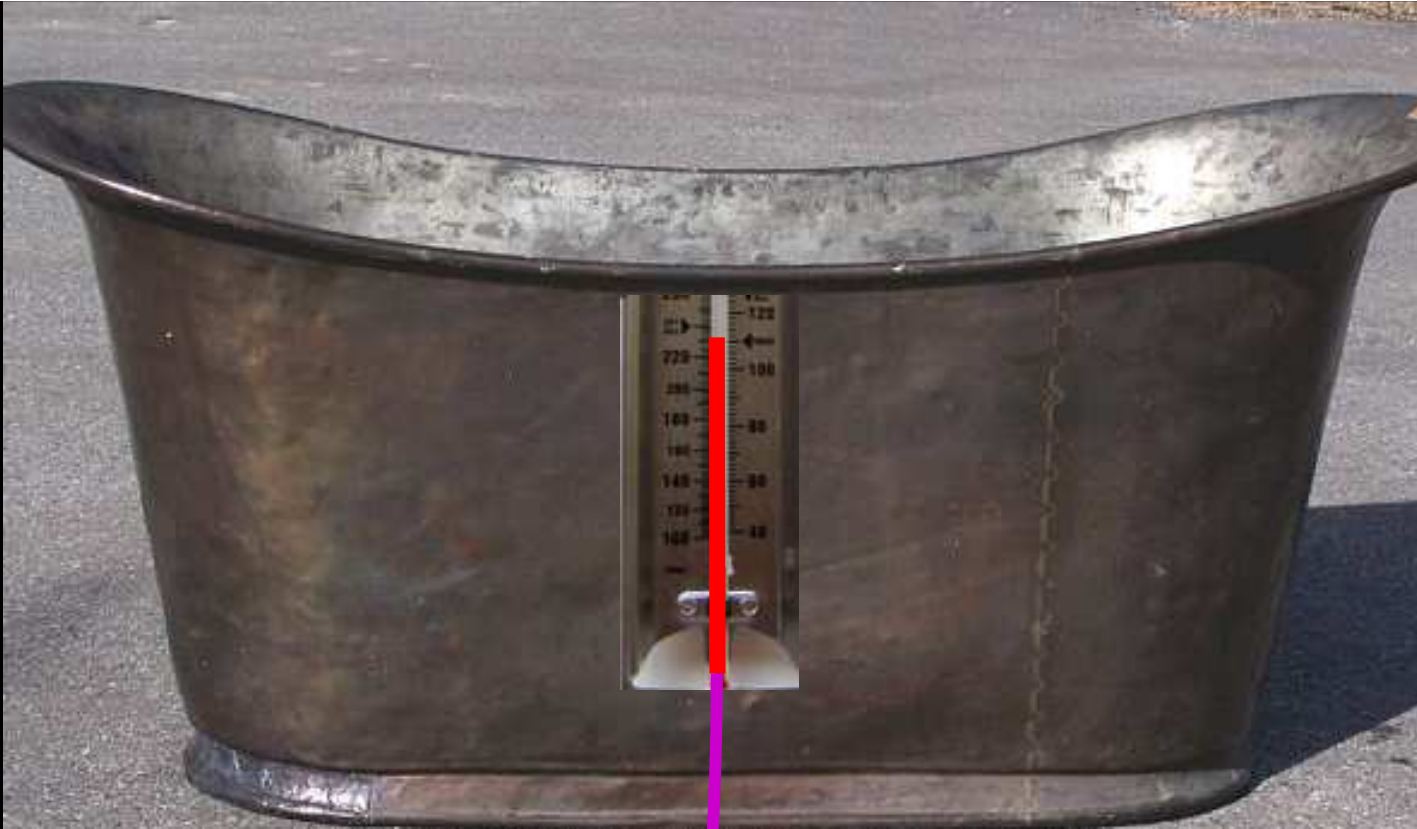




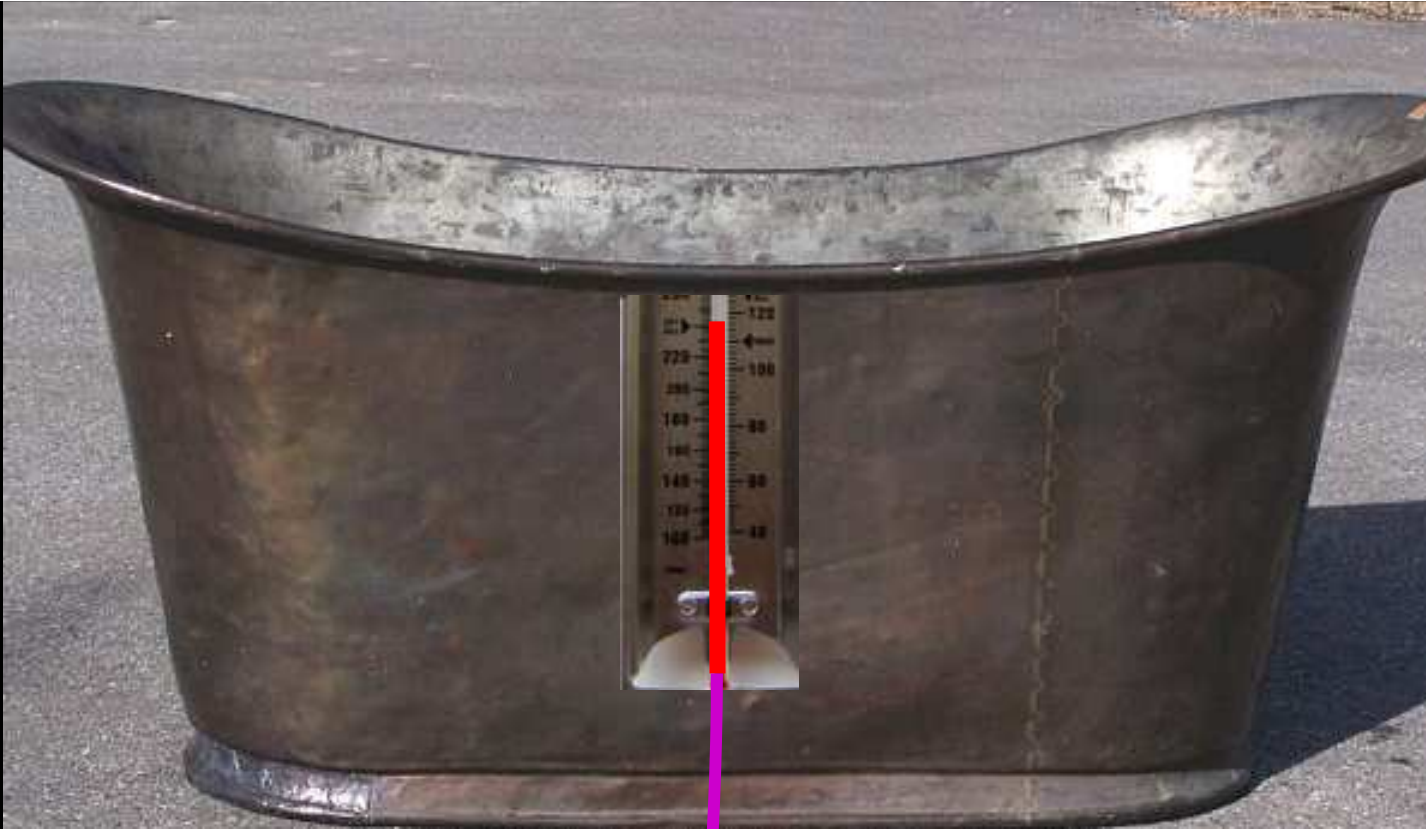
**Positive feedback
stronger than
Negative feedback**



**Positive feedback
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Negative feedback**

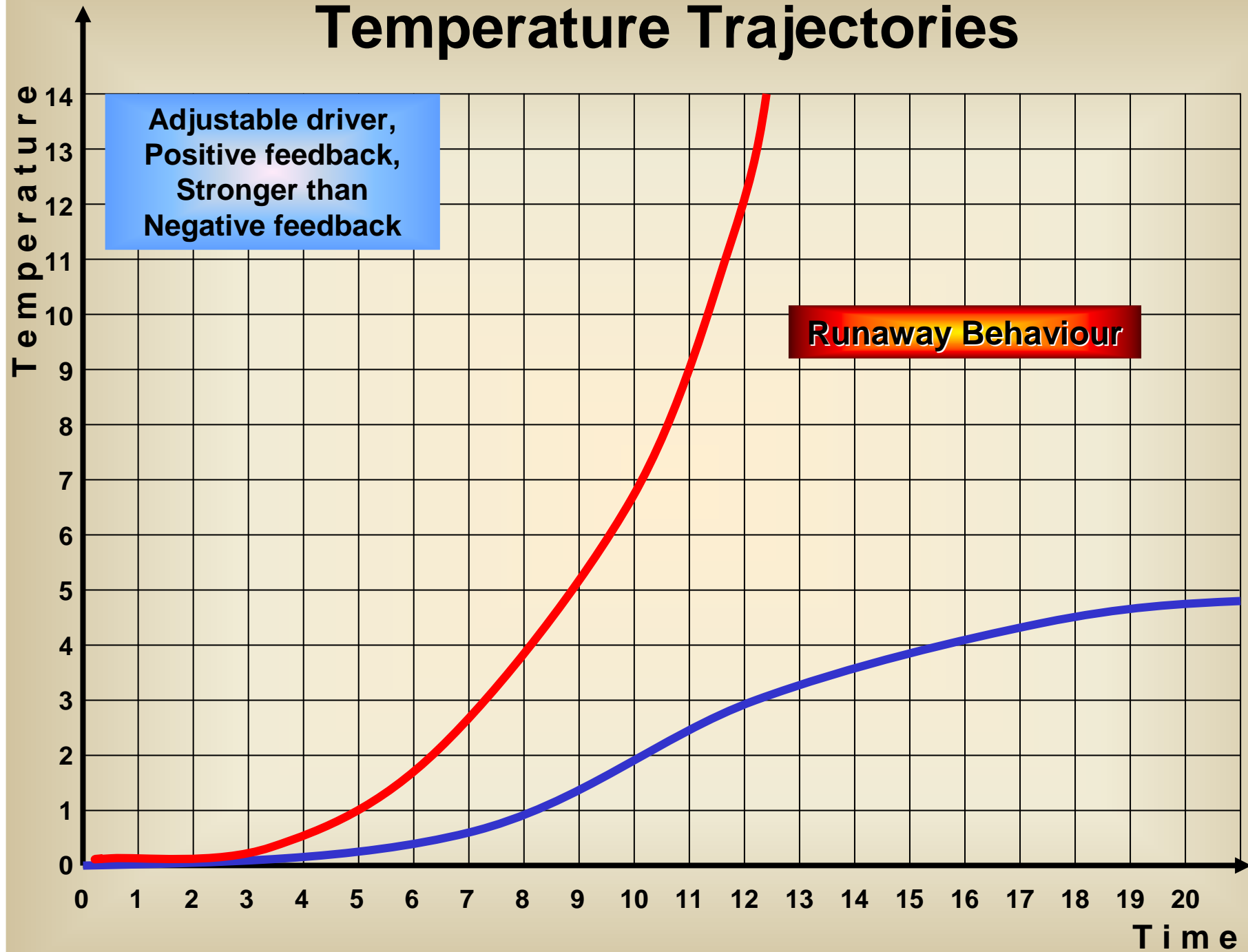


**Positive feedback
stronger than
Negative feedback**

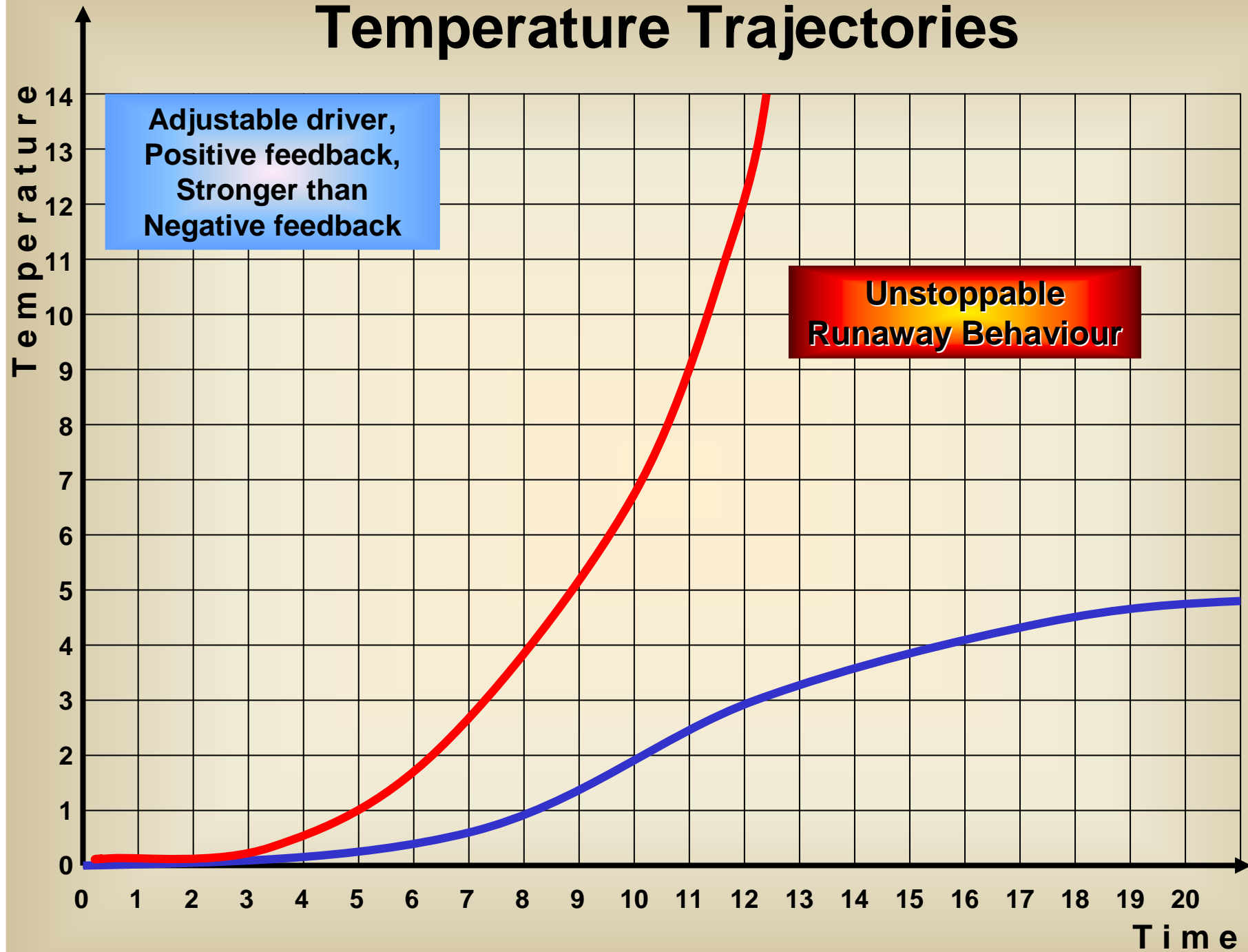


**Positive feedback
stronger than
Negative feedback**

Temperature Trajectories



Temperature Trajectories



“Critical Threshold”

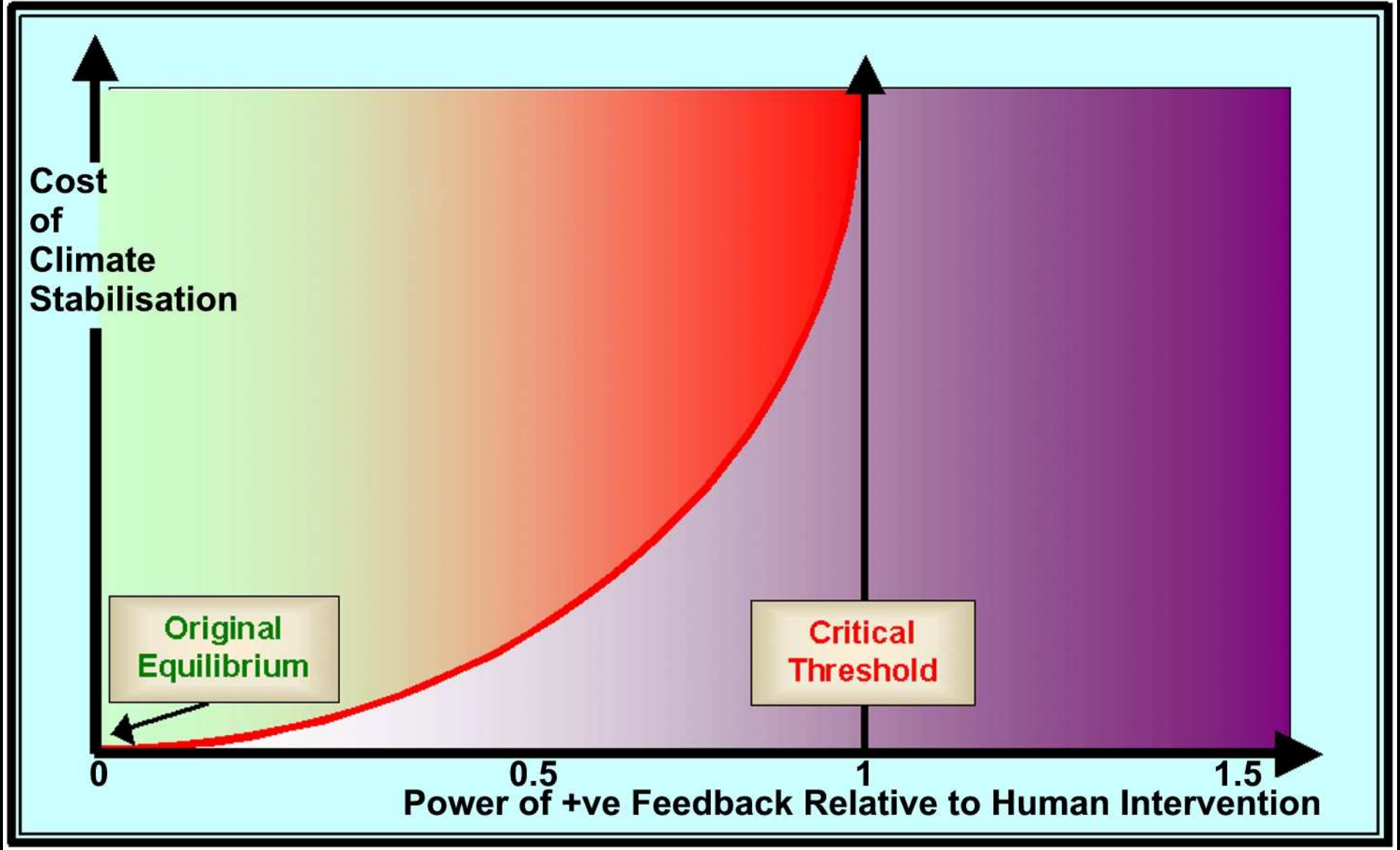
**the boundary condition of
unstoppable runaway global
heating**

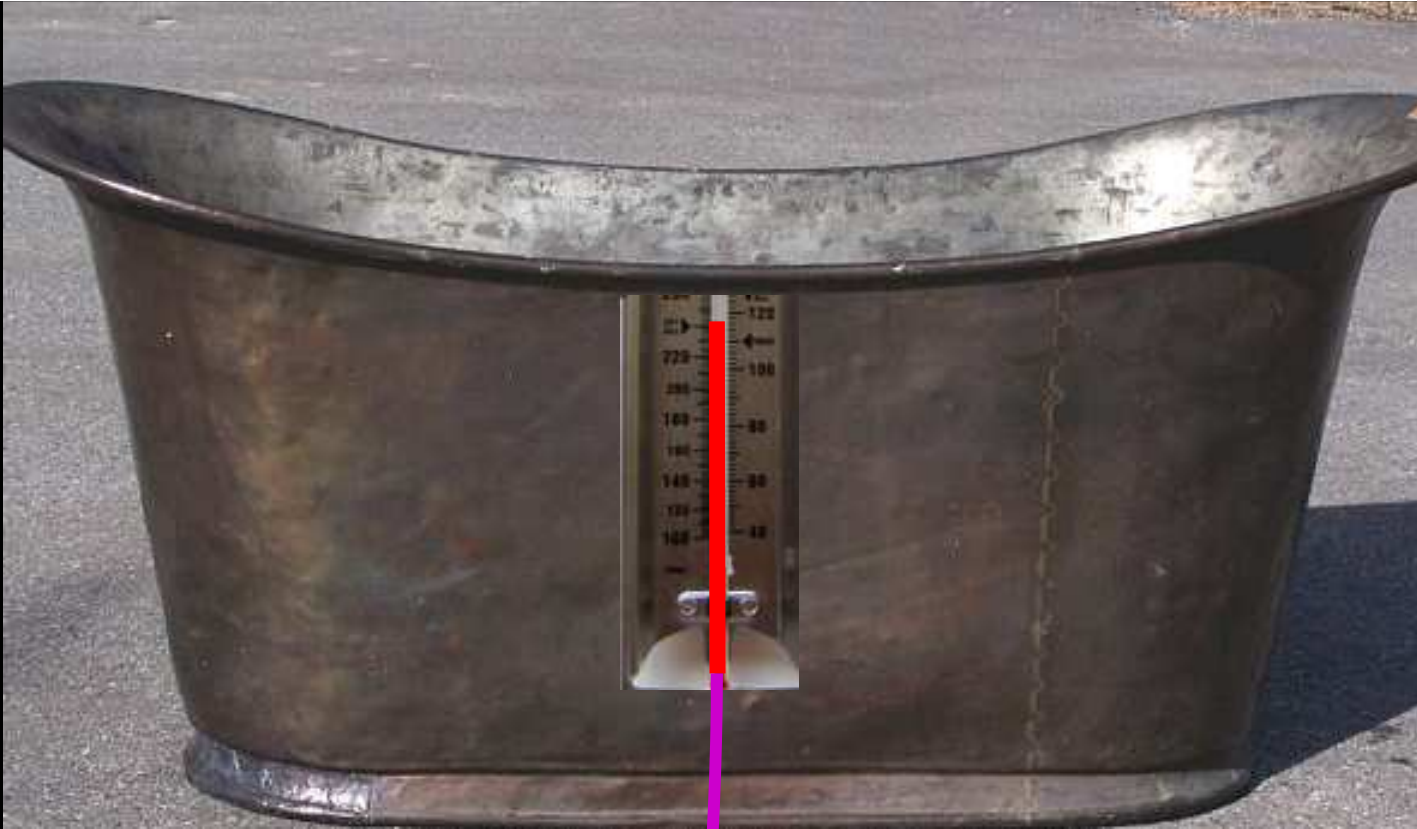
“Critical Threshold”

**the point beyond which
the power of positive feedback
overwhelms the capacity for
human intervention**

“Critical Threshold”

**the point towards which
the cost of climate stabilisation
escalates asymptotically
towards infinity**





Positive feedback
stronger than
Negative feedback



**Unstoppable
Runaway Behaviour**



The “Bath-Tub” Metaphor



Meta for the Planet

The

APOLLO-GAIA

Project

**Feedback Dynamics
Simulator**

Net Radiative Imbalance Or Global Heating

**The Gap between Energy received from the Sun
and
Energy radiated back into space from the Earth**

Net Radiative Imbalance Or Global Heating

NRI

is the core parameter of the
Feedback Dynamics Simulator

The logo for NRI (National Resource Institute) features the letters 'NRI' in a bold, red, sans-serif font. The letters are set against a rectangular background with a yellow-to-orange gradient. This background is enclosed within a thin blue border, which is itself surrounded by a slightly thicker red border. The entire logo is centered at the top of the slide.

NRI

The value of NRI is governed by four flows:



The value of NRI is governed by four flows:

1: Change in Solar Radiance



The value of NRI is governed by four flows:

1: Change in Solar Radiance

2: Anthropogenic Forcing



The value of NRI is governed by four flows:

1: Change in Solar Radiance

2: Anthropogenic Forcing

3: Consequential Feedback

The logo for NRI (National Resources Institute) features the letters 'NRI' in a bold, red, sans-serif font. The letters are set against a rectangular background with a yellow-to-orange gradient. This background is enclosed within a thin blue border, which is itself inside a larger, slightly thicker red border. The entire logo is centered at the top of the slide.

NRI

The value of NRI is governed by four flows:

1: Change in Solar Radiance

2: Anthropogenic Forcing

3: Consequential Feedback

4: Radiative Damping



The value of NRI is governed by four flows:

1: Change in Solar Radiance

2: Anthropogenic Forcing

3: Consequential Feedback

4: Radiative Damping

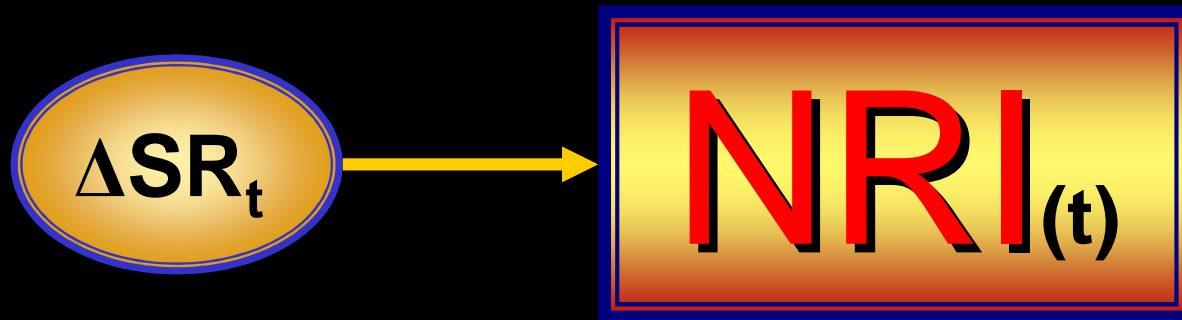
All values are measured in watts per square metre: wm^{-2}

The Core Structure

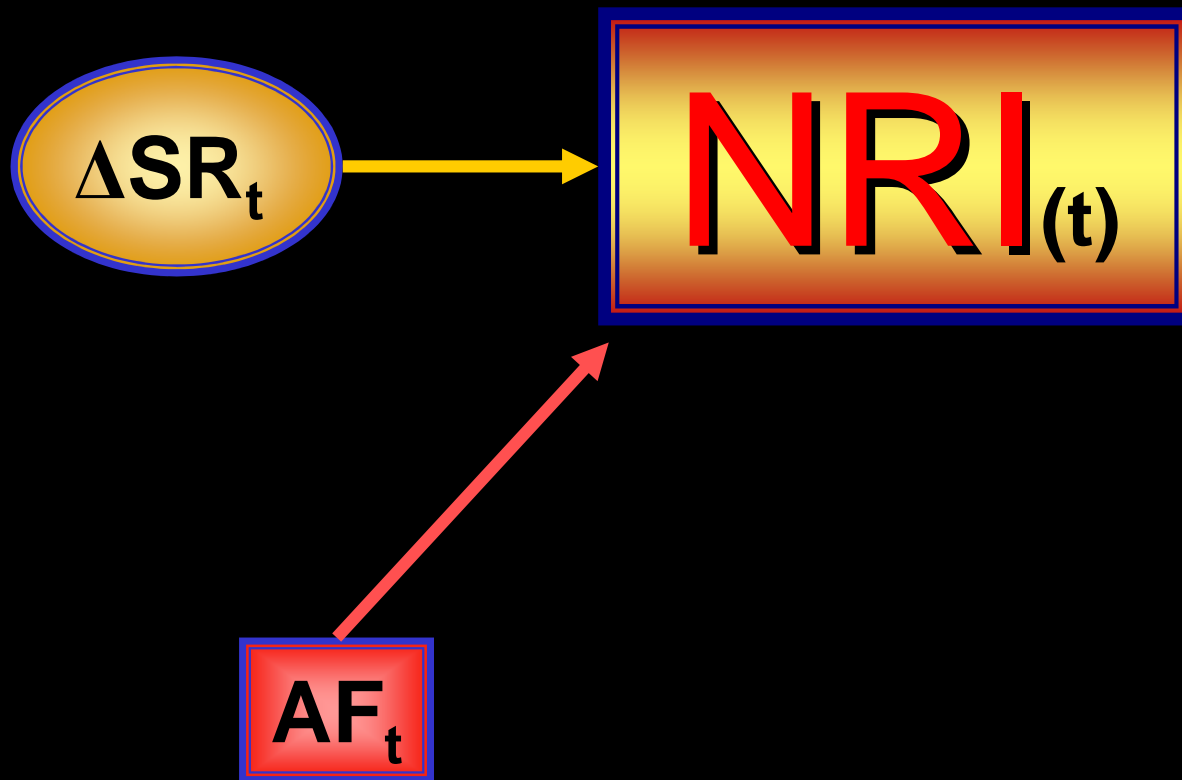
The logo for NRI(t) is centered on the slide. It consists of the letters 'NRI' in a large, bold, red font, followed by '(t)' in a smaller, black font. The text is set against a rectangular background with a yellow-to-orange gradient. This background is enclosed within a double-line border, with the inner line being red and the outer line being blue.

NRI(t)

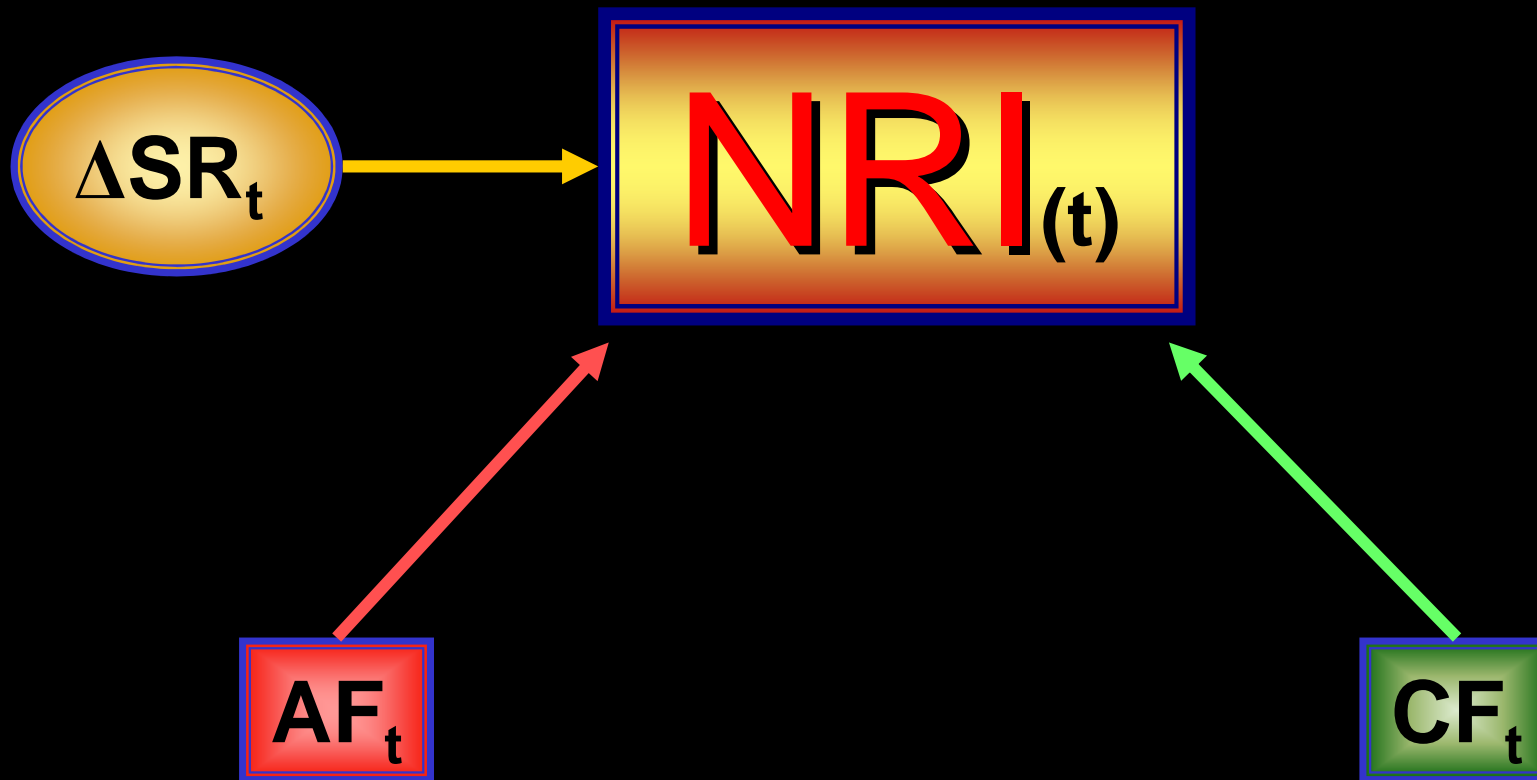
The Core Structure



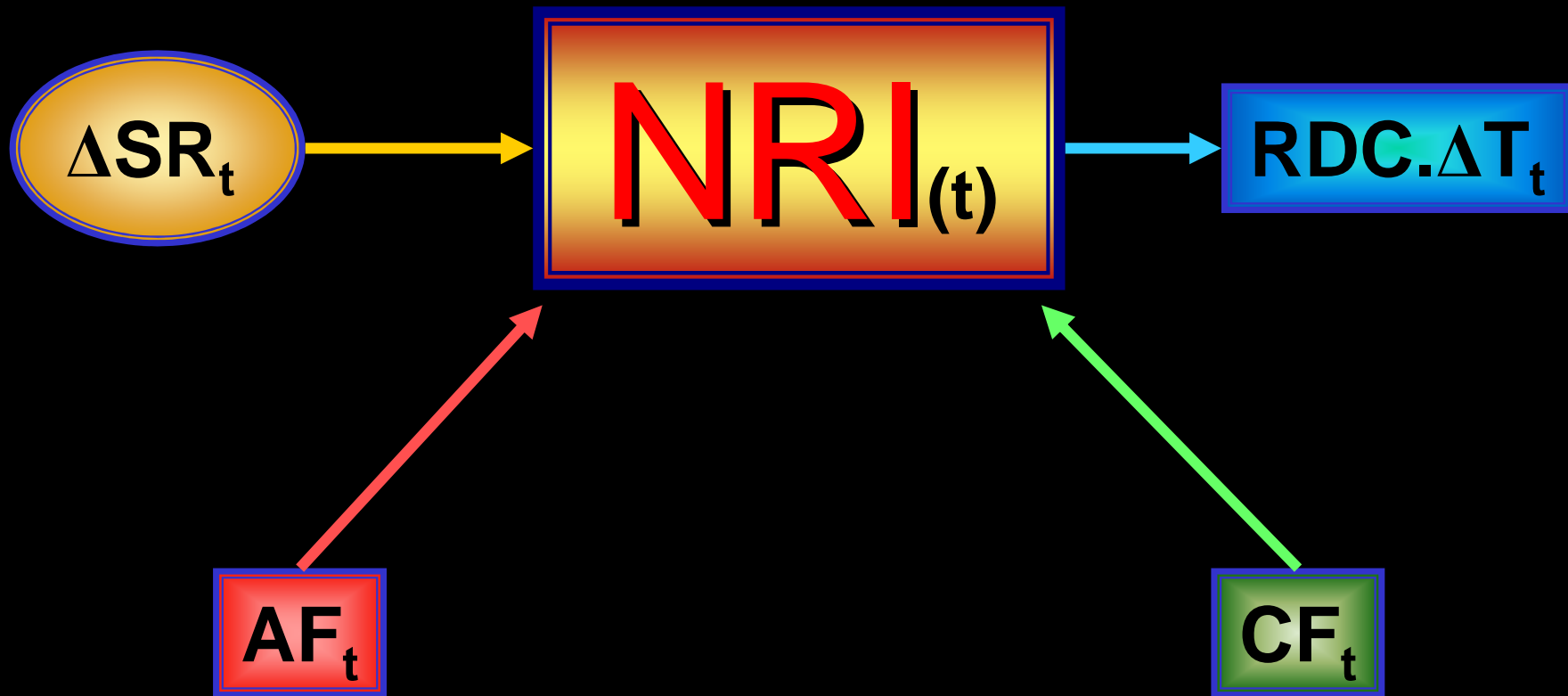
The Core Structure



The Core Structure



The Core Structure



Sub-sections of the Core


$$\Delta SR_t$$

- Solar Radiance changes over time.
- The value of Solar Radiance in 1750 as benchmark (time t_0).
- Change in Solar Radiance at time (t) is designated by ΔSR_t .
- The difference between the absolute value of Solar Radiance at time (t) and that in force at the benchmark time (t_0).
- History of ΔSR_t from 1750 to the present (t=2010) is known.
- Future values of ΔSR_t derived from projection of solar cycles.

Sub-sections of the Core

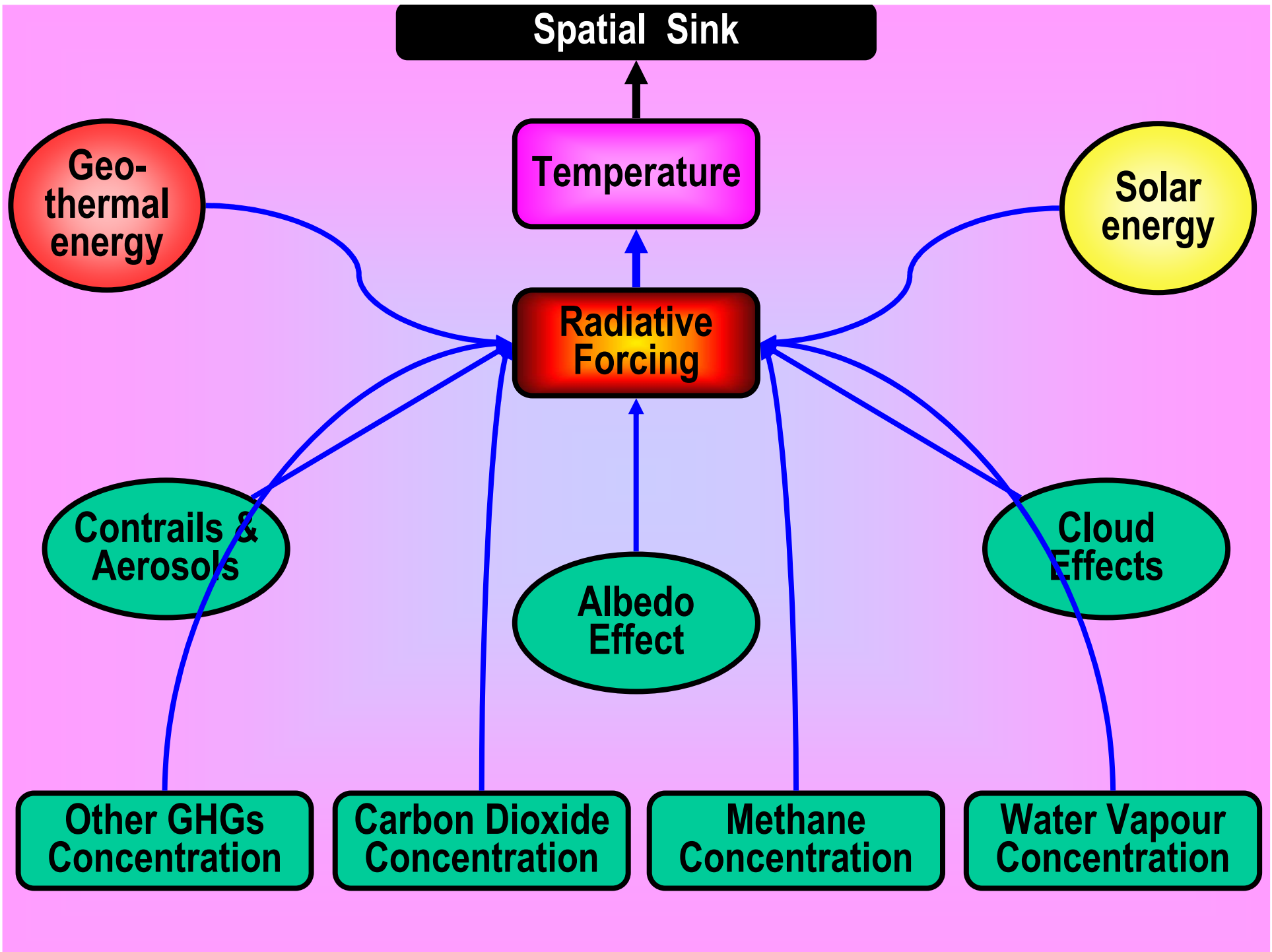
$$RDC \cdot \Delta T_t$$

- The Radiative Damping Coefficient is defined as the extra energy radiated to the spatial sink per 1°K rise in the average surface temperature of the earth.
- It is calculated by application of the Stephan-Boltzmann law and stands at $3.3 \text{ w.m}^{-2} \cdot ^{\circ}\text{K}^{-1}$.
- The value of the Radiative Damping at time (t) is the product of the Radiative Damping Coefficient and the difference between the average surface temperature of the earth at time (t) and that in force at the benchmark time (t_0).

Sub-sections of the Core

$$AF_t$$

- The value of the Anthropogenic Forcing at time (t) is the net effect of all anthropogenic drivers of climate change.
- Forcings are measured in w.m^{-2} as change from the zero value at the benchmark of time (t_0).
- The full set comprises the following:
 1. Forcing caused by increase in the atmospheric concentration of each of the greenhouse gases.
 2. Forcing caused by change in land use resulting in change in Albedo.
 3. Forcing caused by atmospheric particulates & contrails.

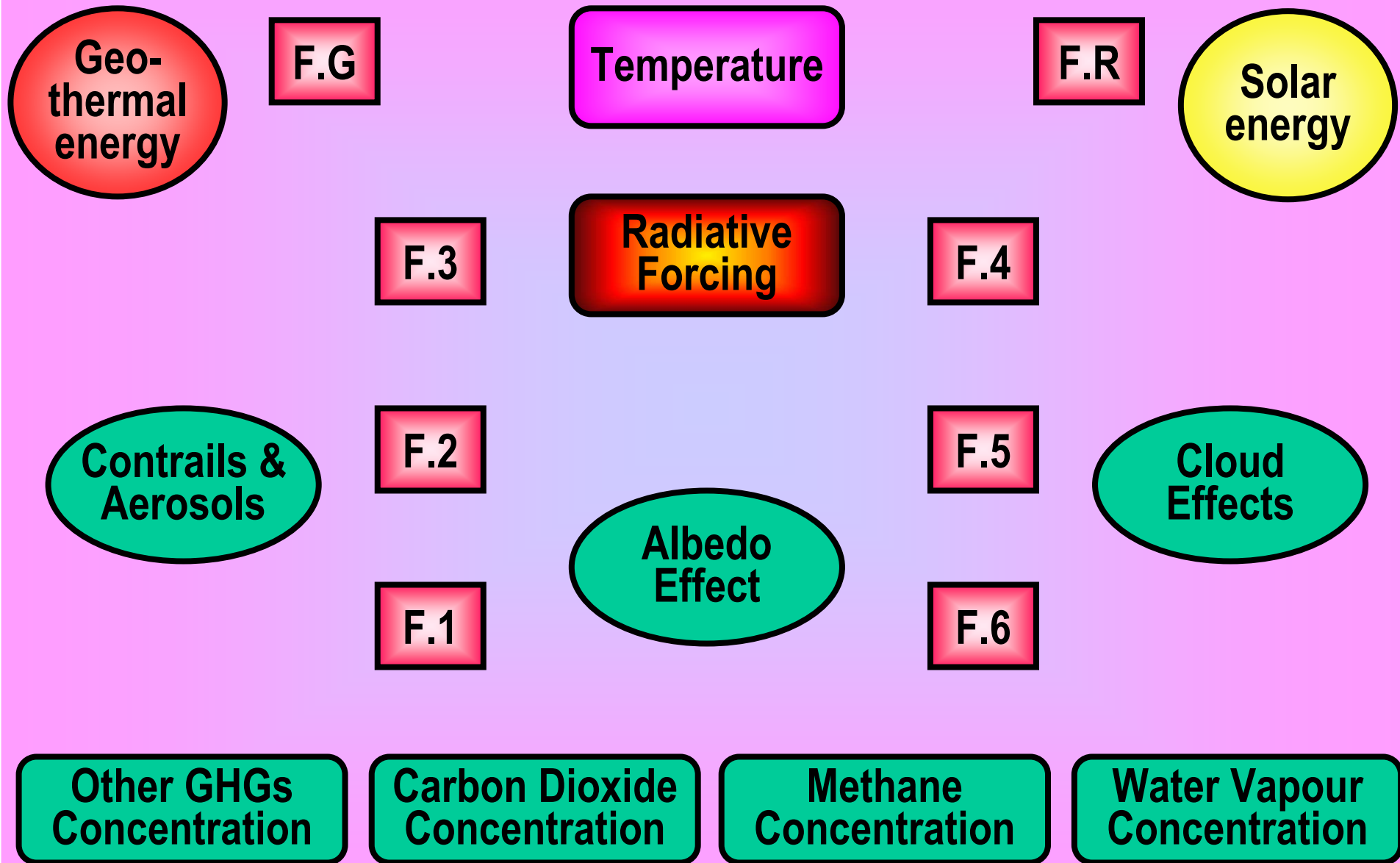


Sub-sections of the Core

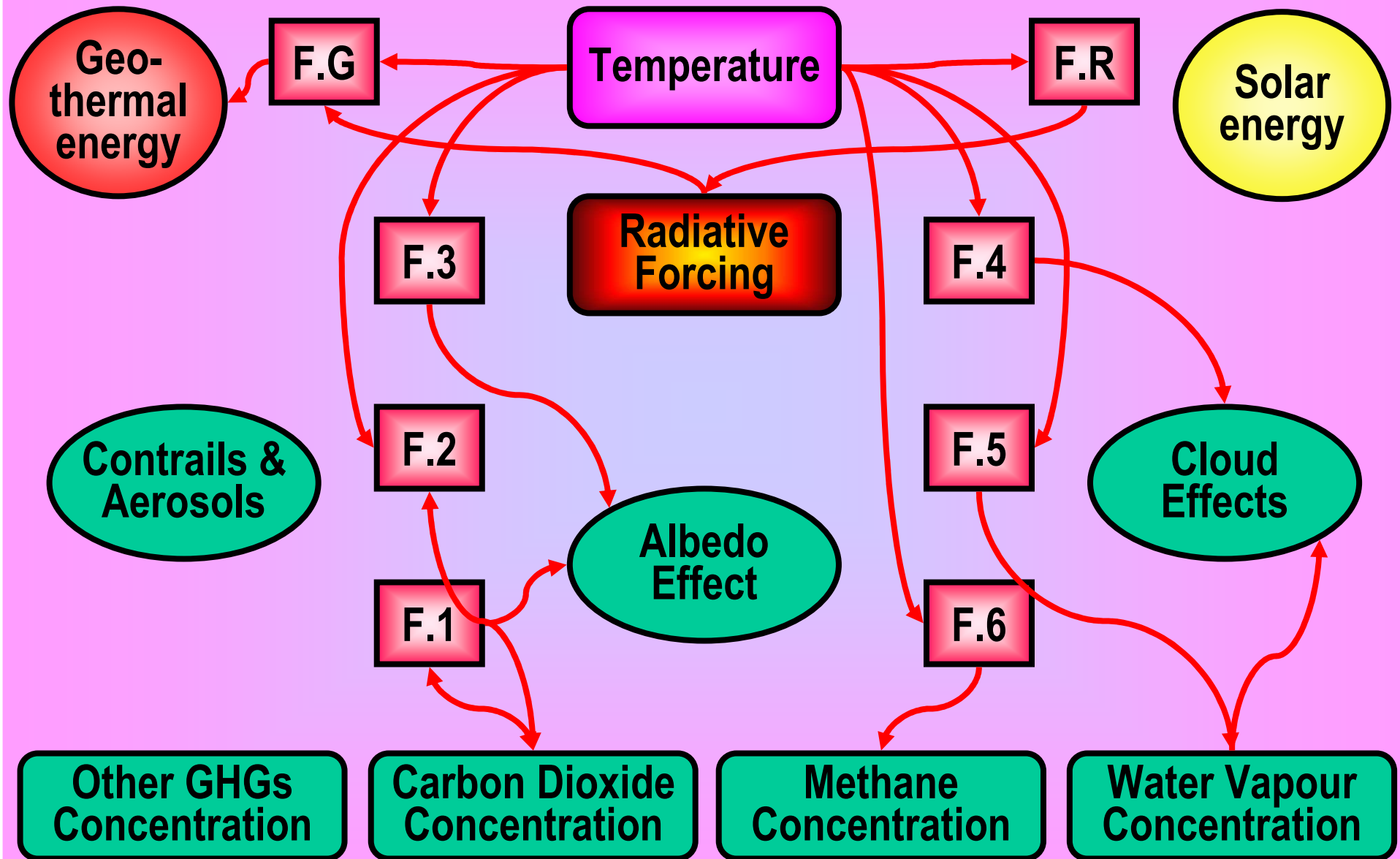
$$CF_t$$

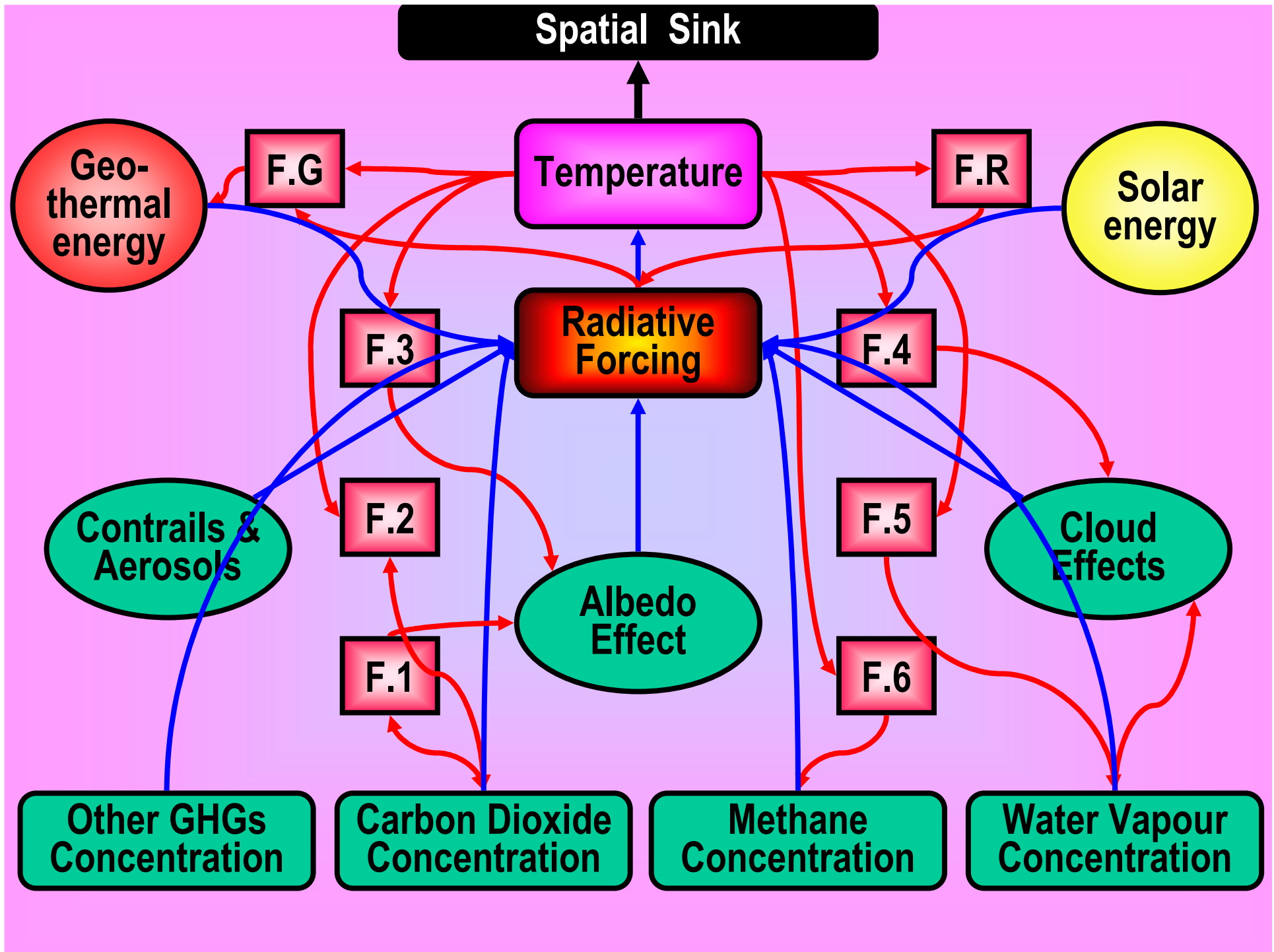
- The value of the Consequential Feedback at time (t) is the net effect of the set of all feedback mechanisms.
- Feedback effects are measured in w.m^{-2} as change from the zero value at the benchmark of time (t_0).
- The full set of feedbacks can be categorised as follows:
 1. Feedbacks driven by change in concentration of specific GHGs
 2. Feedbacks driven directly by change in Temperature
 3. Hybrid feedbacks driven by a combination of the above
 4. Feedbacks dependent on phase-change mechanisms

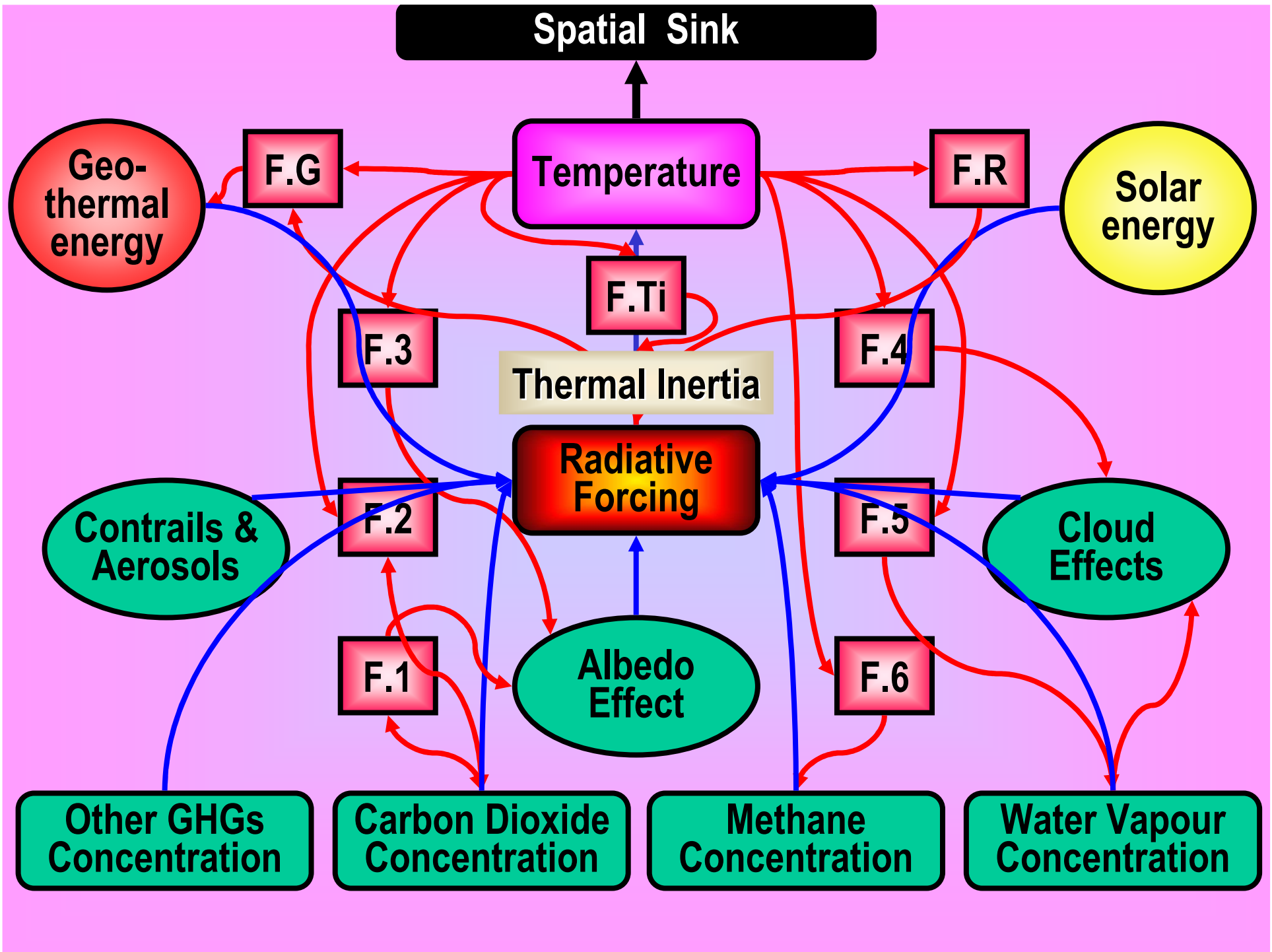
Spatial Sink



Spatial Sink







The Fundamental Equation

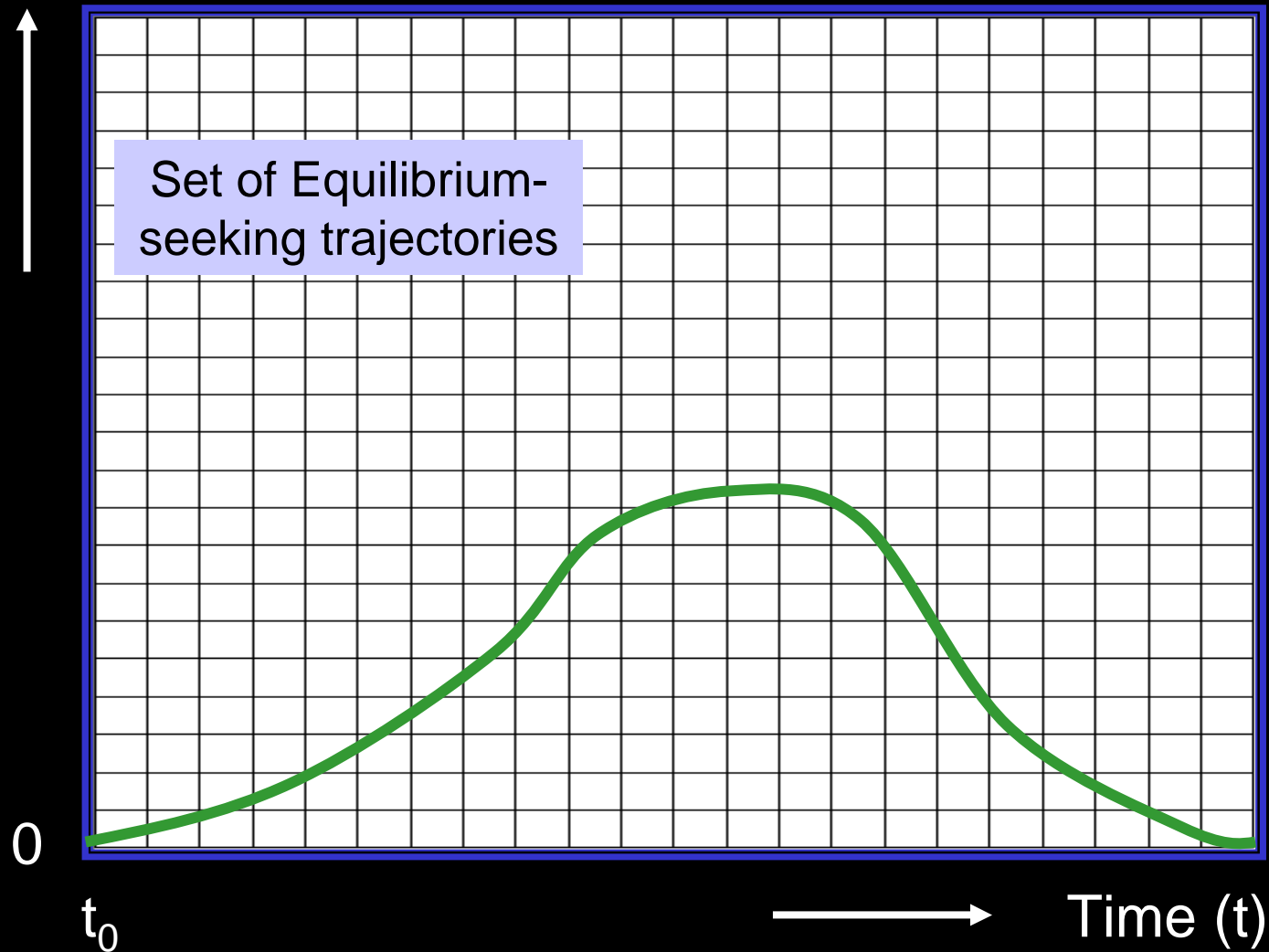
$$\mathbf{NRI}_{(t)} = \Delta SR_t + AF_t + CF_t - RDC \cdot \Delta T_t$$

The Graphical Outputs

1: Net Radiative Imbalance over Time

NRI

Measured
in w.m^{-2}

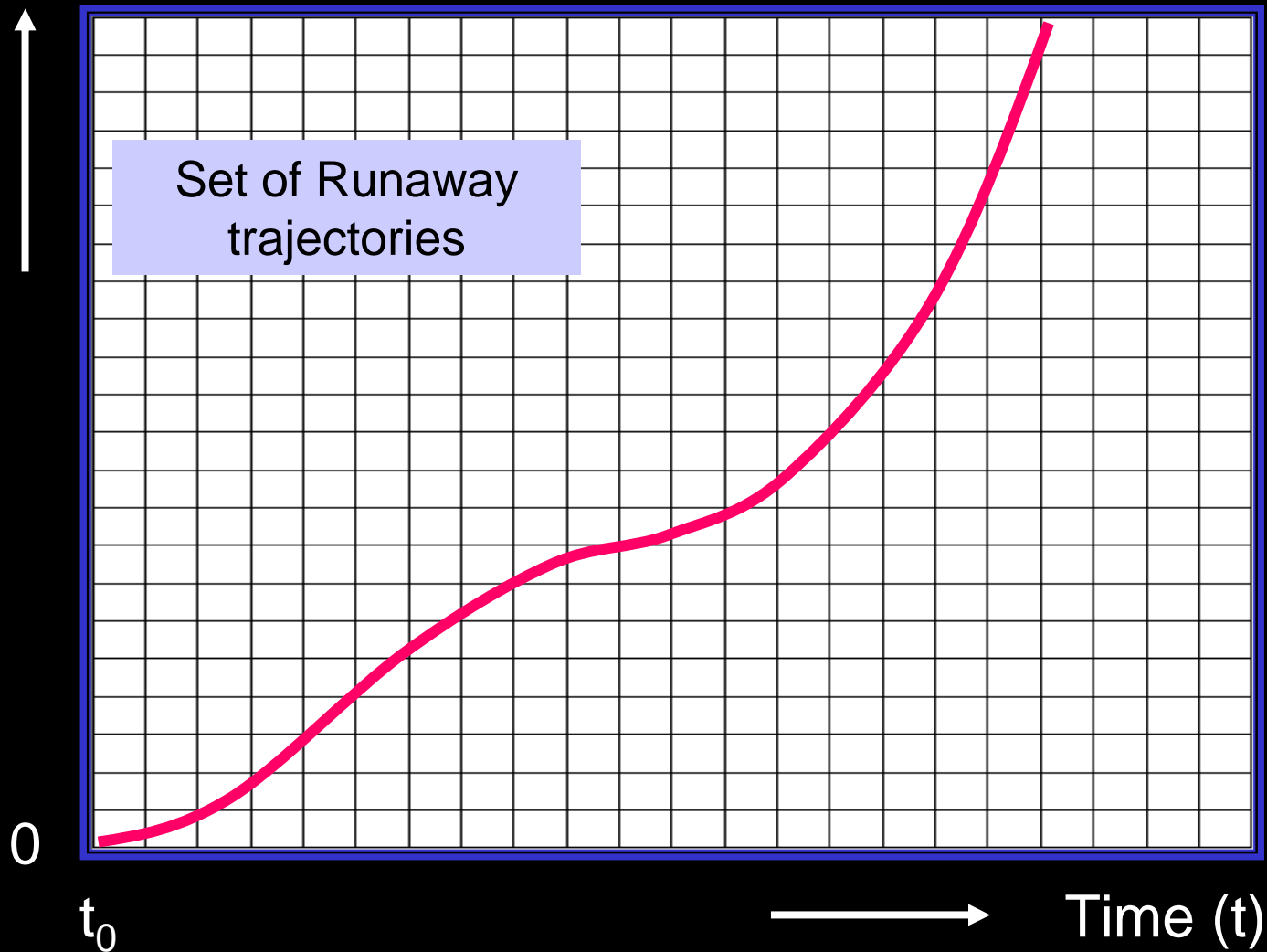


The Graphical Outputs

1: Net Radiative Imbalance over Time

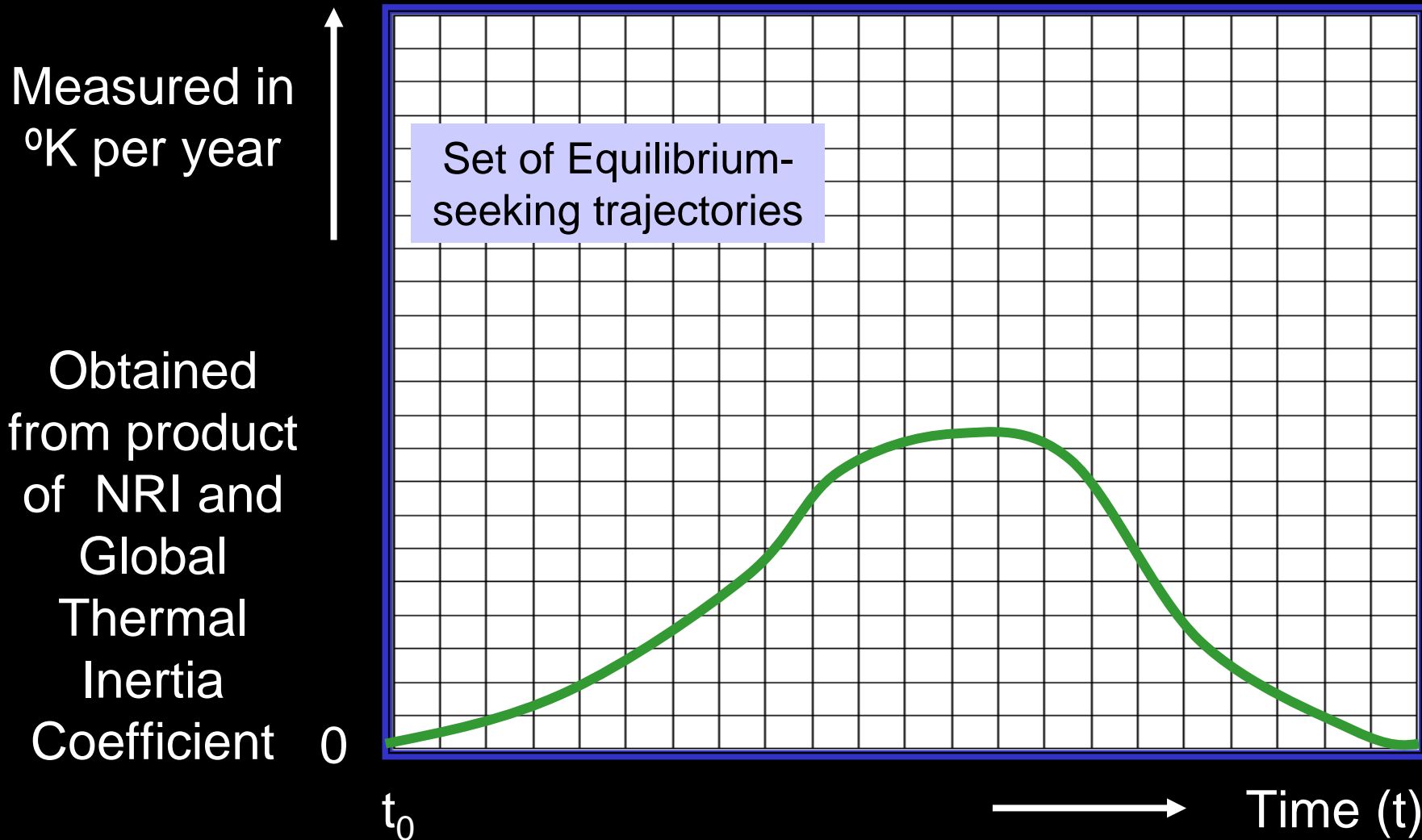
NRI

Measured
in w.m^{-2}



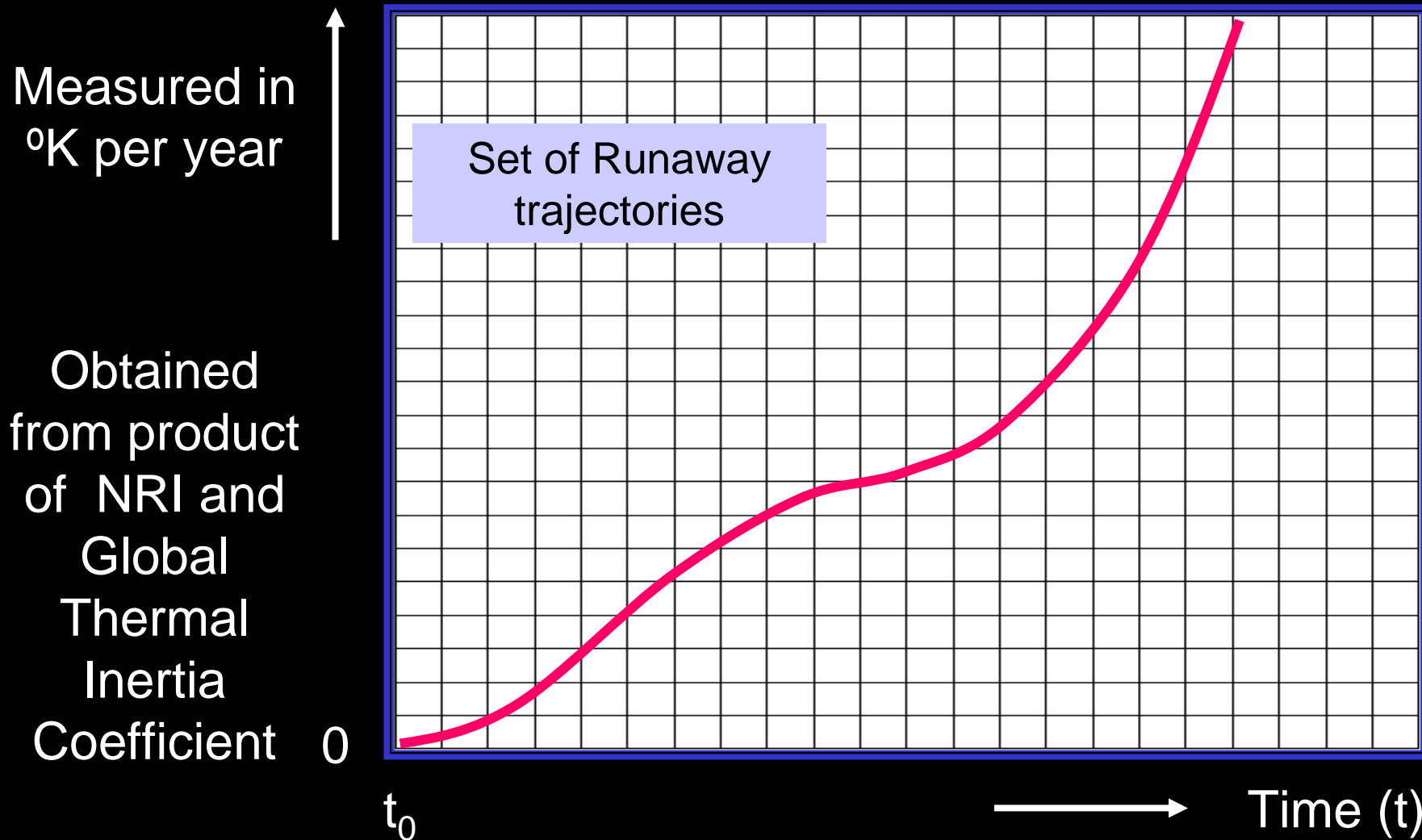
The Graphical Outputs

2: Rate of Change of Temperature over Time



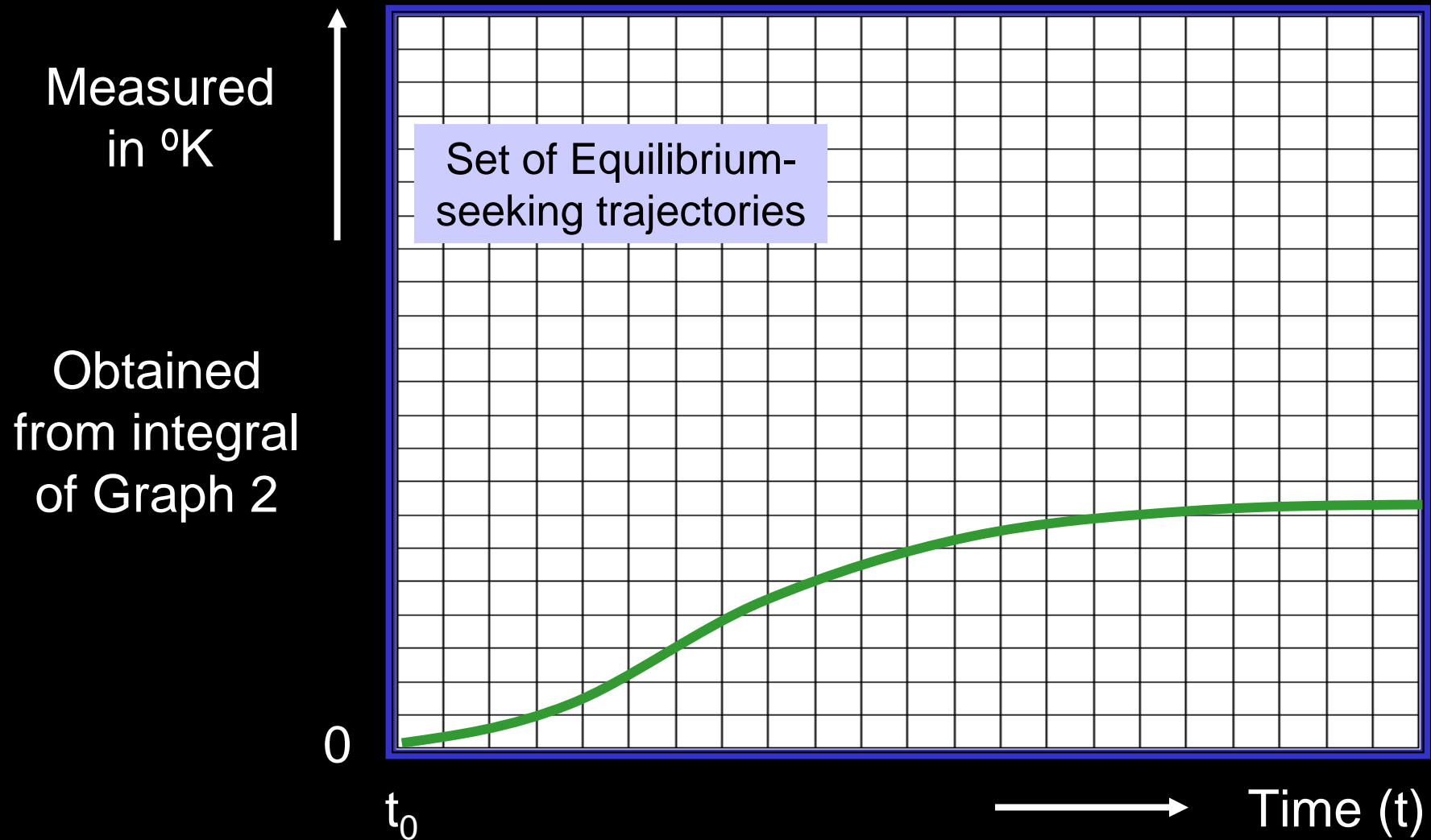
The Graphical Outputs

2: Rate of Change of Temperature over Time



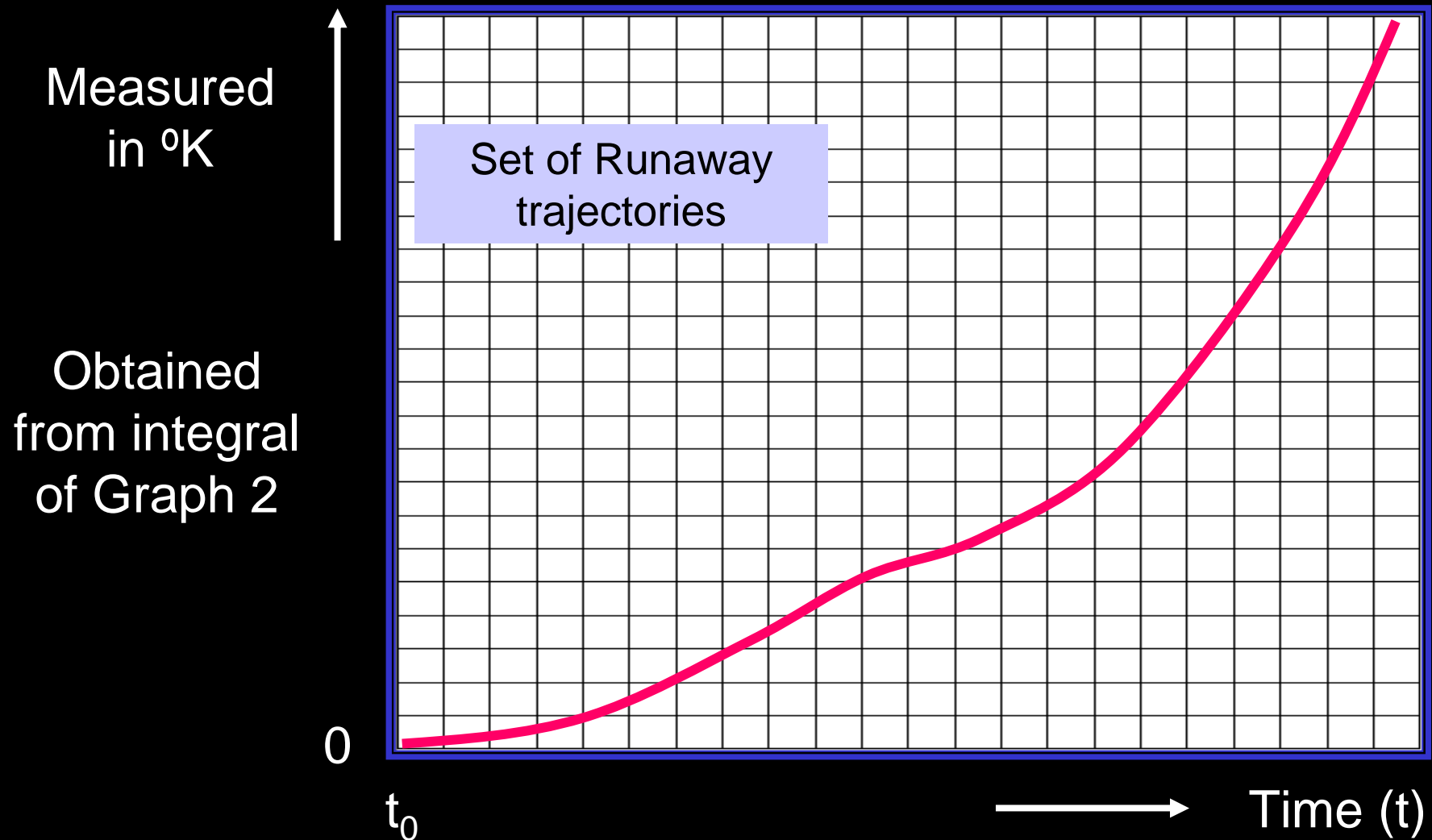
The Graphical Outputs

3: Change in Global Temperature over Time

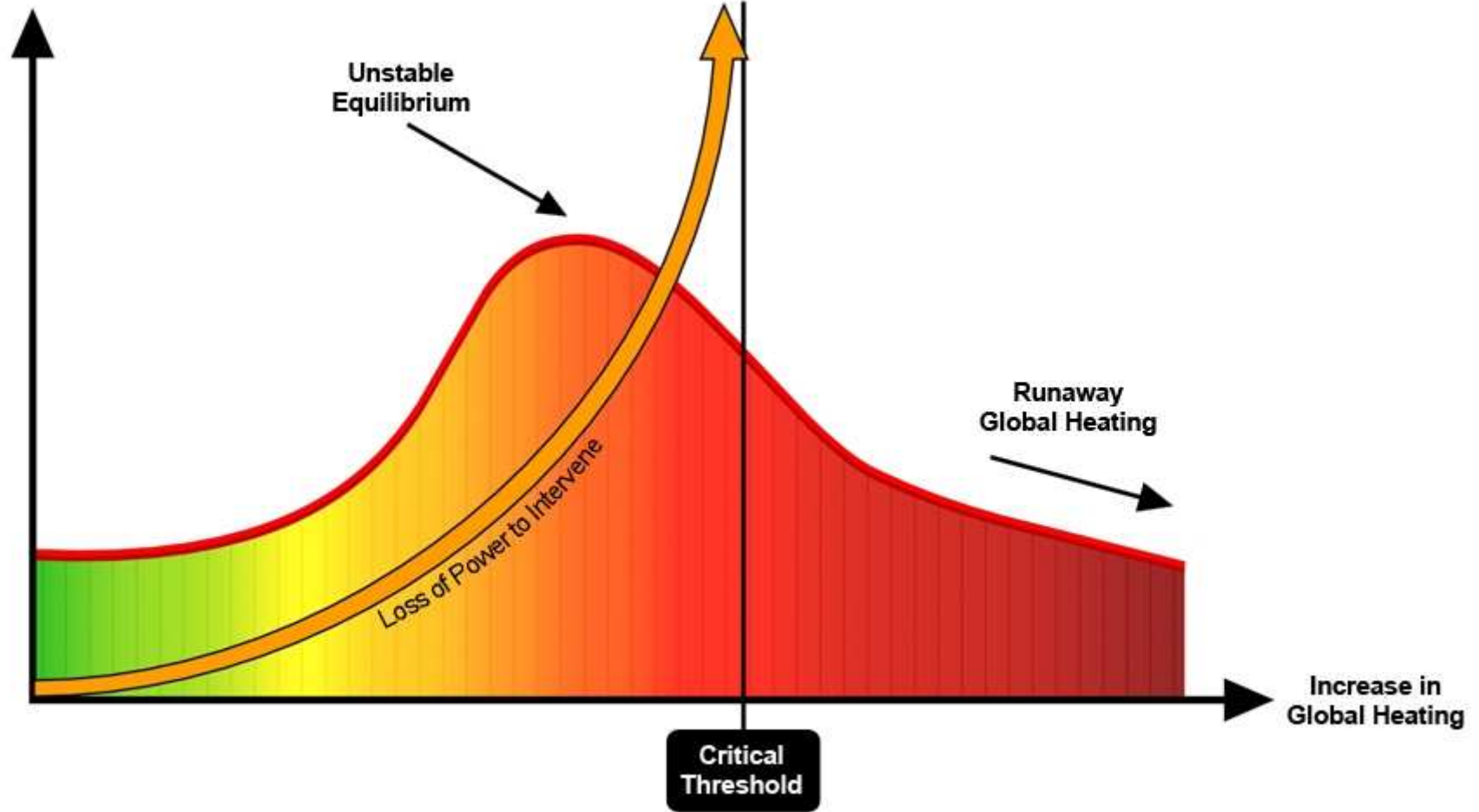


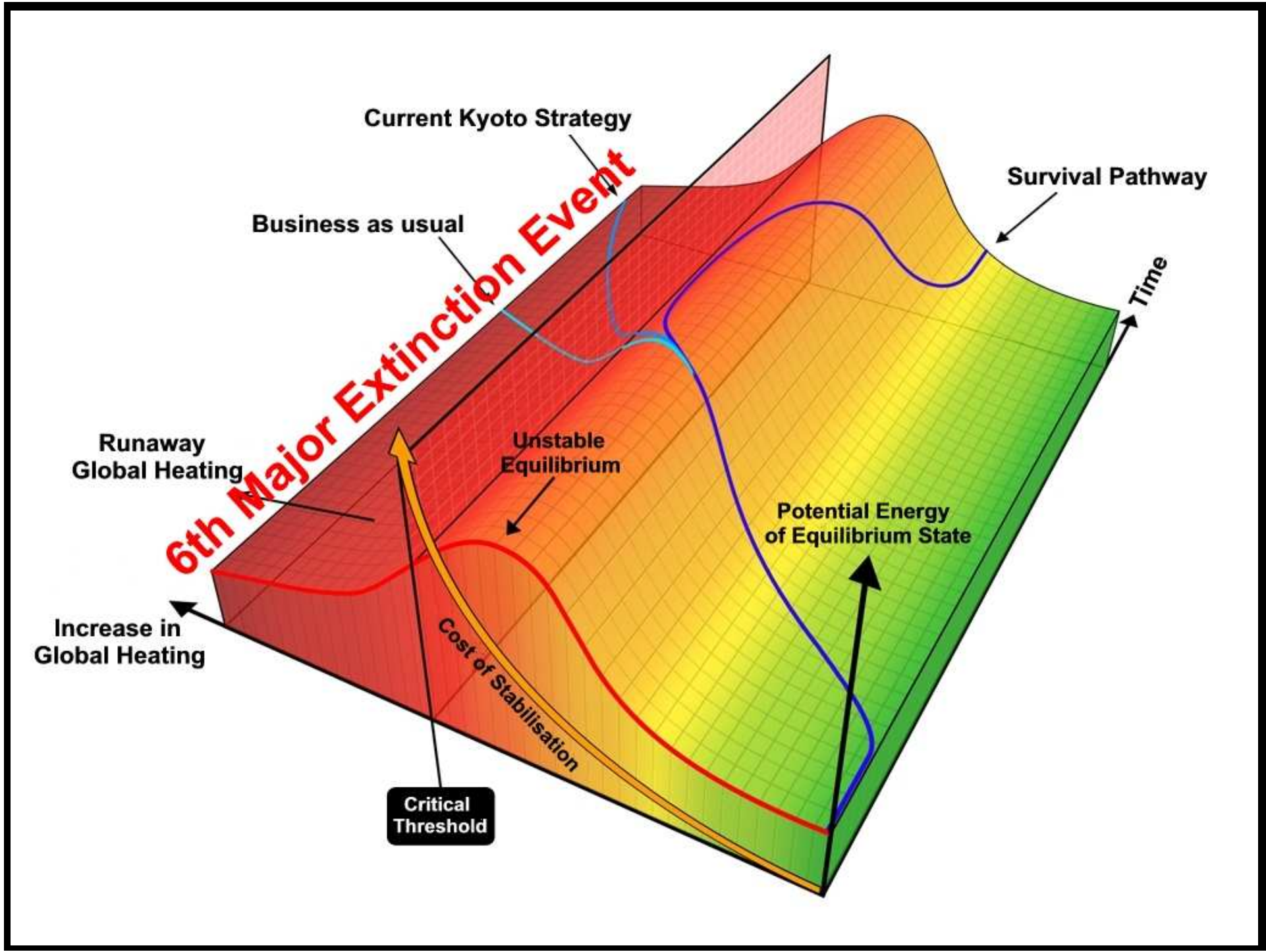
The Graphical Outputs

3: Change in Global Temperature over Time



Potential Energy of Equilibrium State

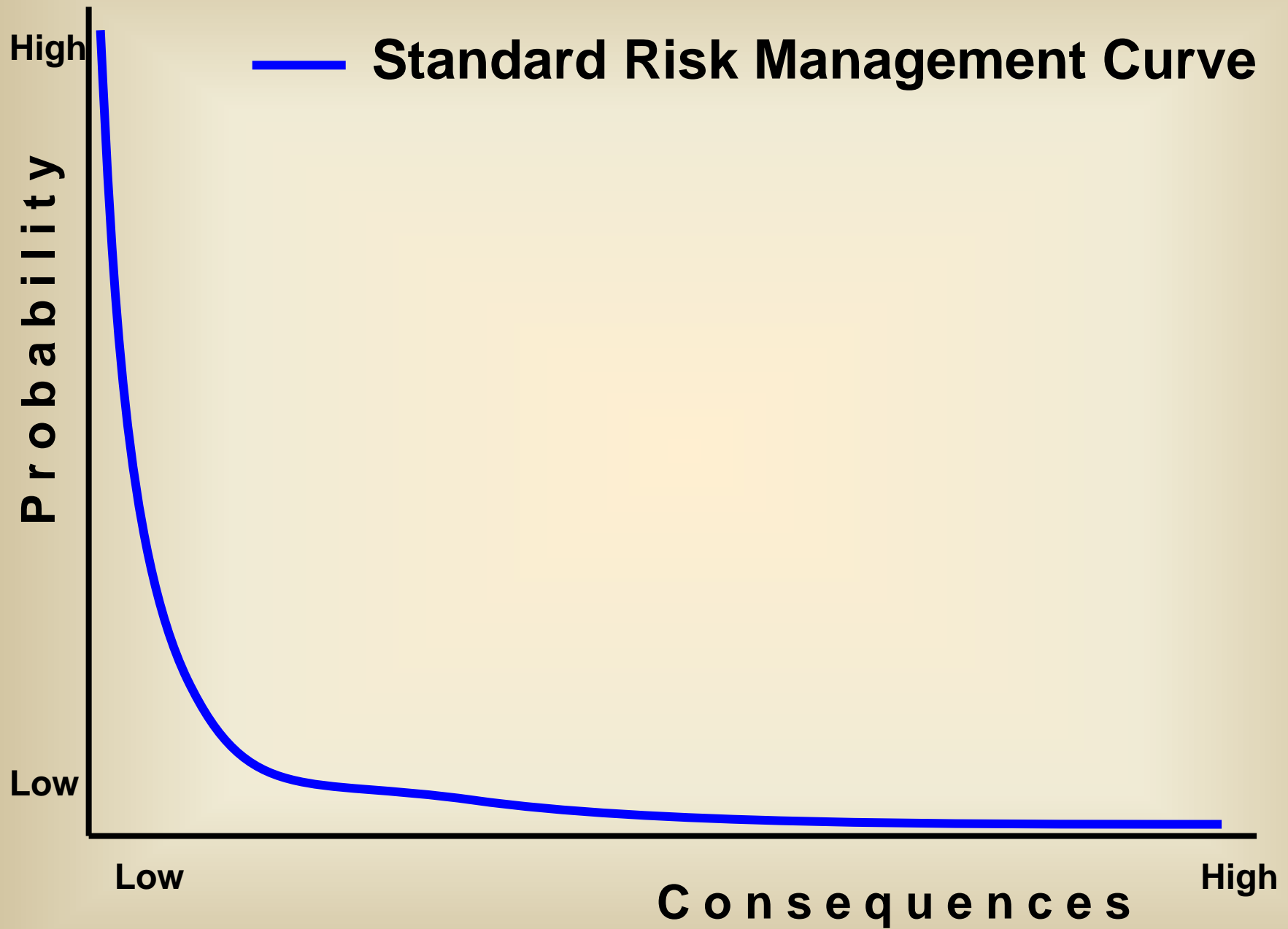


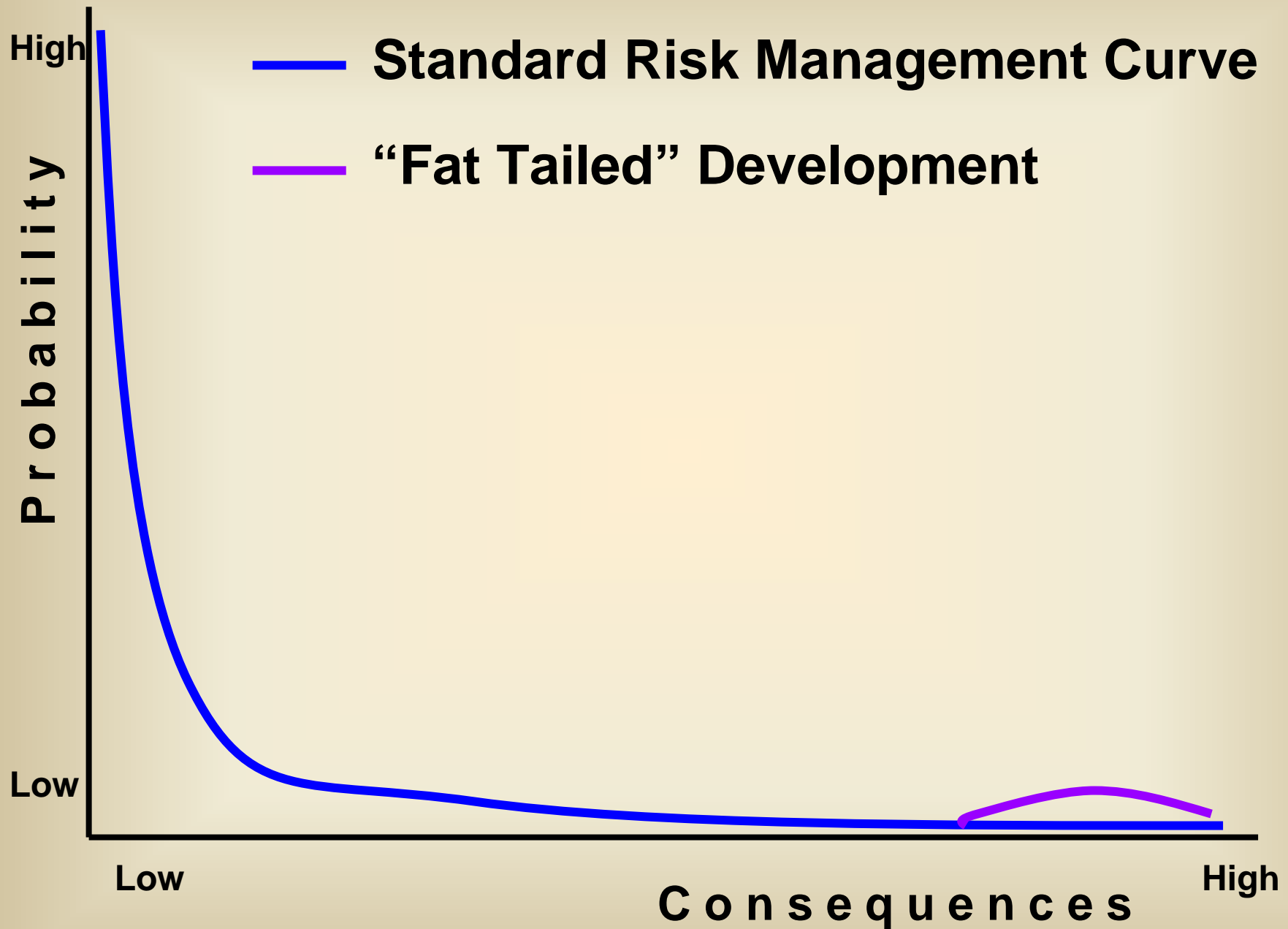


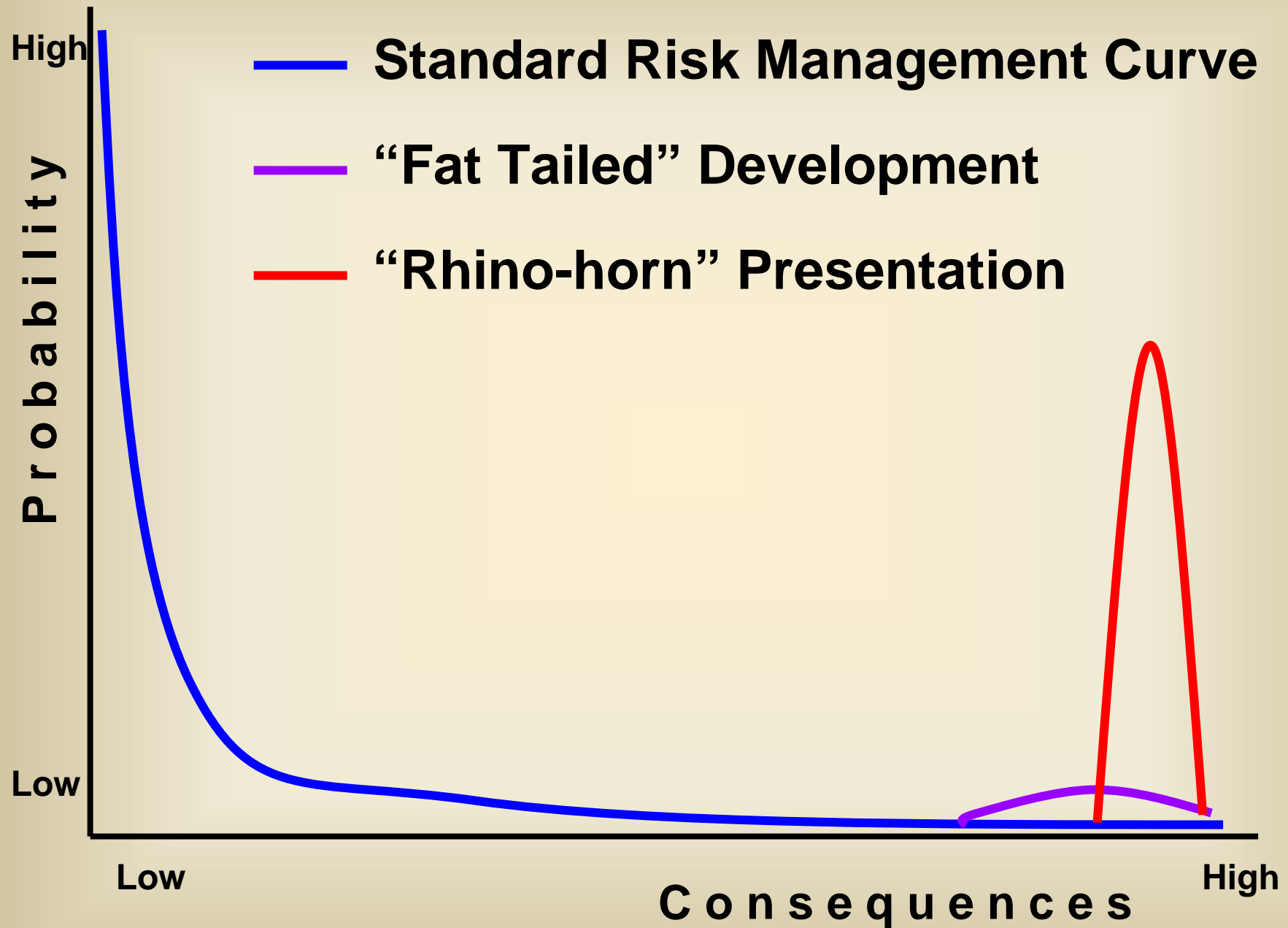
Risk Management

for

Catastrophic Risk







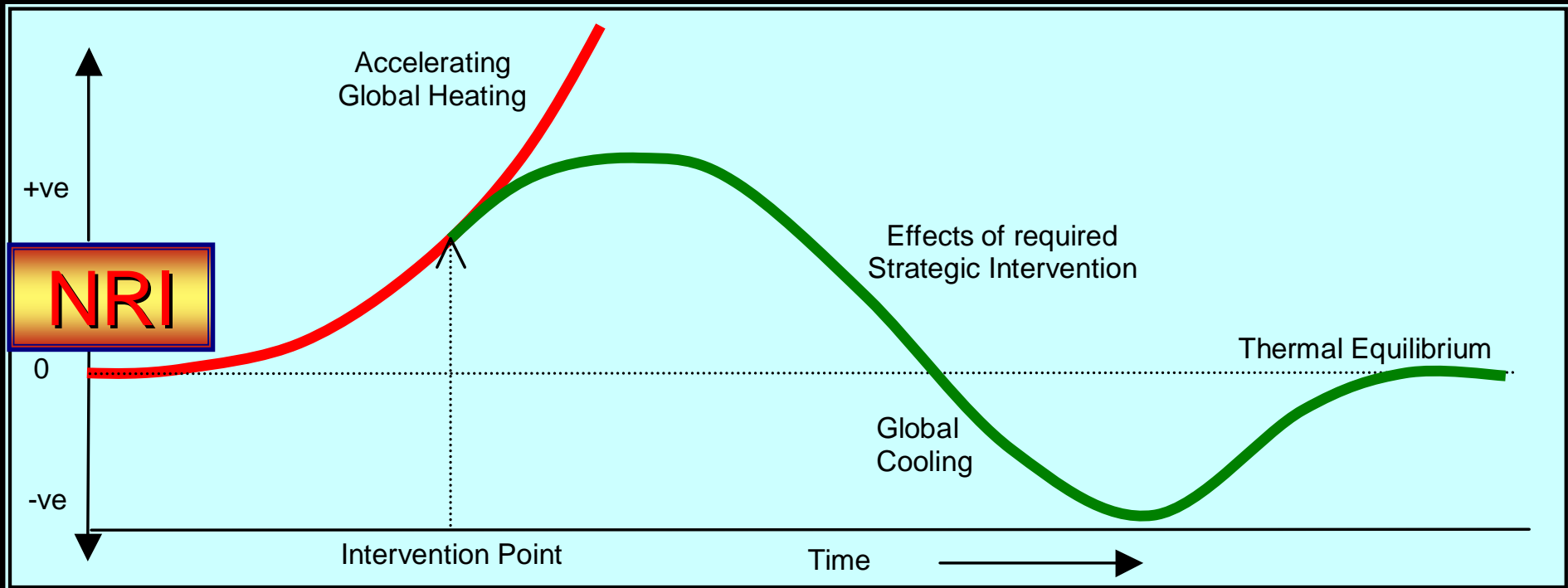
Climate Stabilisation

**Strategic Imperative for
Tomorrow's World**

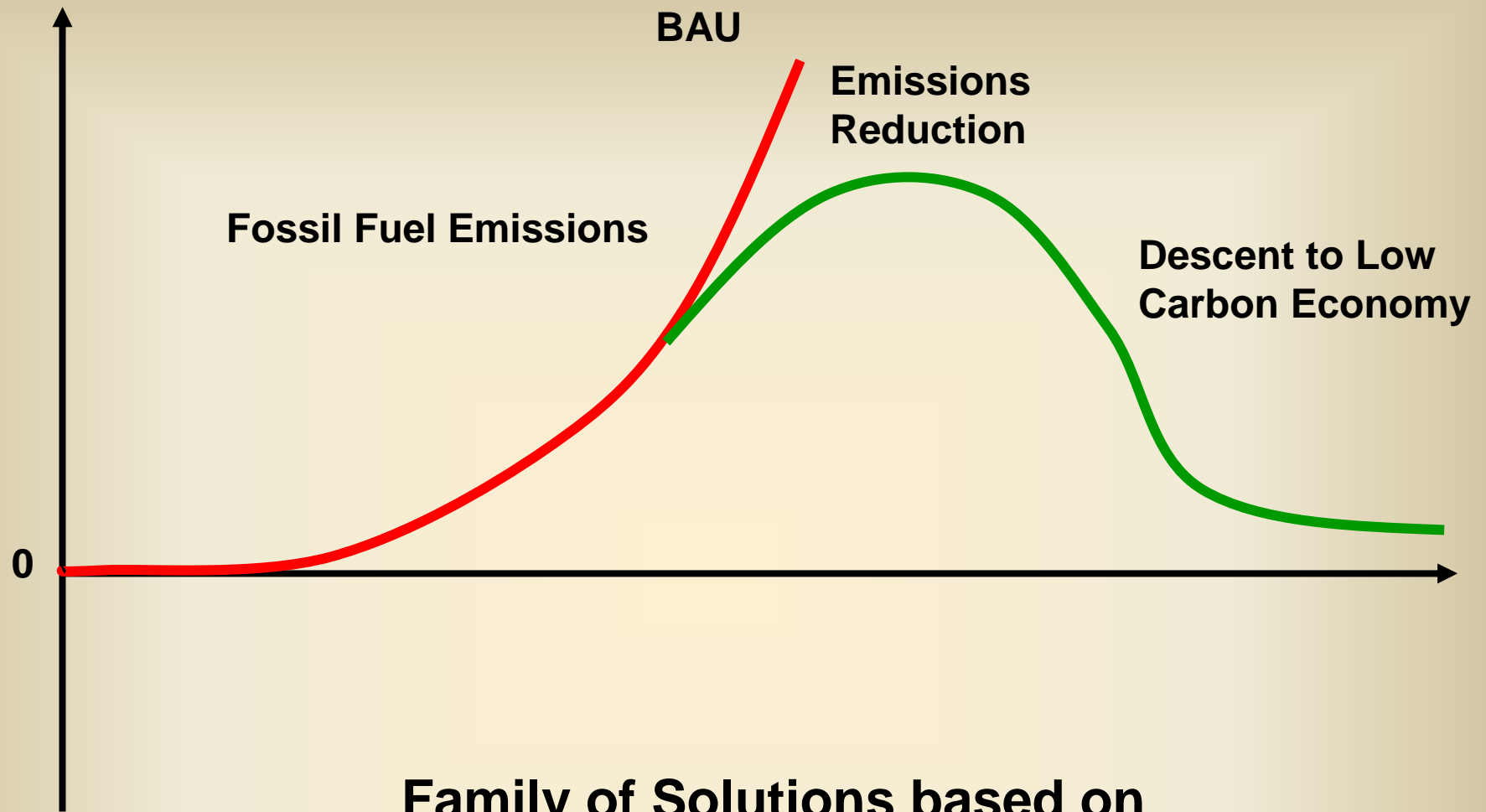
Climate Stabilisation

Return the Energy
Imbalance to Zero

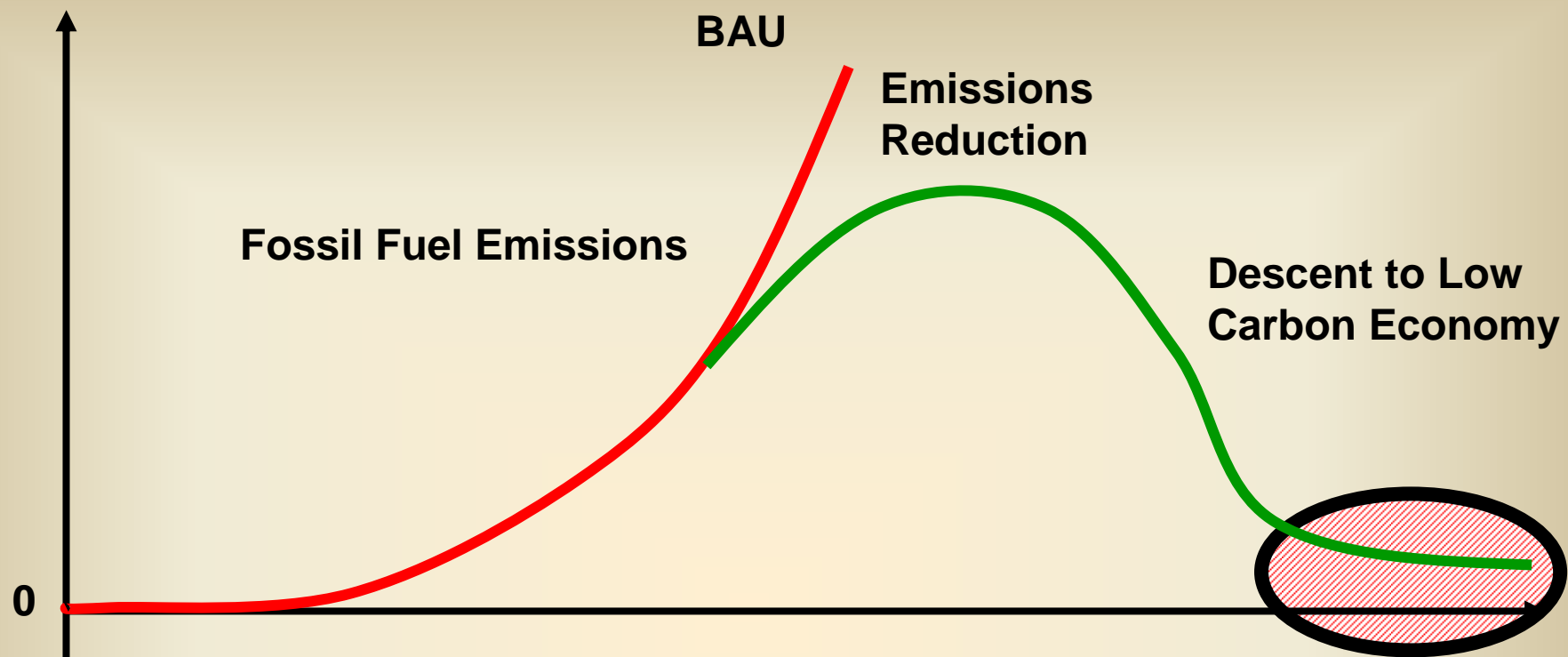
Like This



**Towards
an Effective Strategy
for
Climate Stabilisation**



**Family of Solutions based on
1990's Understanding of
Climate Change**



**Family of Solutions based on
1990's Understanding of
Climate Change**

Imperative to move:

beyond a low carbon economy

Imperative to move:

beyond a low carbon economy

through zero carbon economy

Imperative to move:

beyond a low carbon economy

through zero carbon economy

to a carbon draw-down economy

Imperative to move:

beyond a low carbon economy

through zero carbon economy

to a carbon draw-down economy

At a Global level

Imperative to move:

beyond a low carbon economy

through zero carbon economy

to a carbon draw-down economy

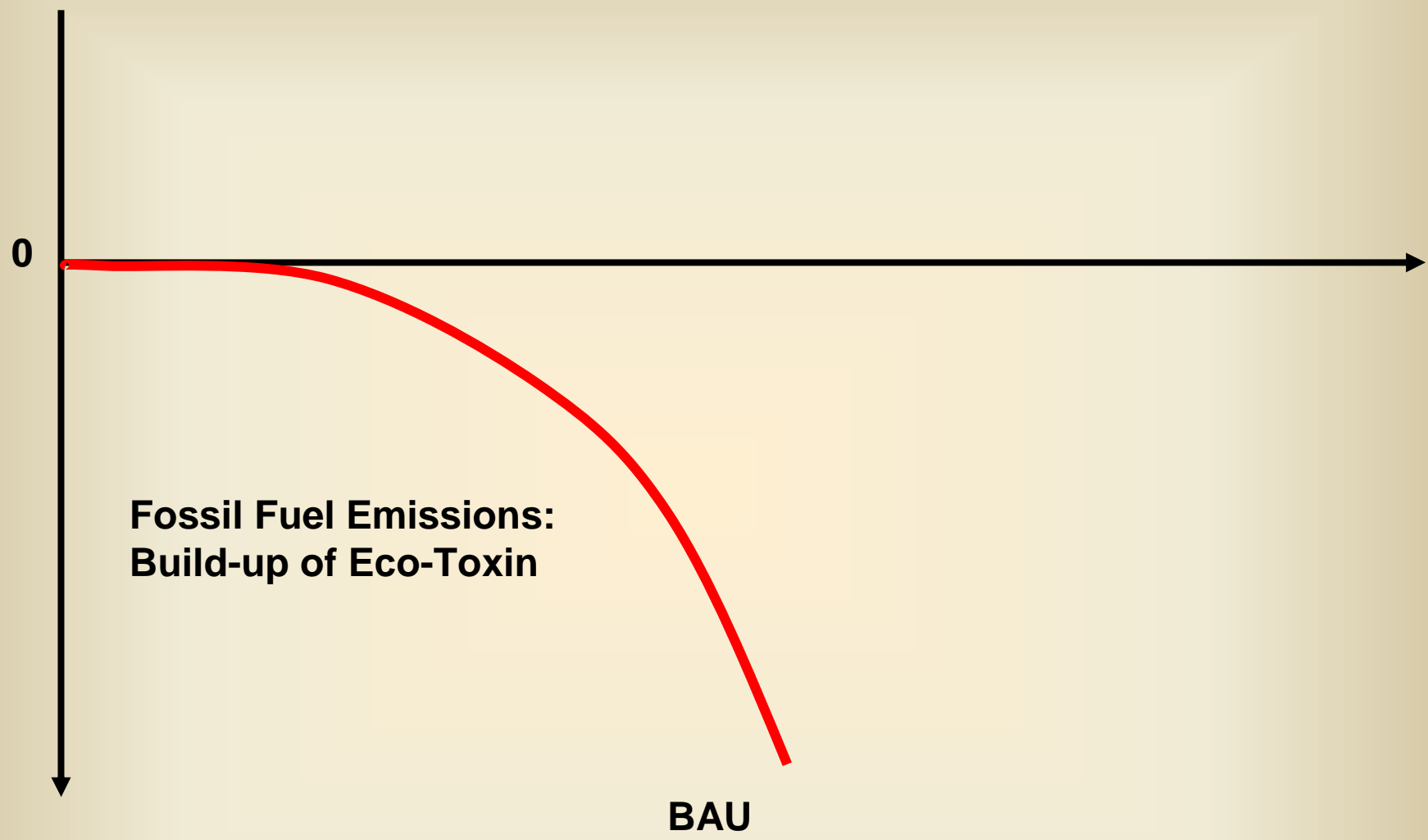
At a Global level

In the shortest possible time

**CO₂ emitting
fossil fuel is an energy
source whose time is
over!**

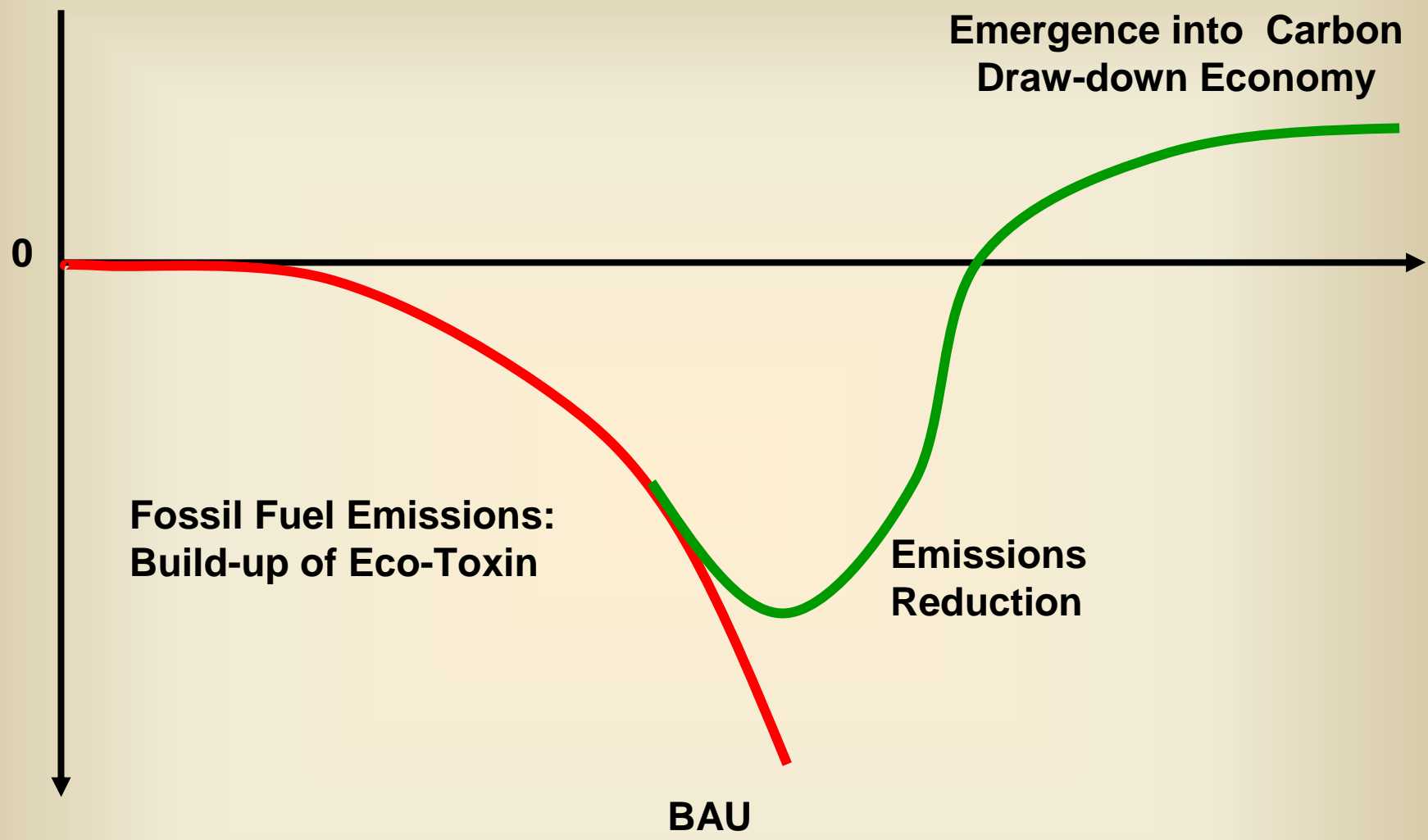
**Change from treating it
as a scarce resource
with high value**

**To an eco-toxin
to be removed
as quickly as possible!**



**Fossil Fuel Emissions:
Build-up of Eco-Toxin**

BAU



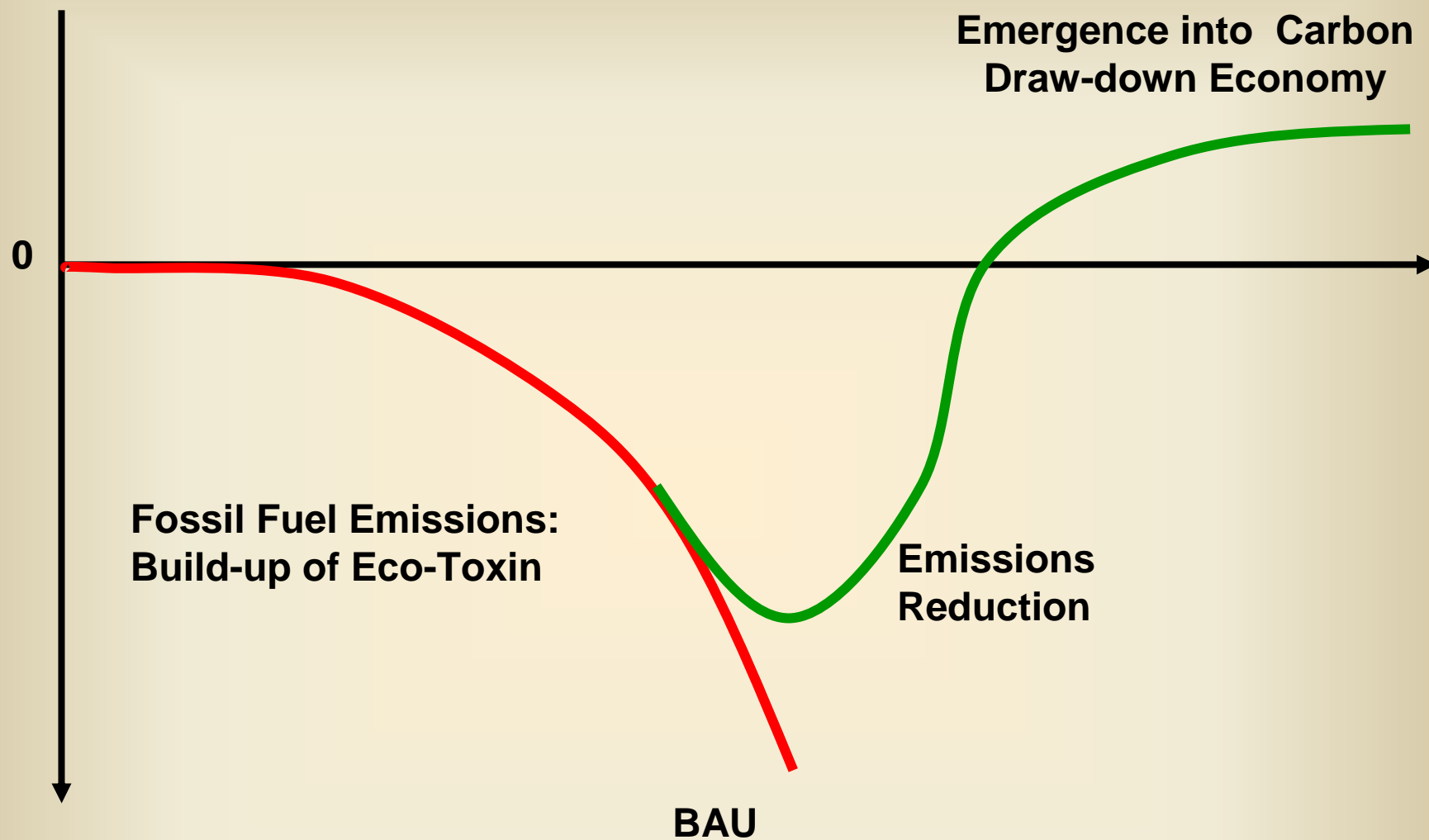
0

Fossil Fuel Emissions:
Build-up of Eco-Toxin

BAU

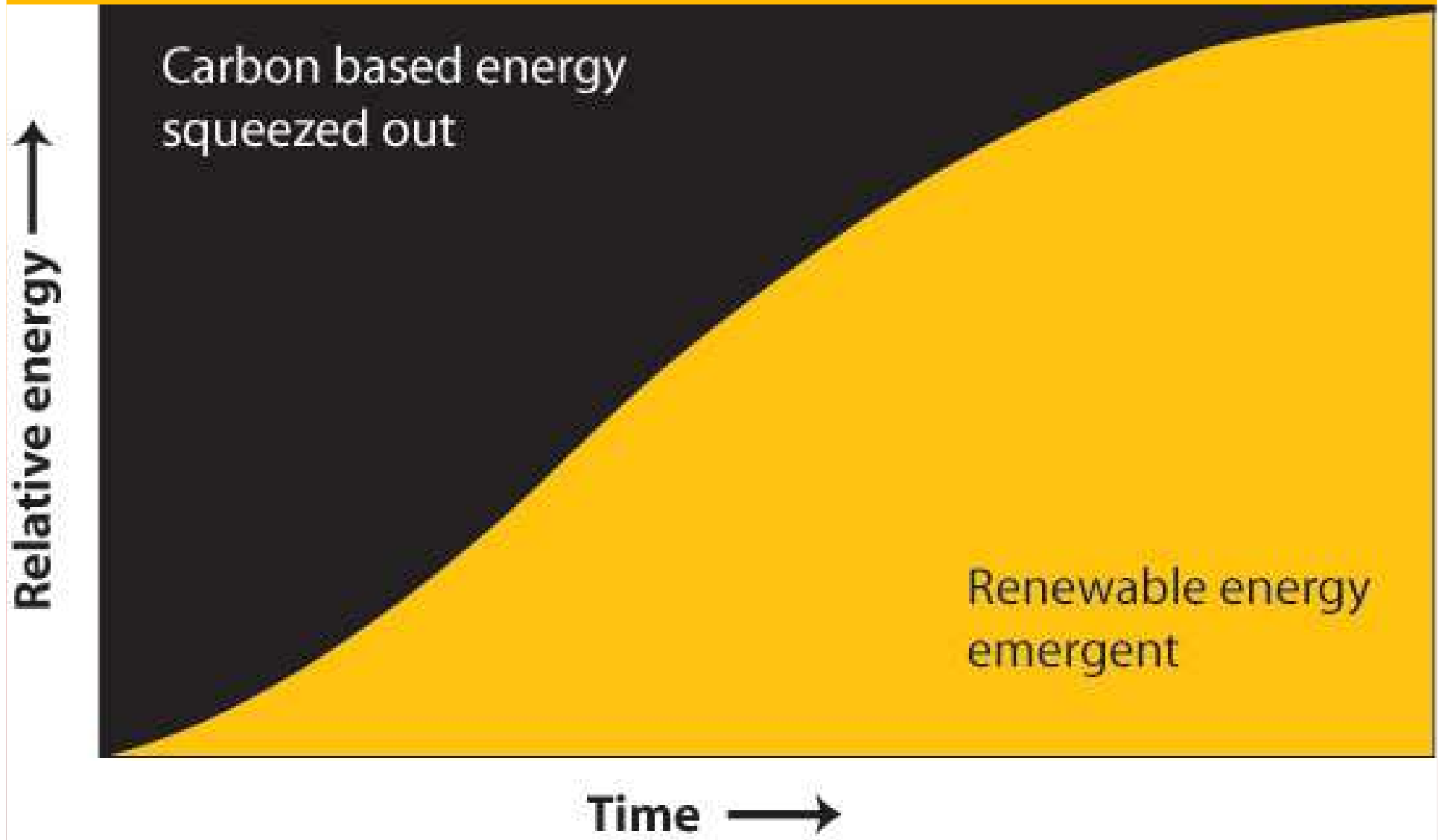
Emissions
Reduction

Emergence into Carbon
Draw-down Economy

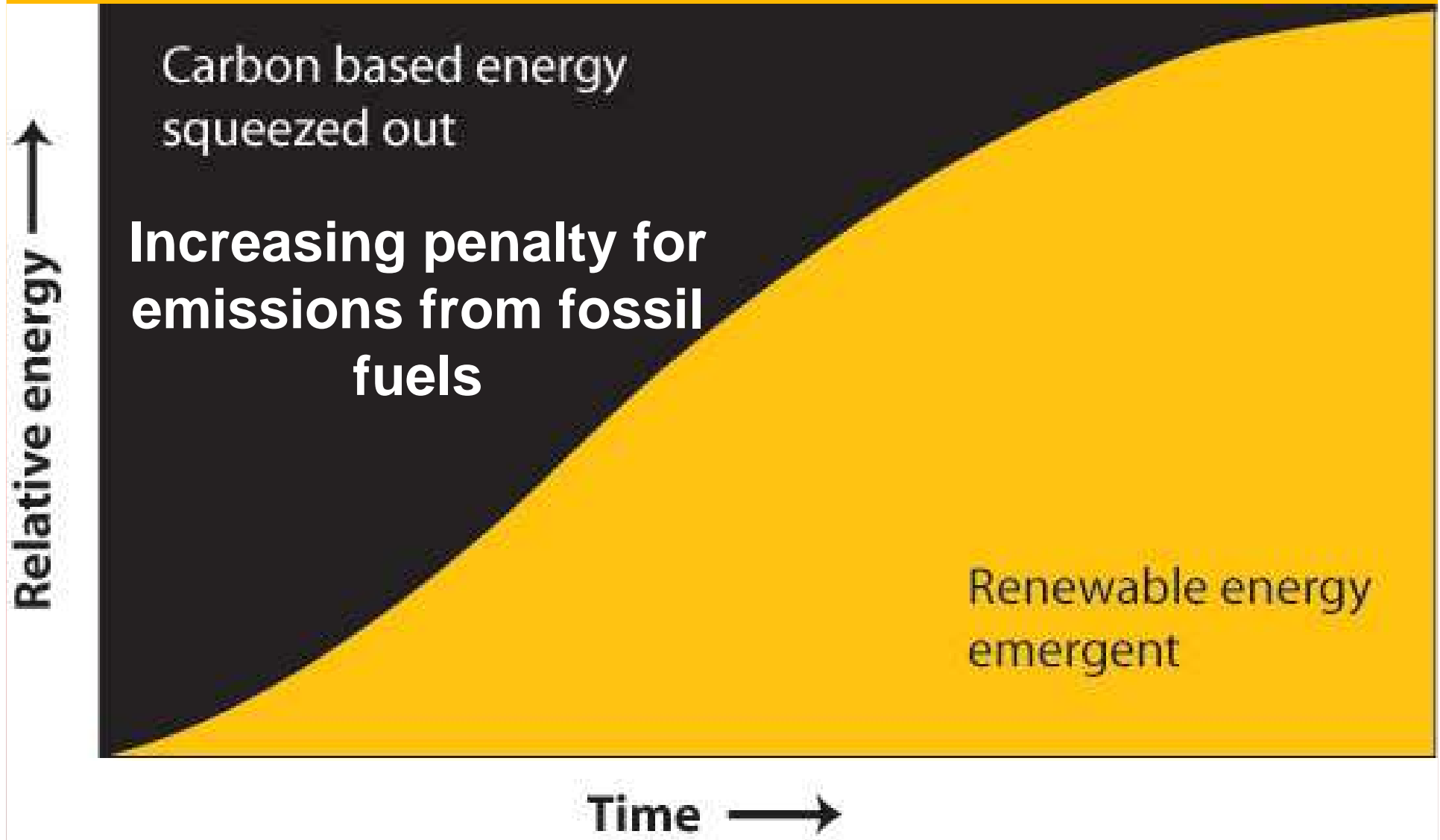


**Solutions based on Current Understanding of
Climate Dynamics**

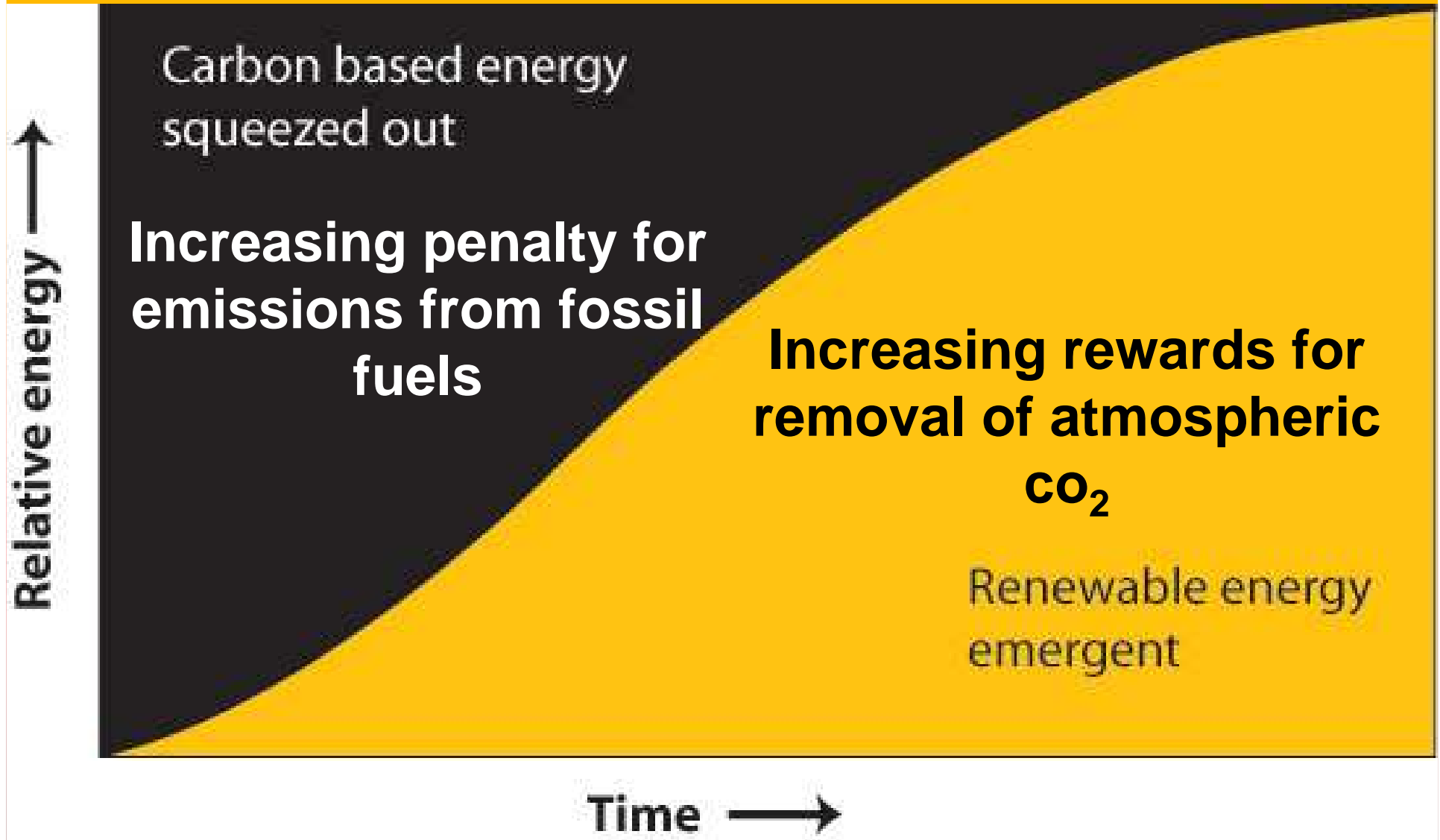
Metamorphosis



Metamorphosis



Metamorphosis





Part 2:

Social Dynamics and the Application of Complexity



Gaia

The Whole Earth System



GEO SPHERE



**GEO
SPHERE**

**BIO
SPHERE**



**GEO
SPHERE**

The diagram consists of three overlapping circles. The top-left circle is brown with a fine grid pattern and contains the text 'GEO SPHERE'. The top-right circle is light green with a fine grid pattern and contains the text 'BIO SPHERE'. The bottom circle is light blue with a fine grid pattern and contains the text 'ANTHROPO- SPHERE'. The circles overlap in the center, and the background is a photograph of the Earth from space.

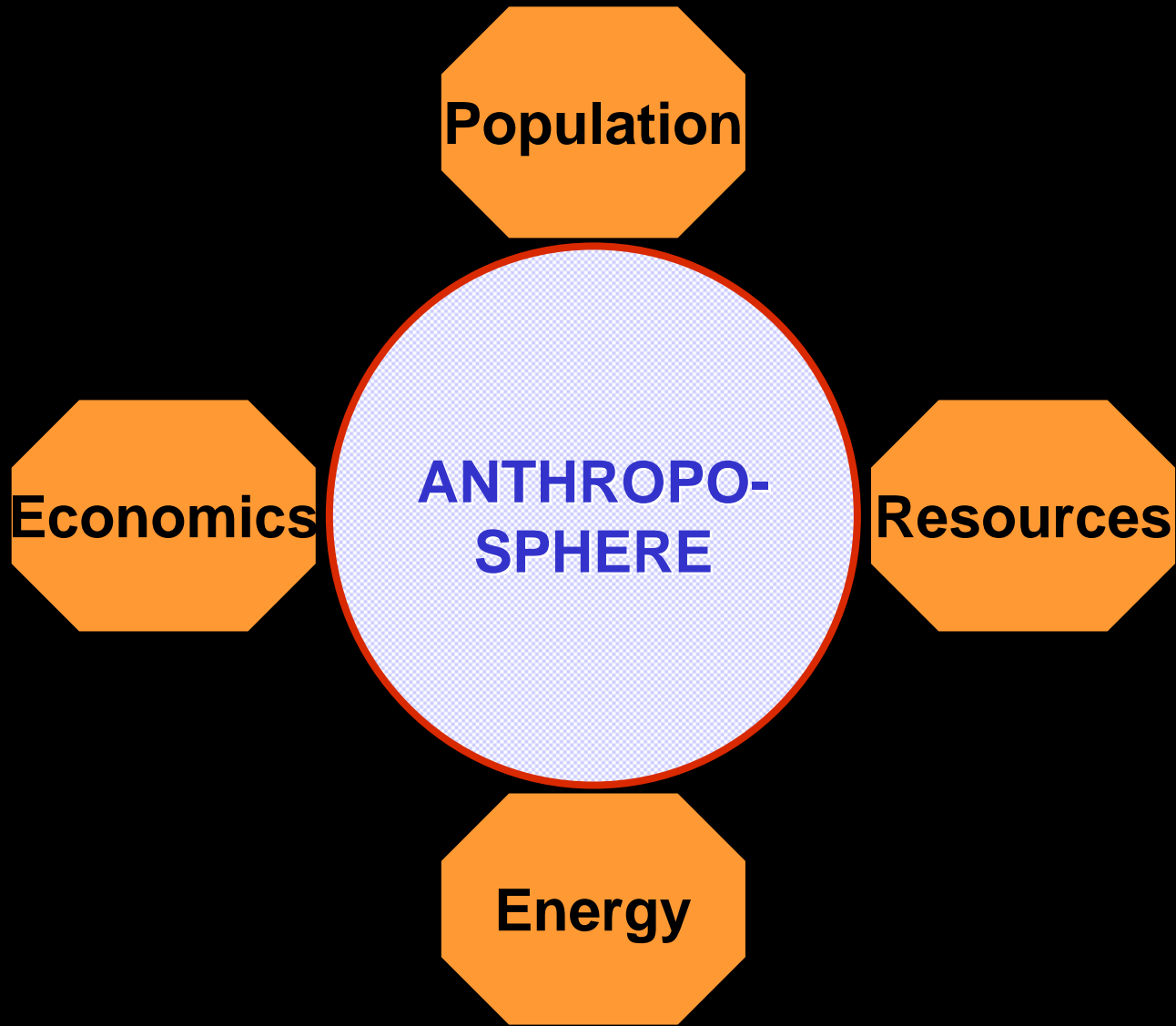
**BIO
SPHERE**

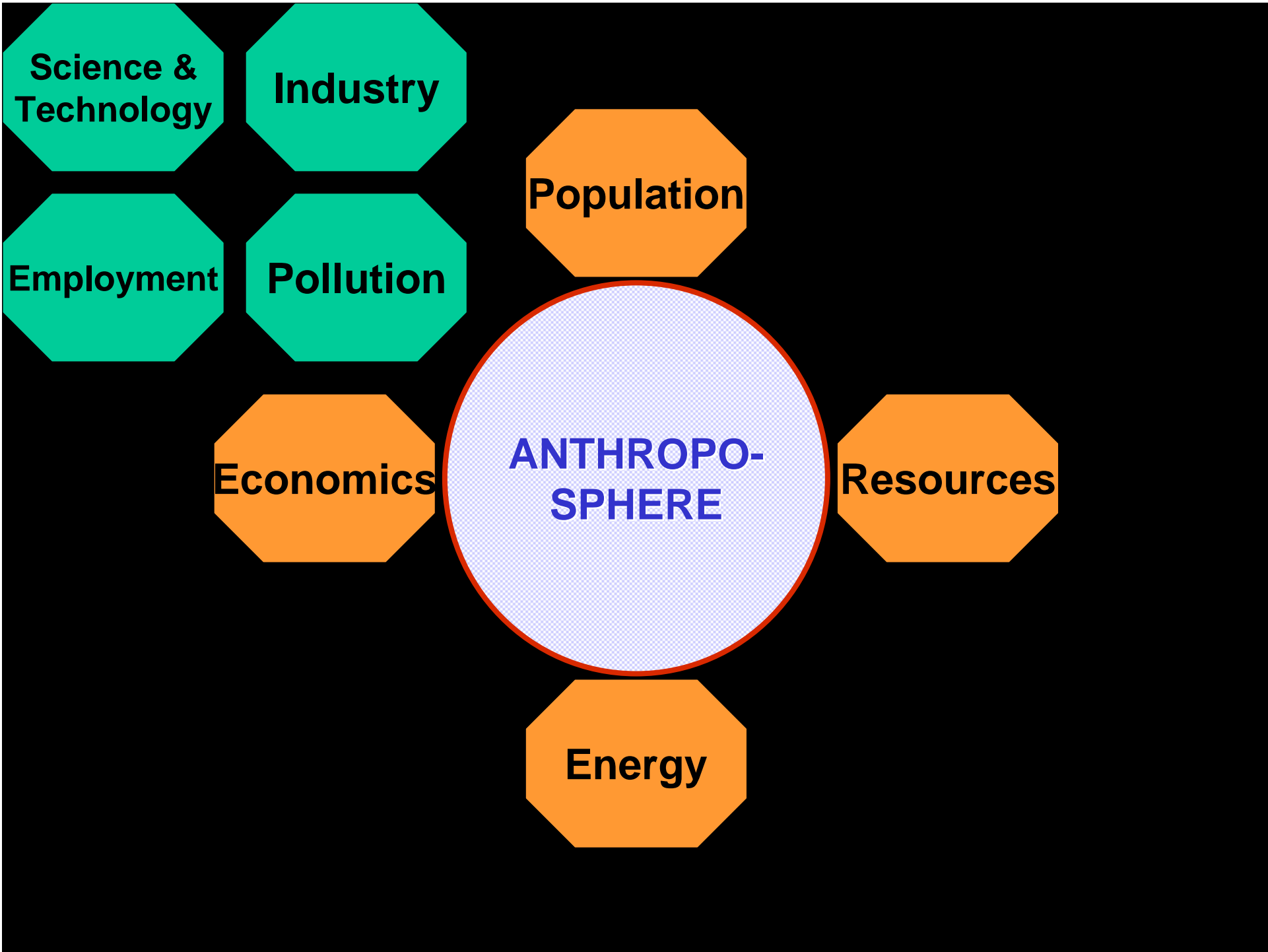
**ANTHROPO-
SPHERE**

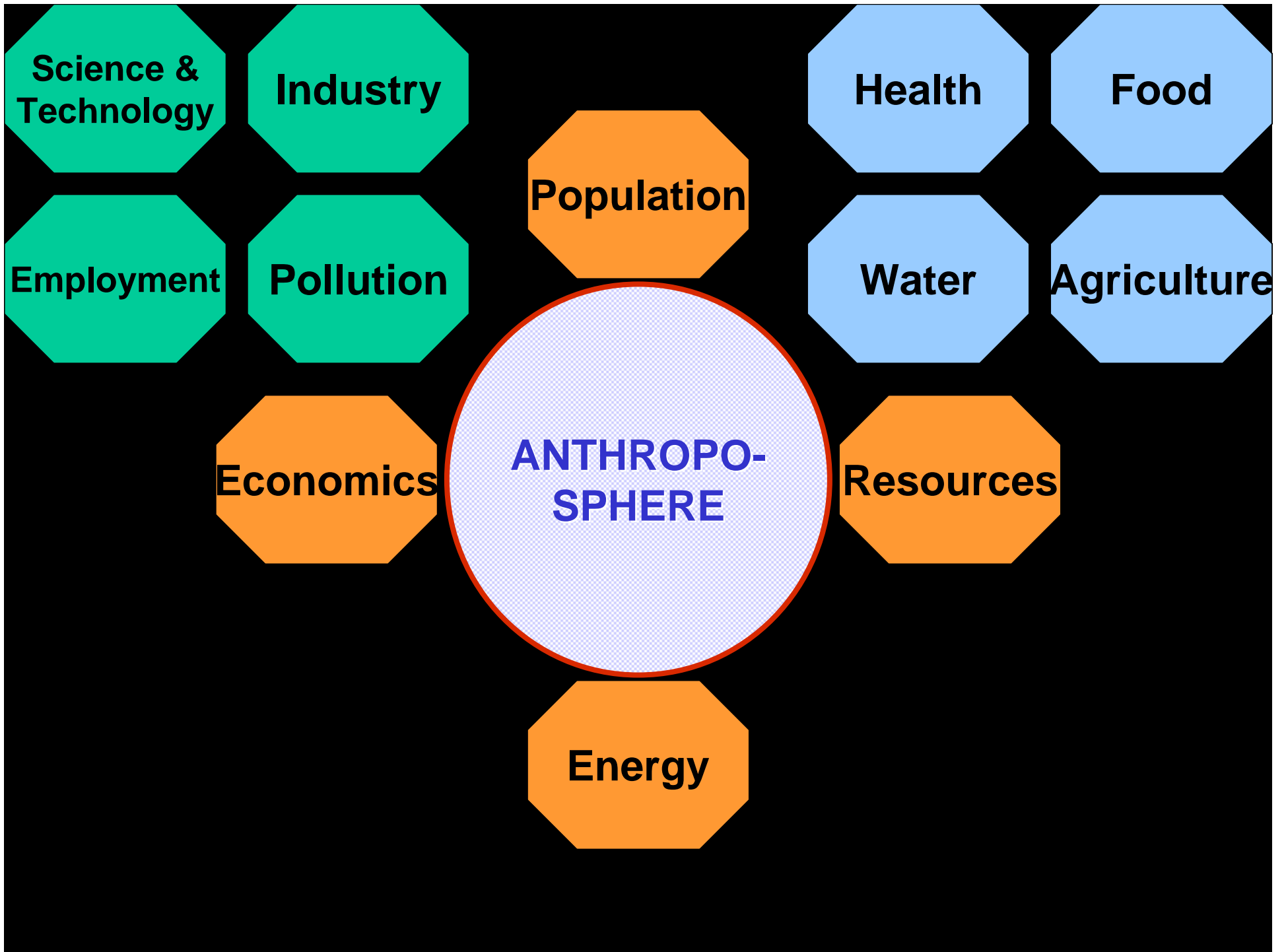
A Matrix of co-evolutionary sub-systems

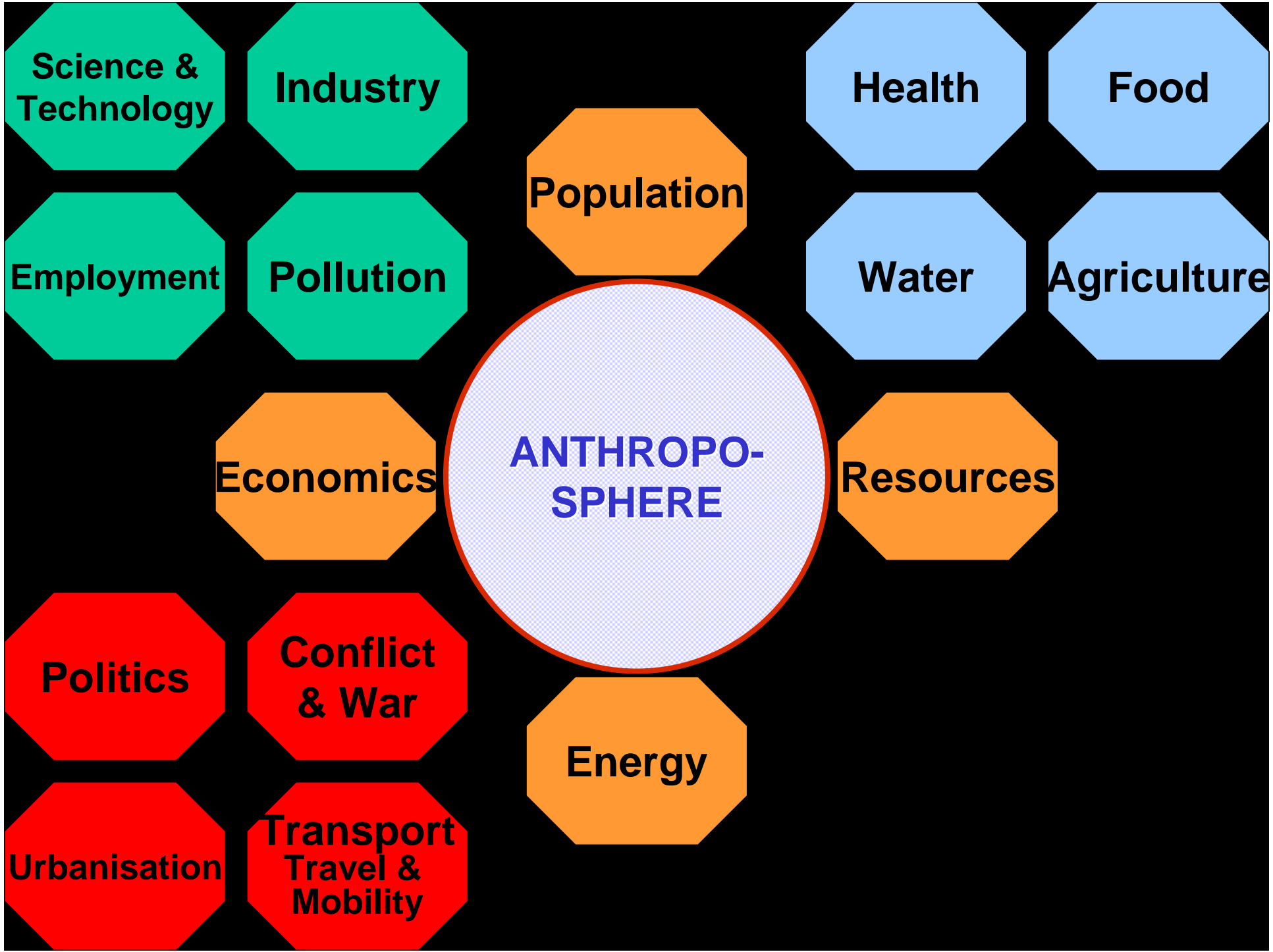


**With an array of non-linear feedbacks
between all elements**









Science & Technology

Industry

Health

Food

Population

Employment

Pollution

Water

Agriculture

Economics

ANTHROPO-SPHERE

Resources

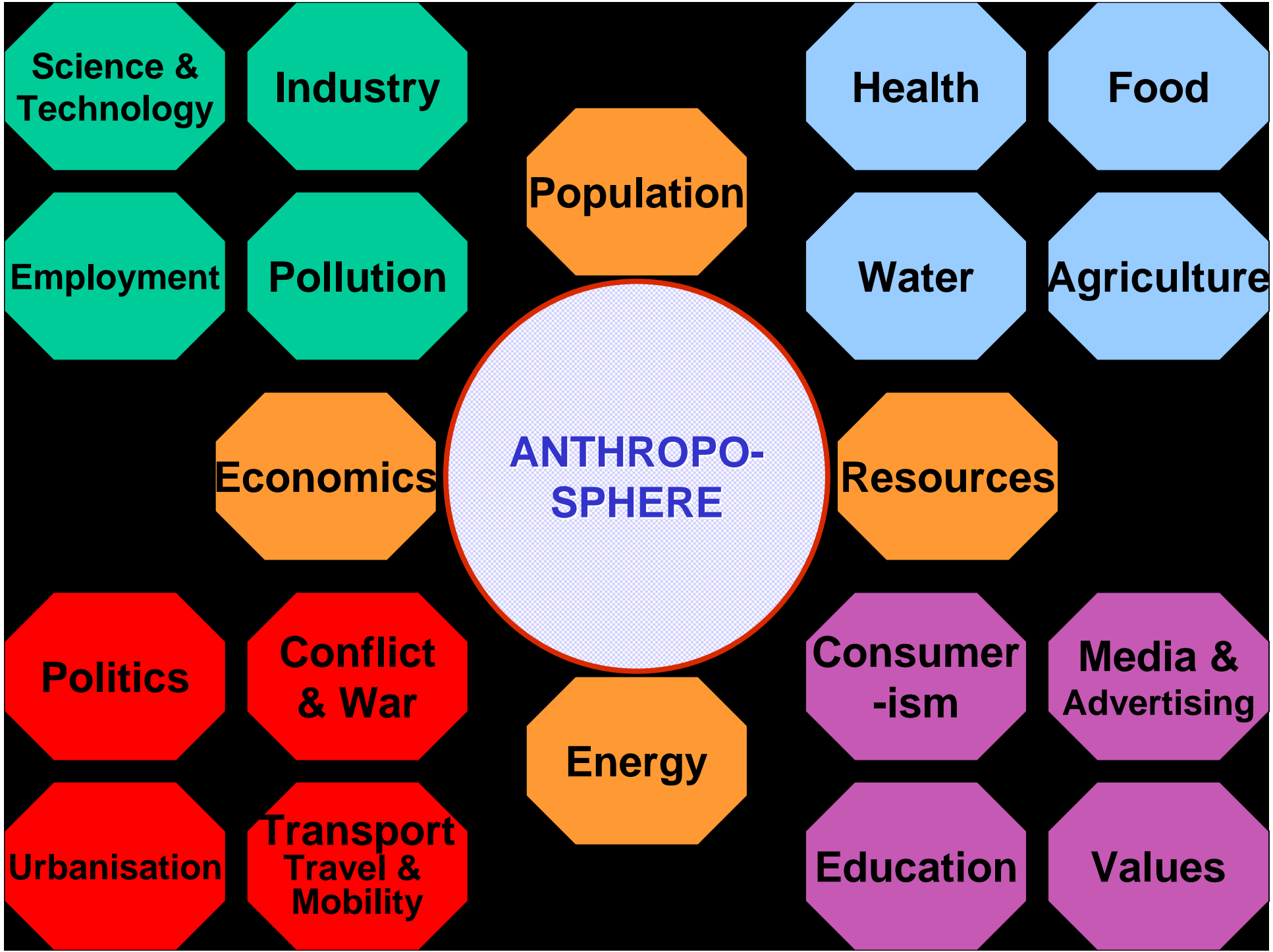
Politics

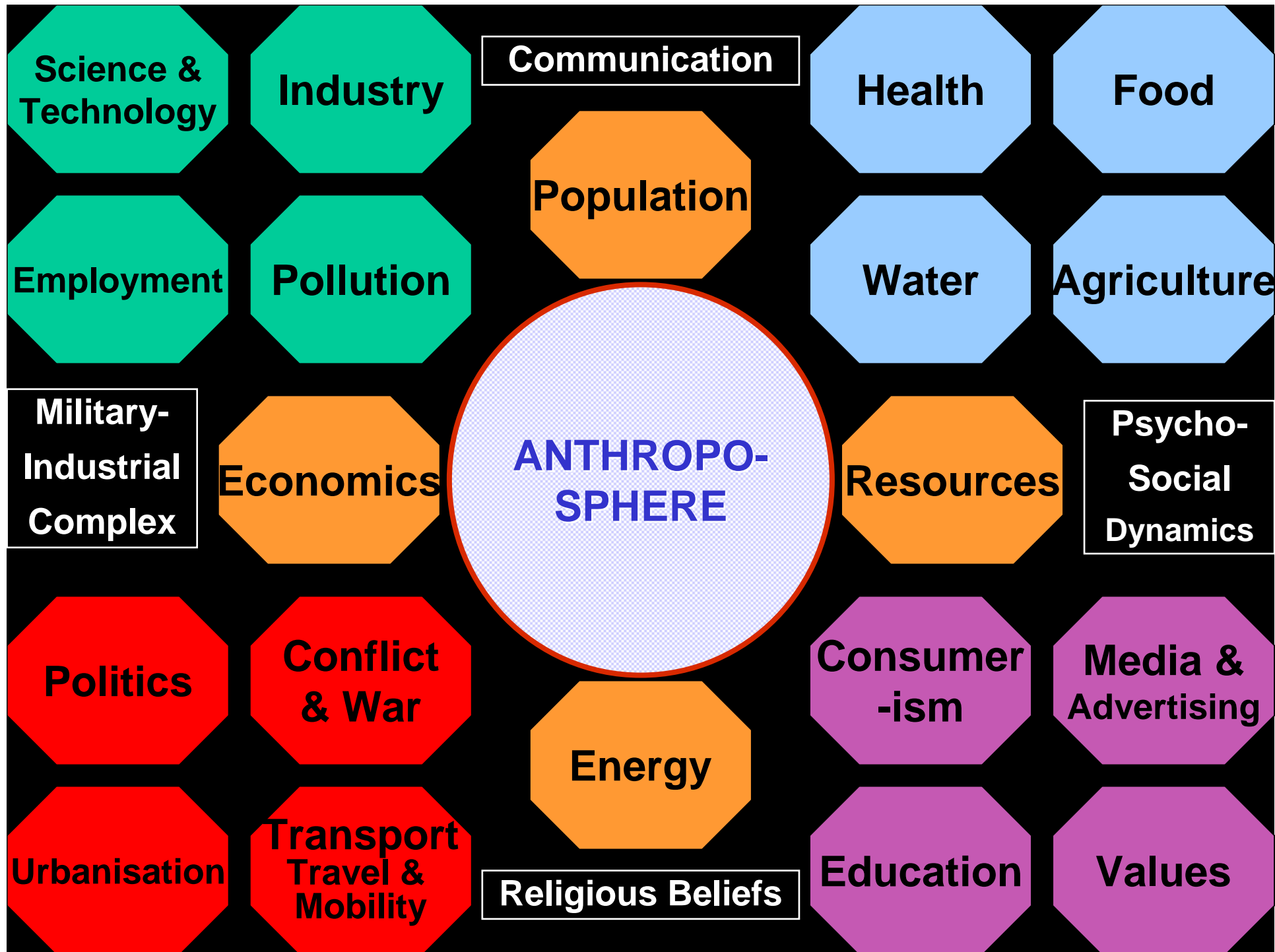
Conflict & War

Energy

Urbanisation

Transport Travel & Mobility





**Worst Case Scenario
Is entered by passing**

The Point of No Return:

**the Critical Threshold
at the**

Convergence of Complex Systems.

Worst Case Scenario

Is accelerated by:

Worst Case Scenario

Is accelerated by:

Collapse of Resilience

Worst Case Scenario

Is accelerated by:

Collapse of Resilience

Economic implosion

INSIDE THIS WEEK: A 14-PAGE SPECIAL REPORT ON GLOBALISATION

The Economist

SEPTEMBER 20TH - 26TH 2008

www.economist.com

Who killed New Labour?

The war in Pakistan's tribal areas

America's unending culture wars

How to save fish

The last typewriter-repair man

What next?



Worst Case Scenario

Is accelerated by:

Collapse of Resilience

Economic implosion

Climate impacts

Worst Case Scenario

Is accelerated by:

Collapse of Resilience

Economic implosion

Climate impacts

Resource deprivation

Worst Case Scenario

Is accelerated by:

Collapse of Resilience

Economic implosion

Climate impacts

Resource deprivation

Breakdown of health

Worst Case Scenario

Is accelerated by:

Collapse of Resilience

Economic implosion

Climate impacts

Resource deprivation

Breakdown of health

Global psychosis



**Emergent
Global
Psychosis**



**Emergent
Global
Psychosis**

Panic, Frozen shock,
Terror, Horror,
Paralysis, Paranoia
Aghast, Petrified,
Mesmerised

**Emergent
Global
Psychosis**

Hallucinatory Madness:
Delusional
Schizophrenic
Hyper-symbolic

Panic, Frozen shock,
Terror, Horror,
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Elision of Grief

Massive Splitting
+/- Us/them good/evil
Light/dark Life/death
Spiritual/humanist
Enlightened/lower conscious
Repress fear, emotions,
learning & feedback

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Buddhist Fundamentalism
Regression, Fatalism,
Detachment,
Absorption,
Timelessness

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Anxiolytics: Drugs,
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Sex, Porn, Video-games,
Entertainment

Project evil, Attack,
War on Terror,
Good v Evil,
Destroy, Annihilate,
Armageddon

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Global
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Suppress information,
Escapism, Denial,
Hedonism, Diversion

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Repress fear, emotions,
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Hoarding, Greed, Food,
Feeding frenzy, Wealth,
Energy, Power, Resource,
Consumerism, Bunker,
Hyper-capitalism,
Economic War

Hallucinatory Madness:
Delusional
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Spiritual/humanist
Enlightened/lower conscious
Repress fear, emotions,
learning & feedback

Meditation,
Dissociation,
Hypnotised,
Entranced,
Unconscious

Hoarding, Greed, Food,
Feeding frenzy, Wealth,
Energy, Power, Resource,
Consumerism, Bunker,
Hyper-capitalism,
Economic War

Gaia's evil twin

Life is its own worst enemy

...piece of the moon. See p60



**There now exists a
State of Planetary
Emergency**





APOLLO 13

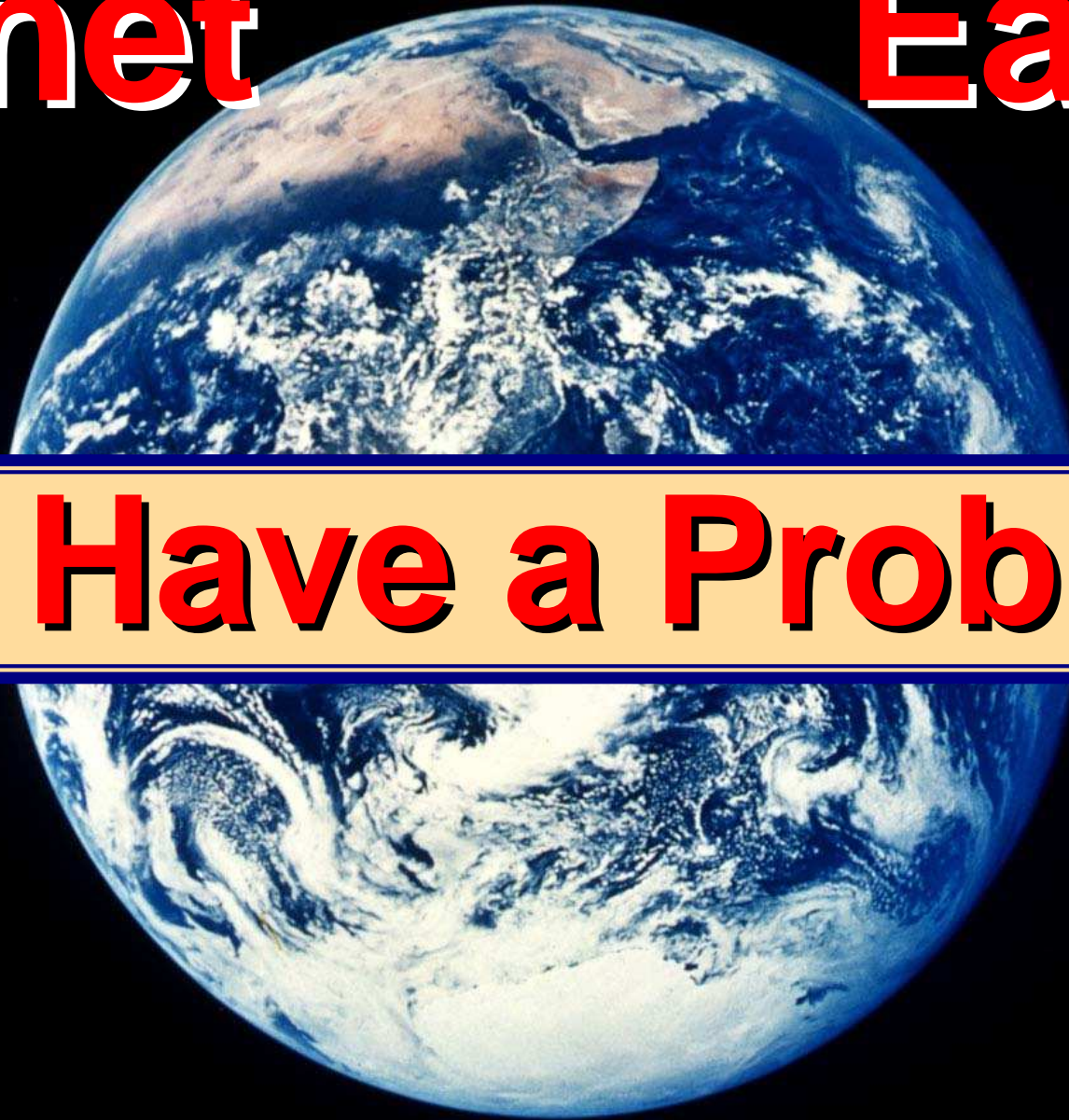


Parable for our Time

Planet

Earth

We Have a Problem





“Failure is not an option”

Gene Kranz

Apollo 13: Mission Controller



DEF-CON ZERO

**Declaring the State
of Planetary Emergency**

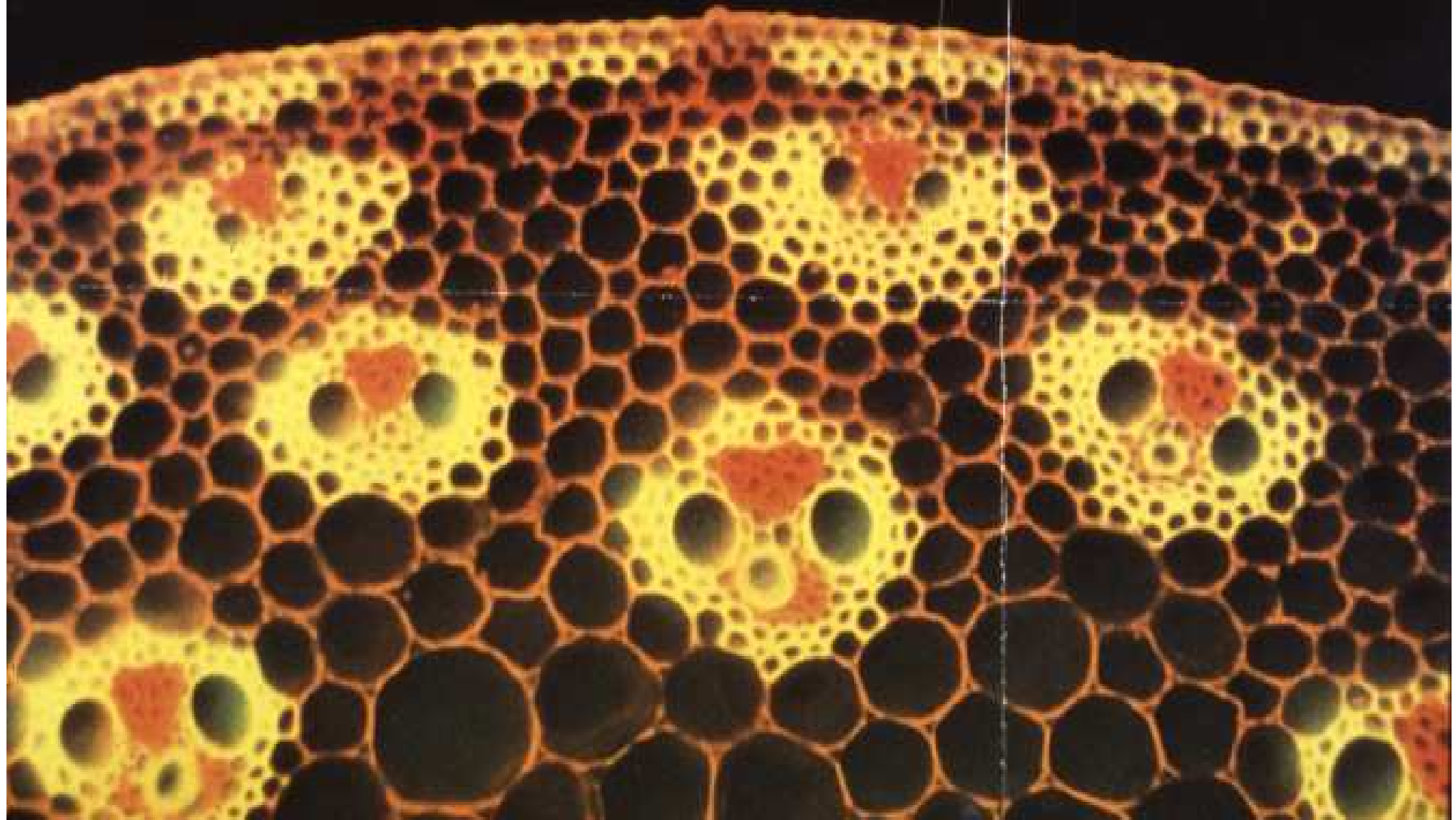
DEF-CON ZERO

Engaging the State
of Planetary Emergency



From
ORGANISATION...

... *to* **ORGANISM**







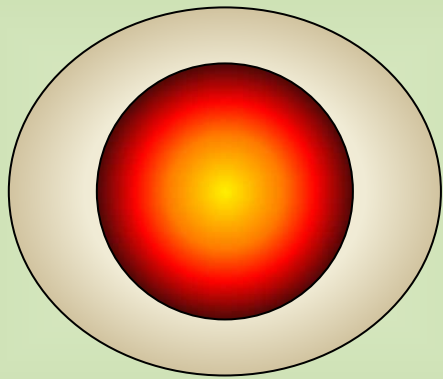


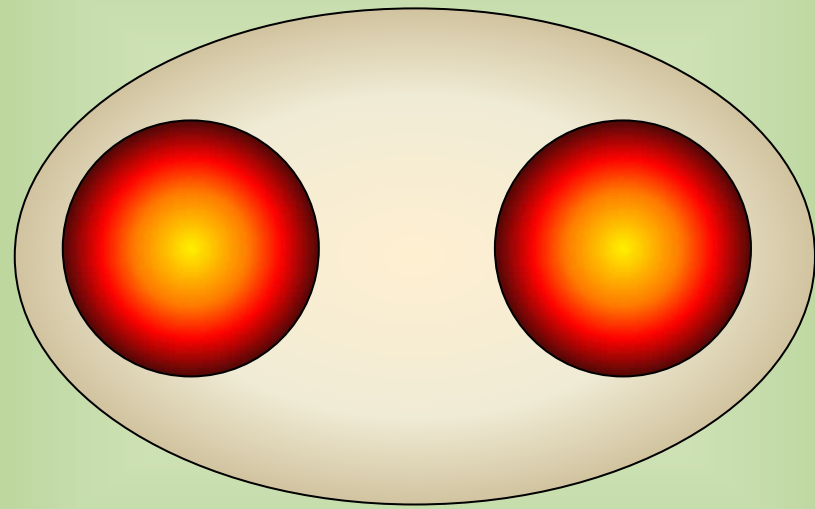


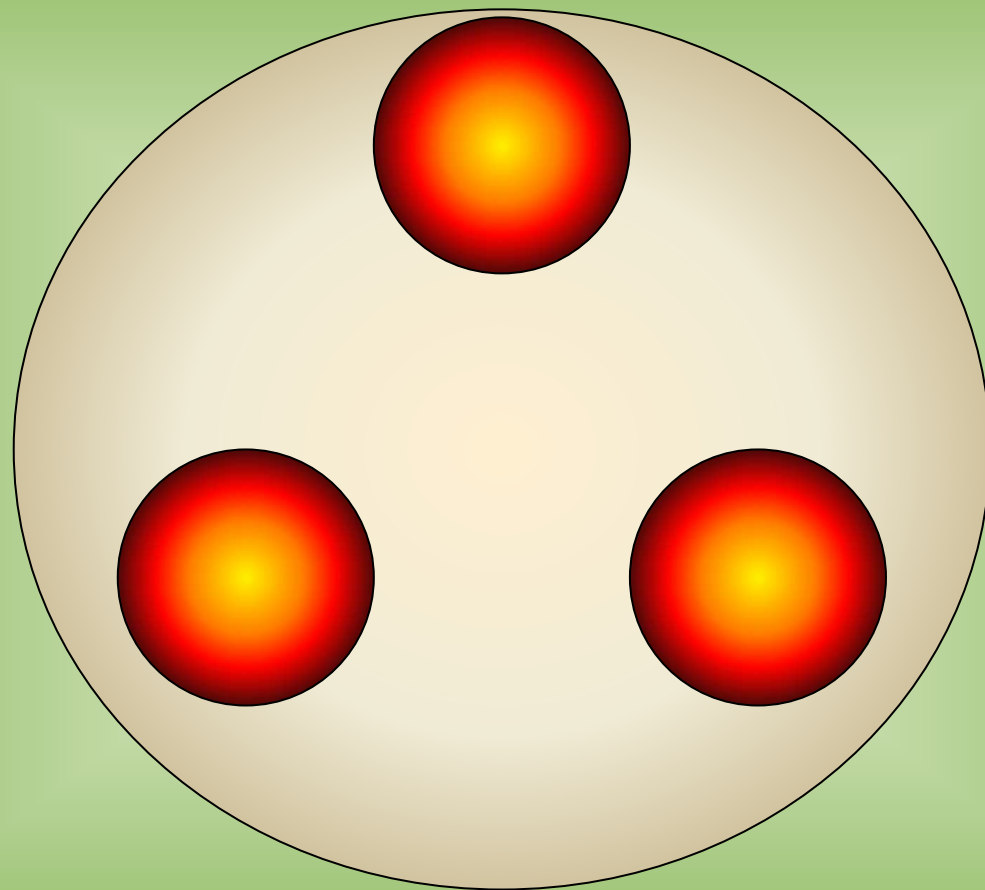


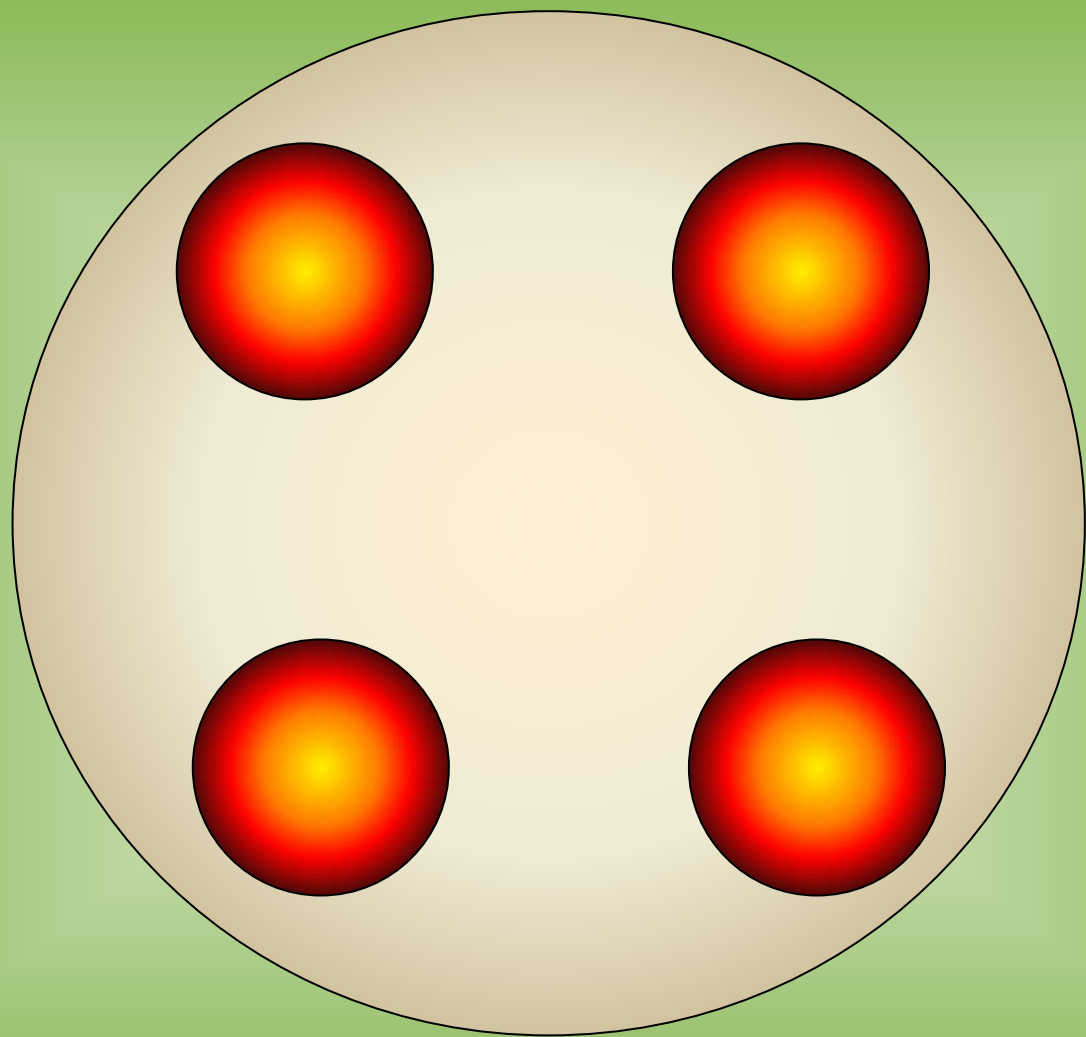
Genesis Wave

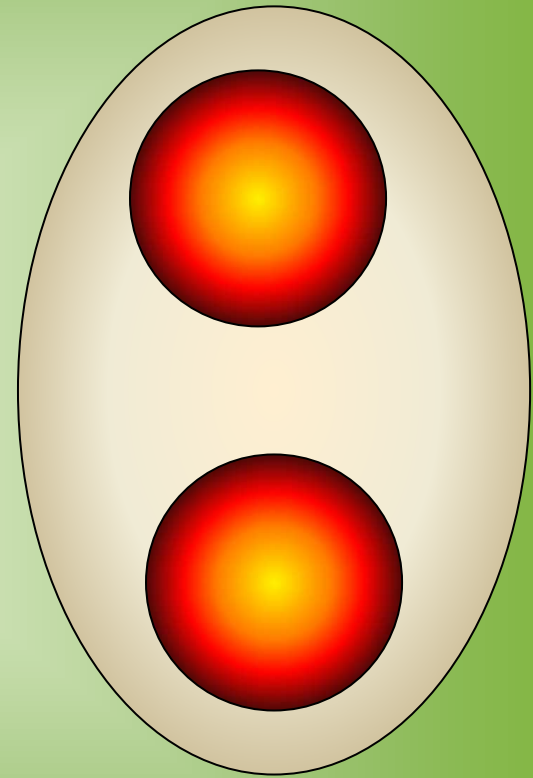
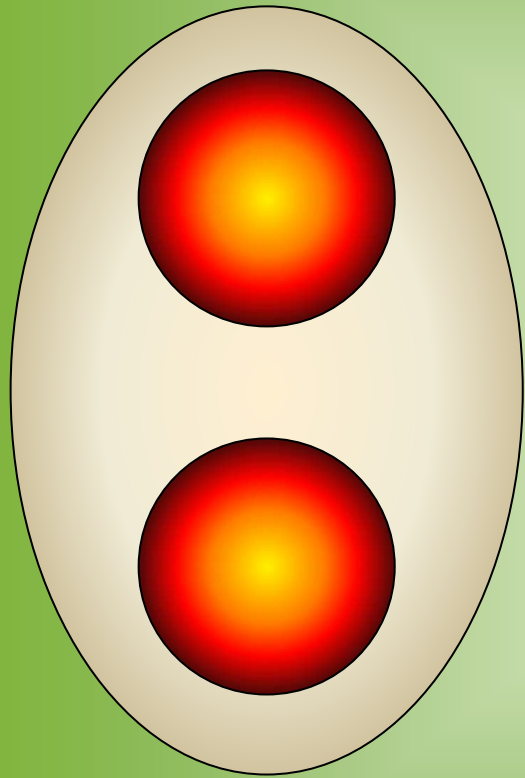
Cellular Growth

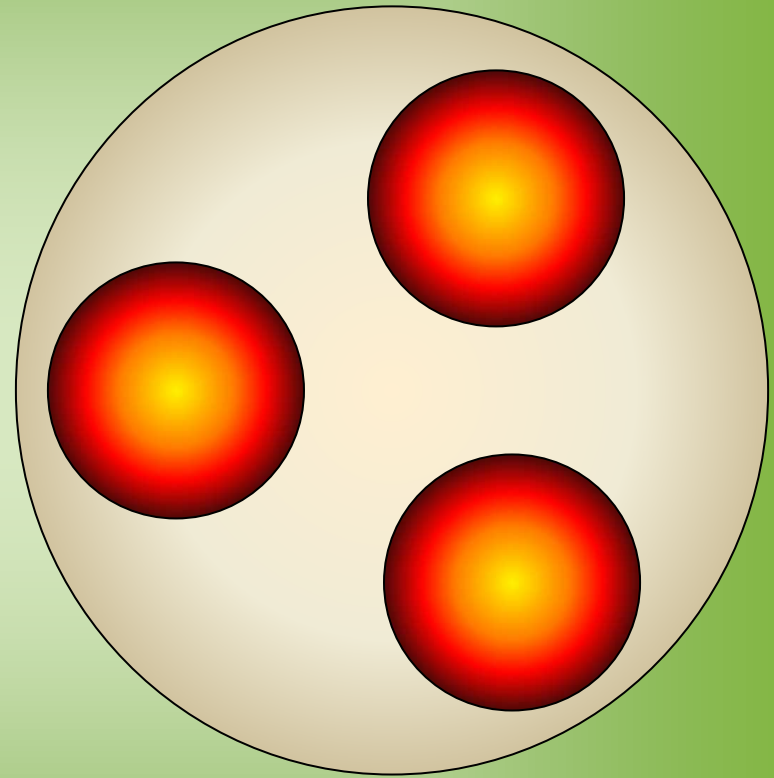
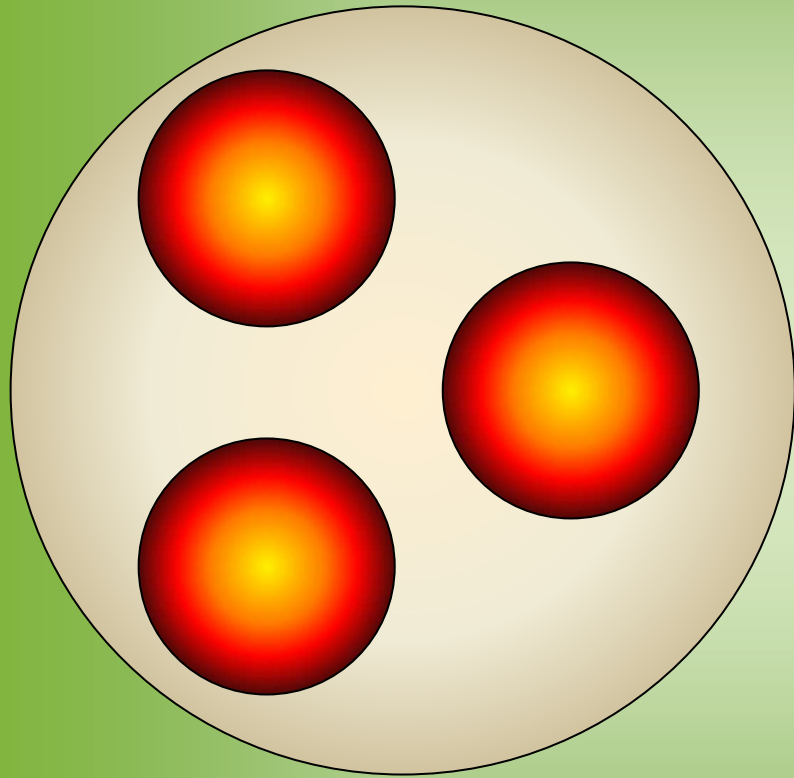


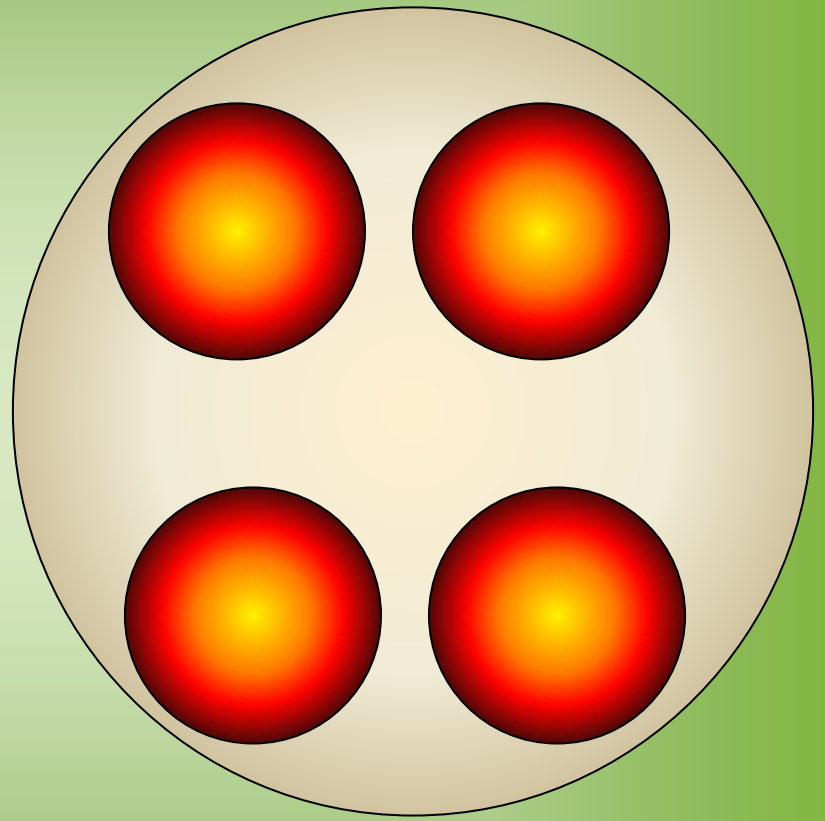
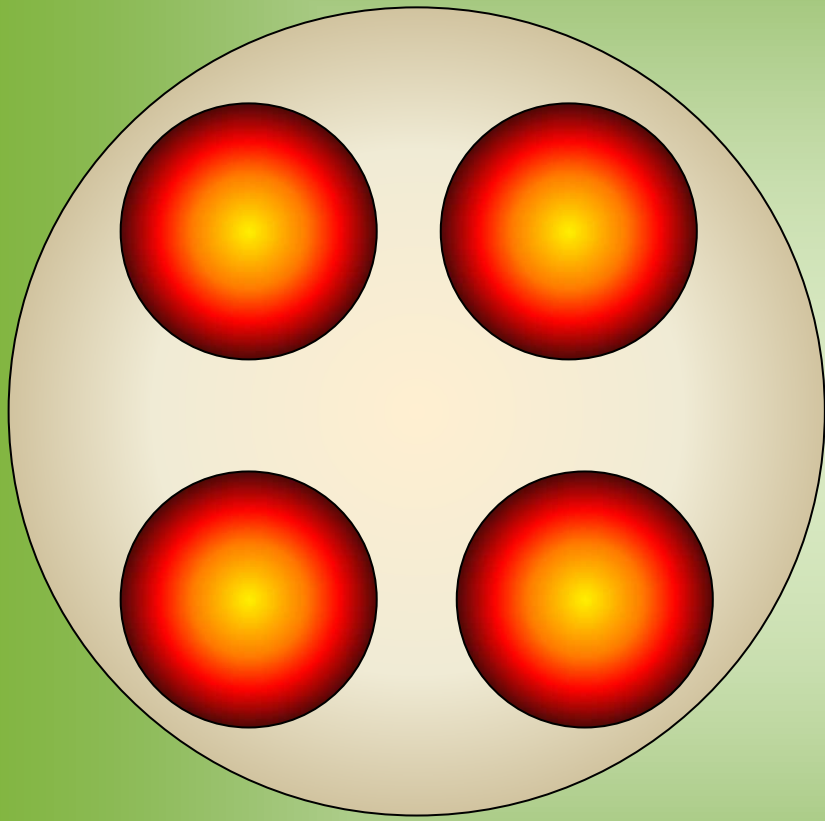


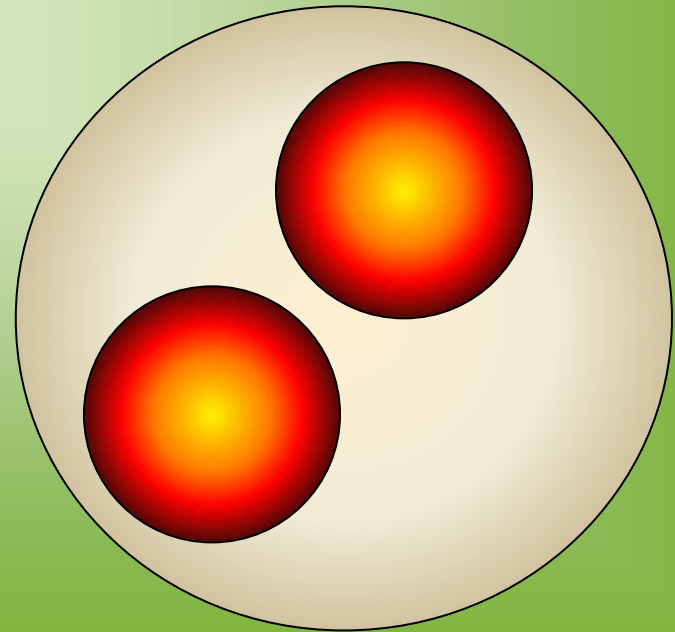
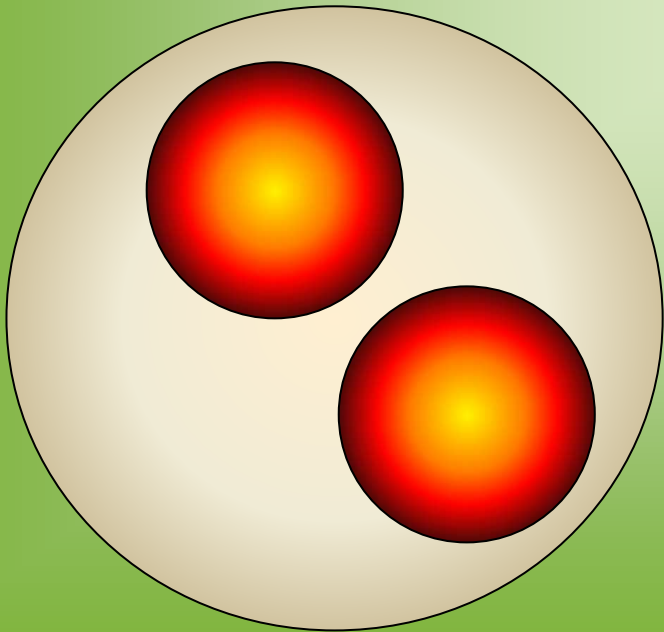
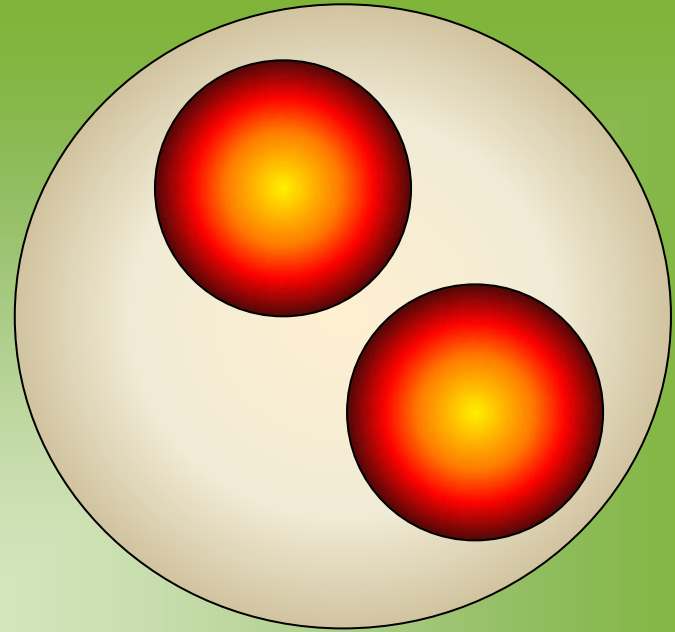
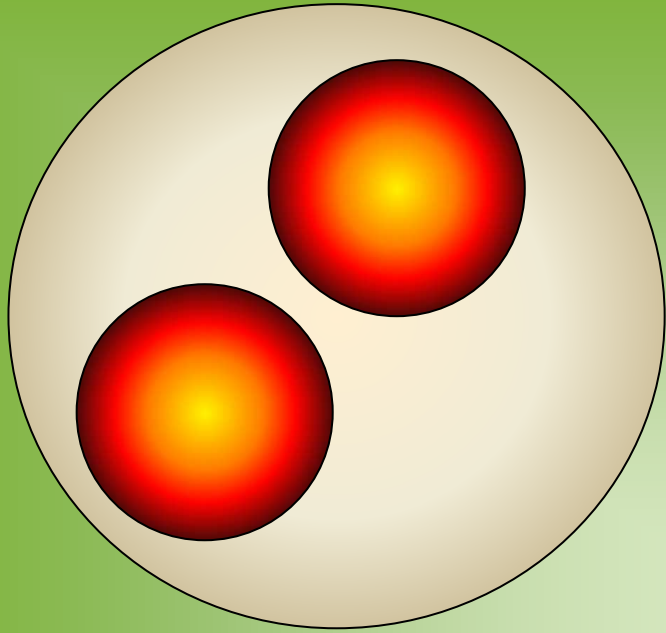


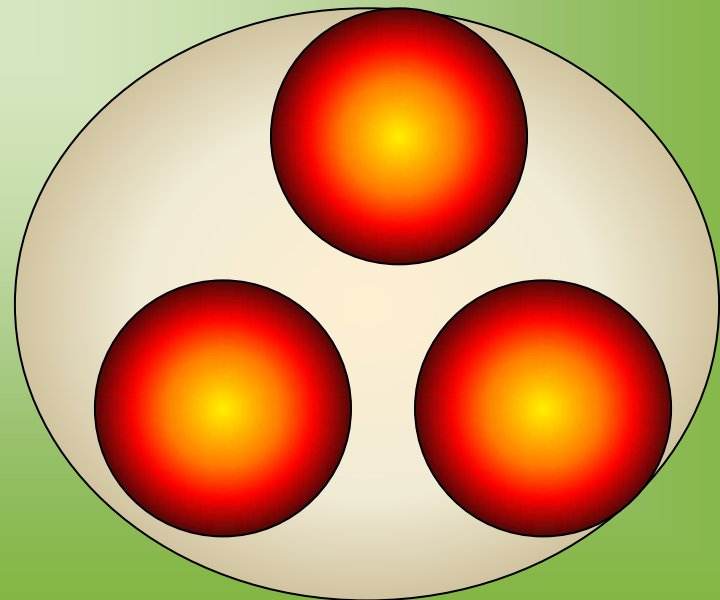
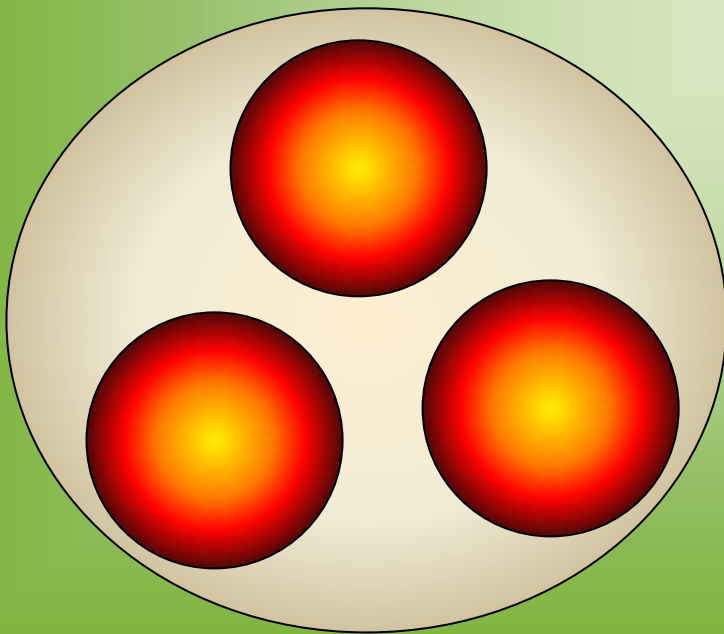
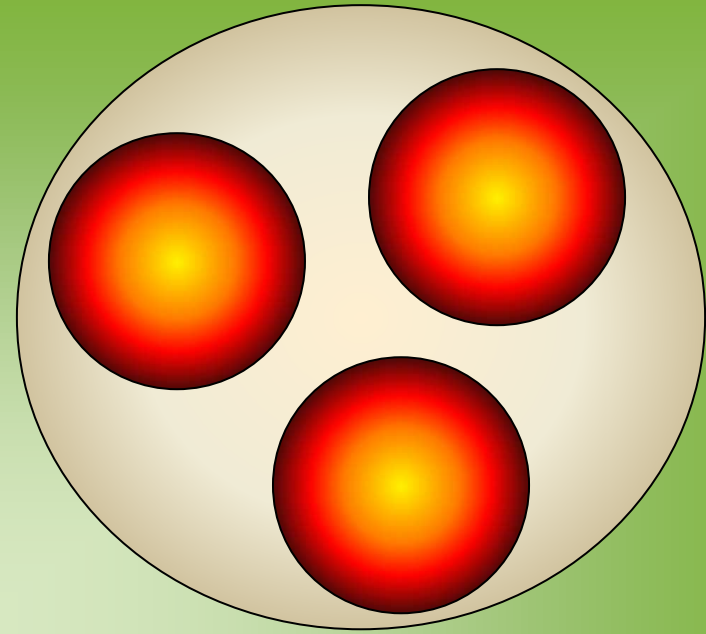
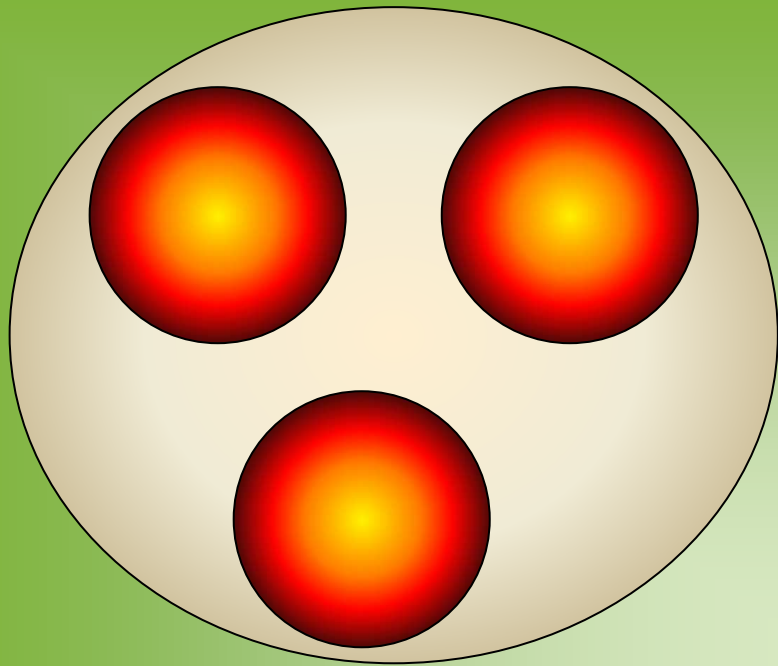


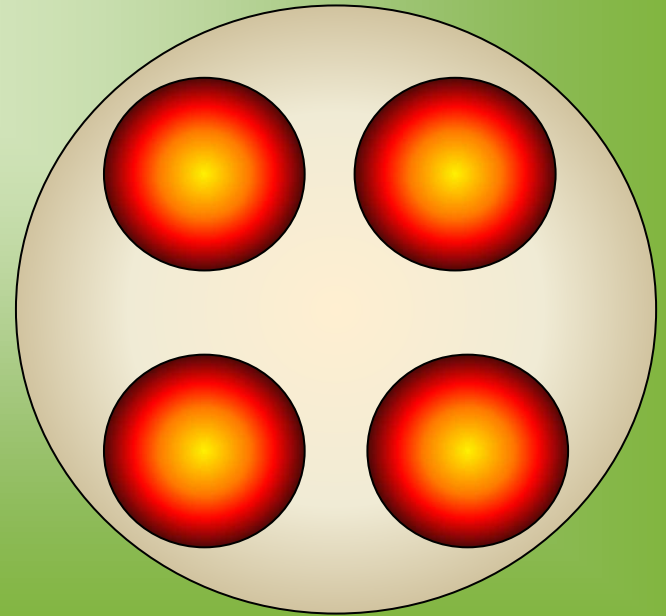
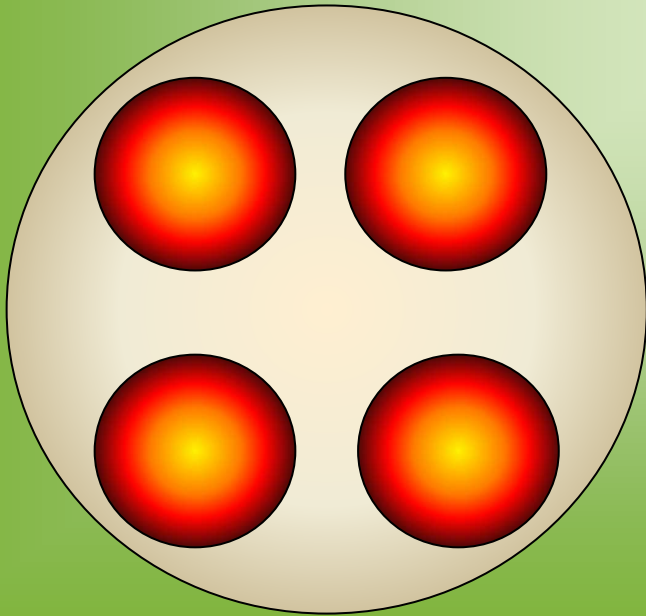
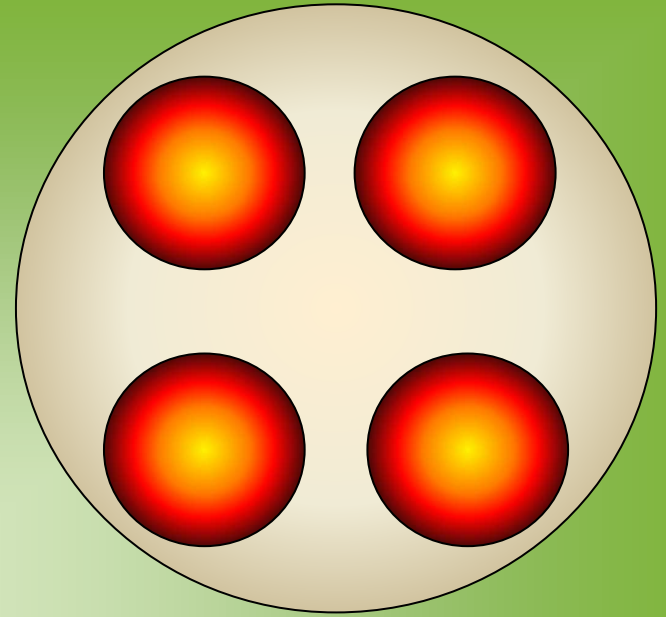
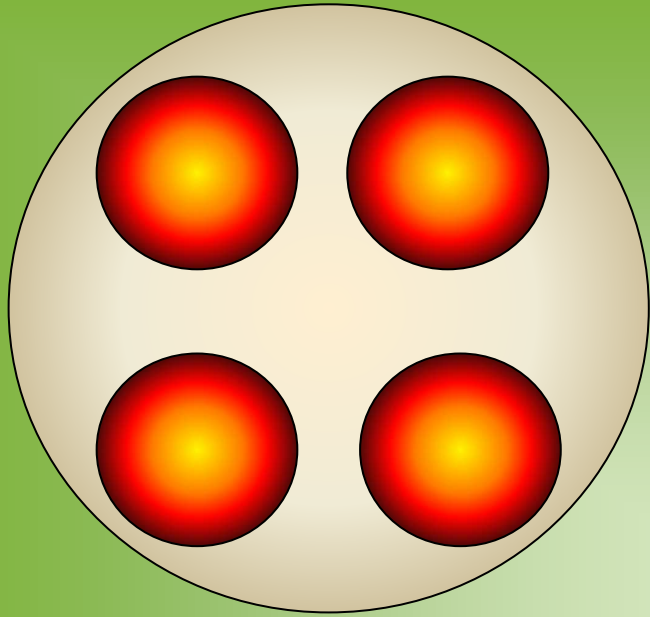


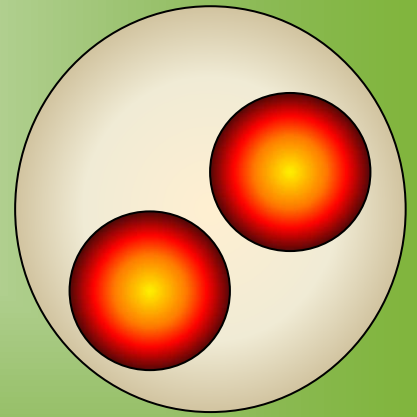
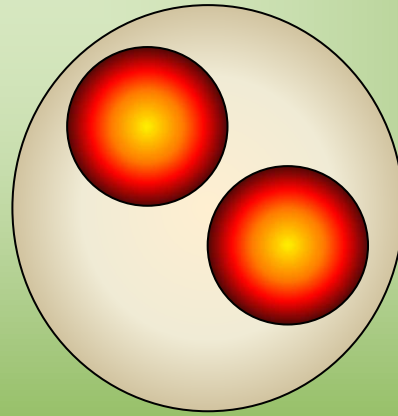
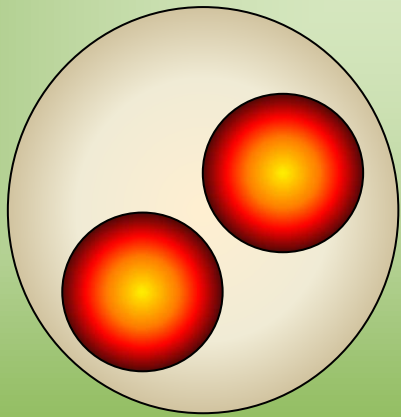
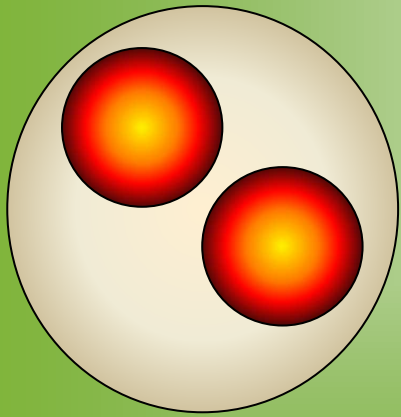
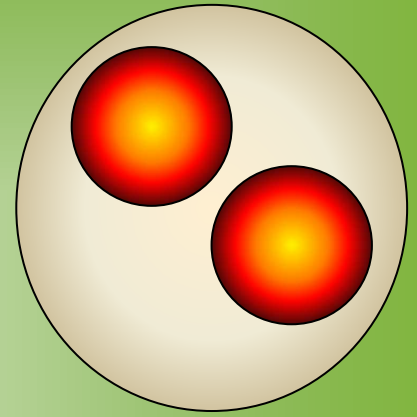
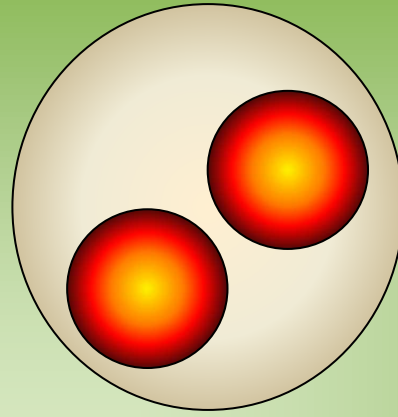
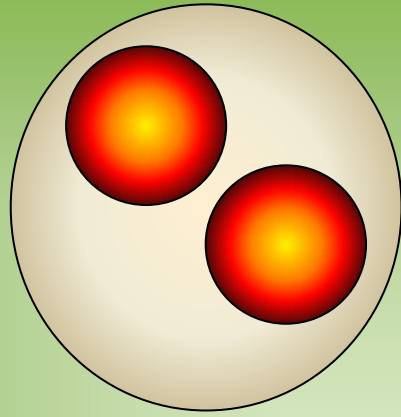
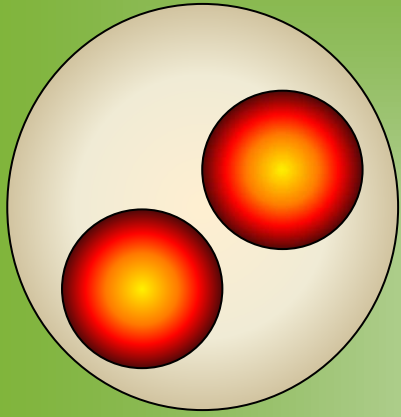


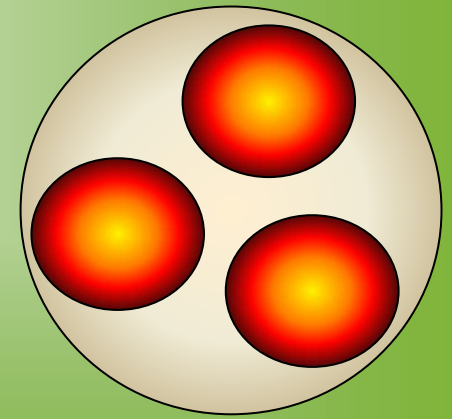
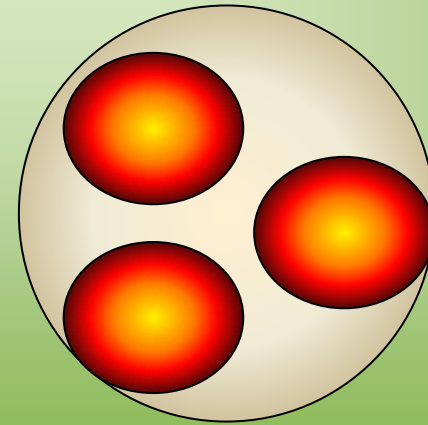
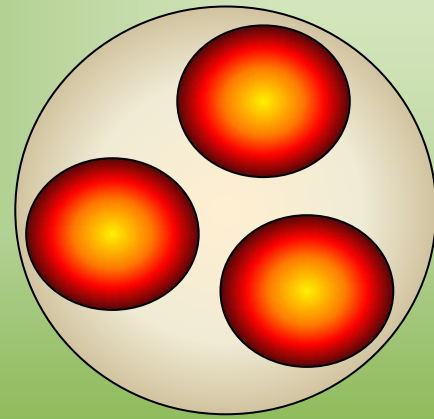
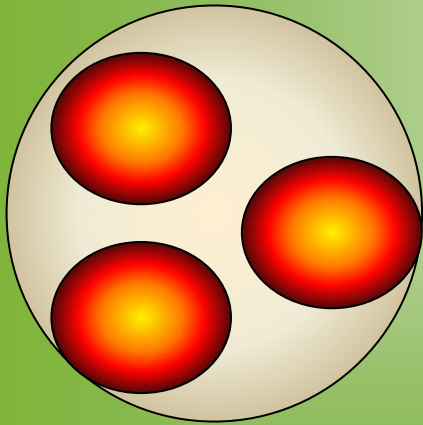
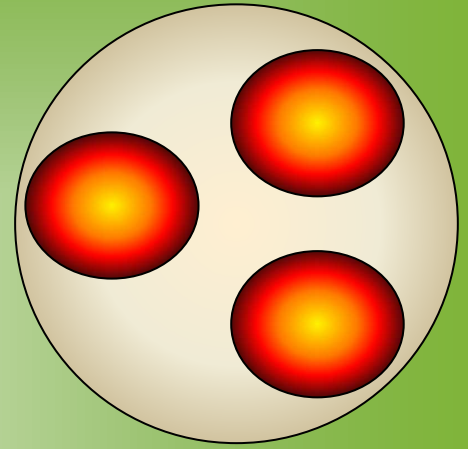
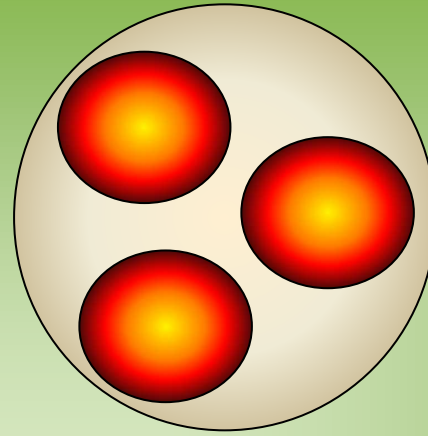
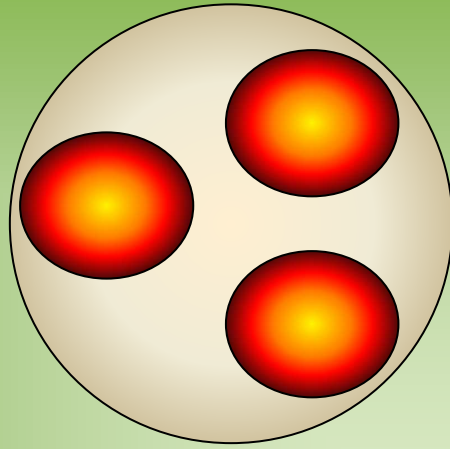
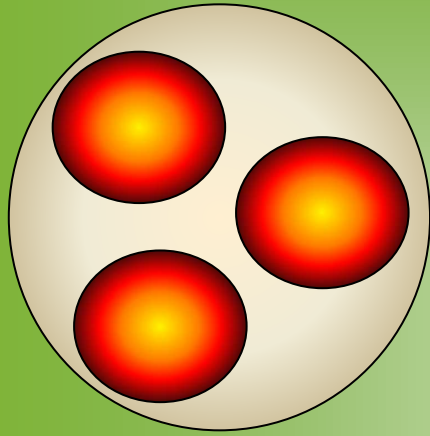


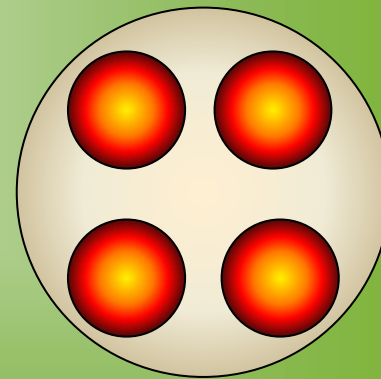
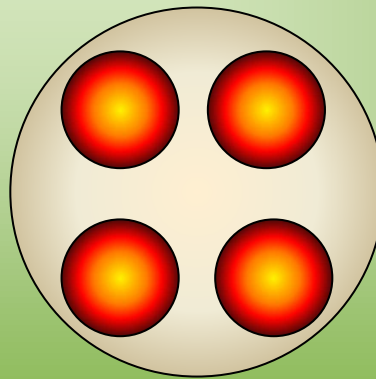
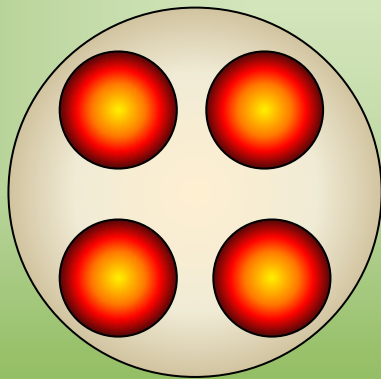
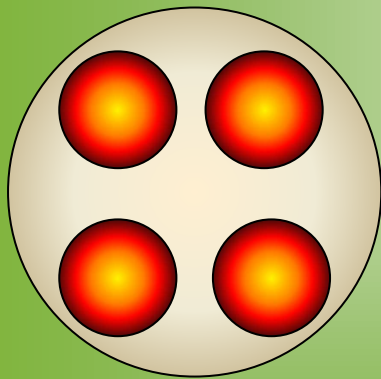
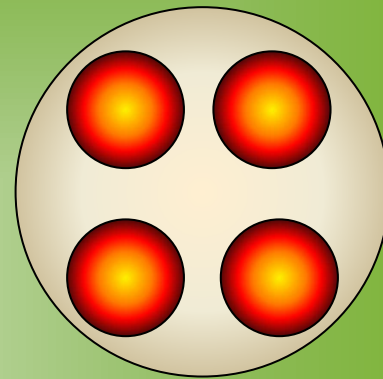
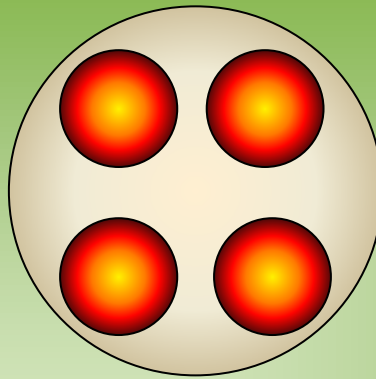
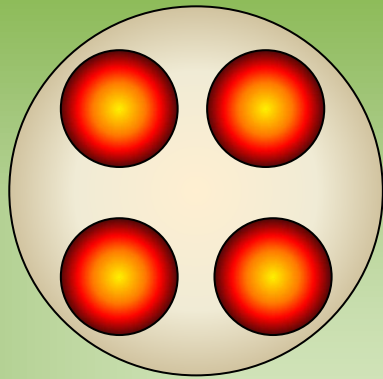
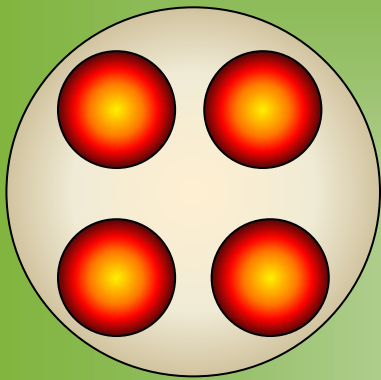


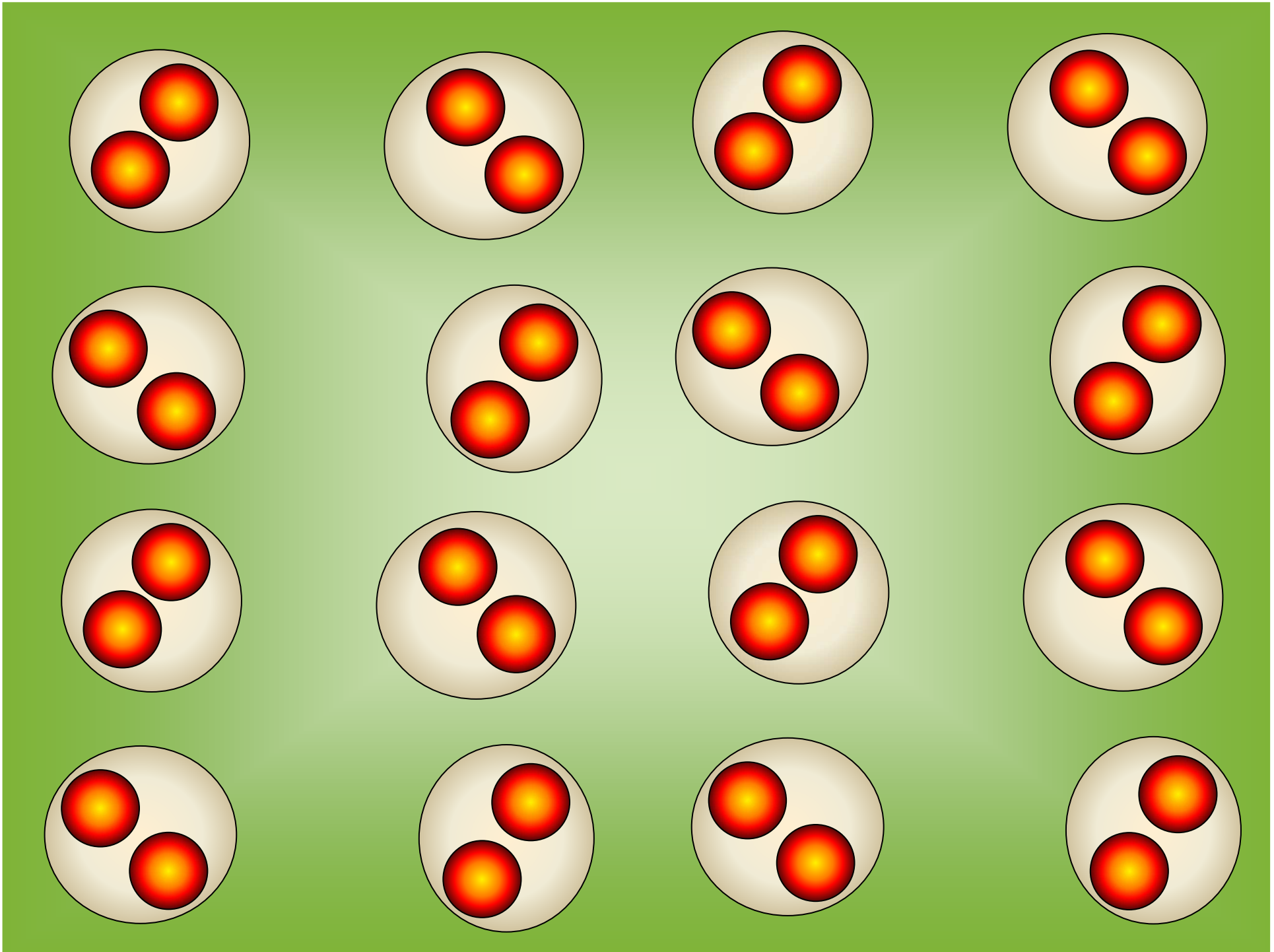


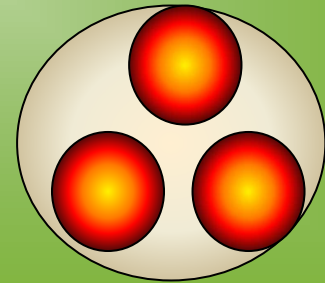
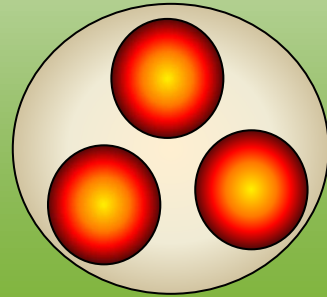
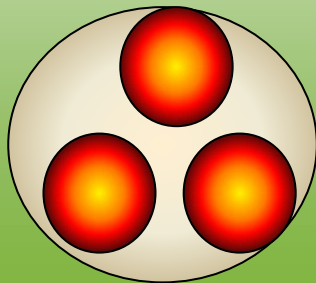
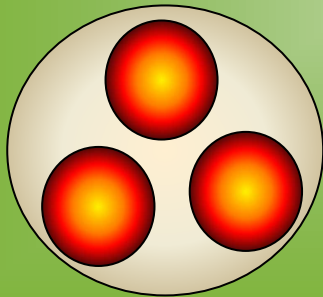
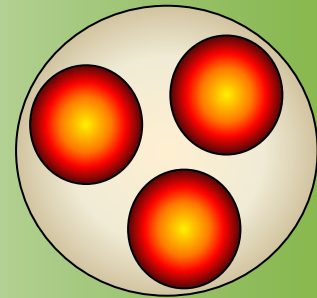
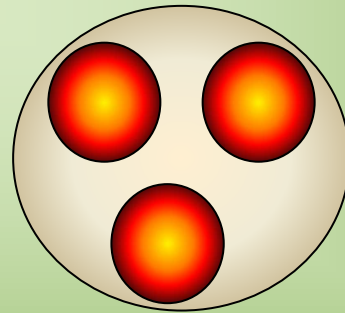
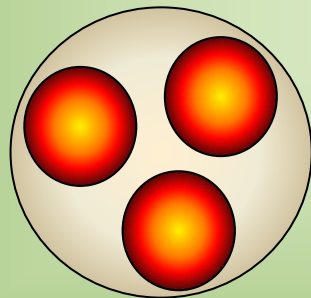
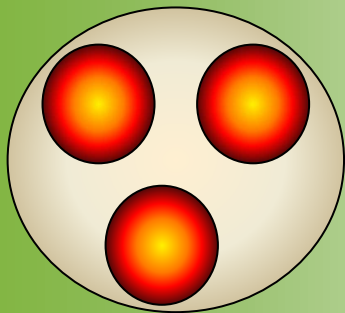
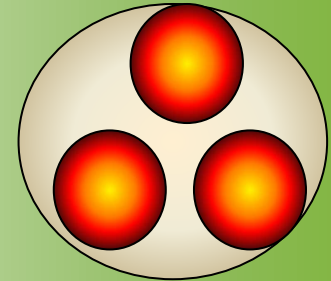
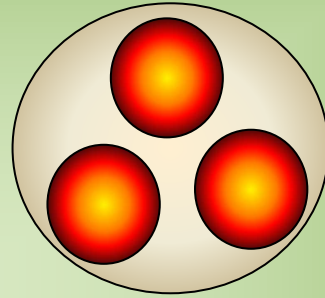
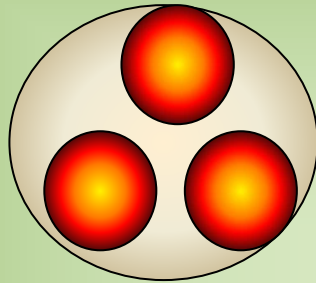
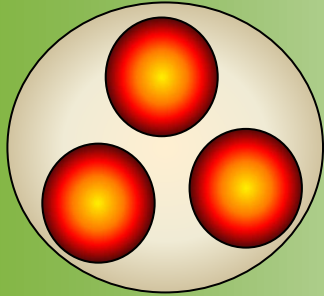
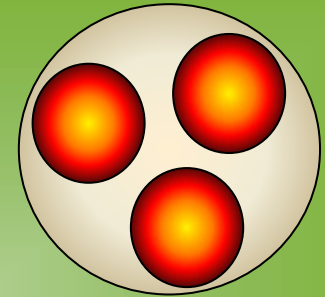
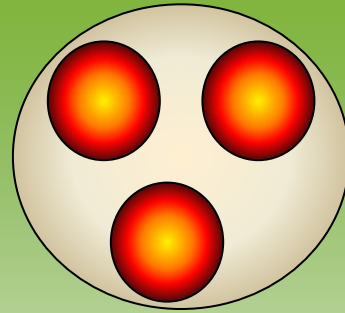
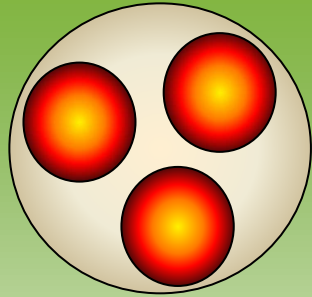
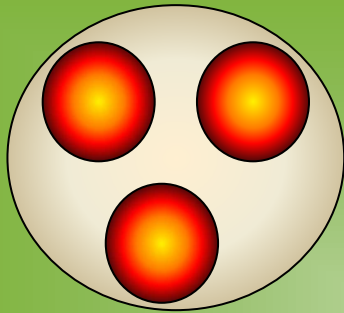


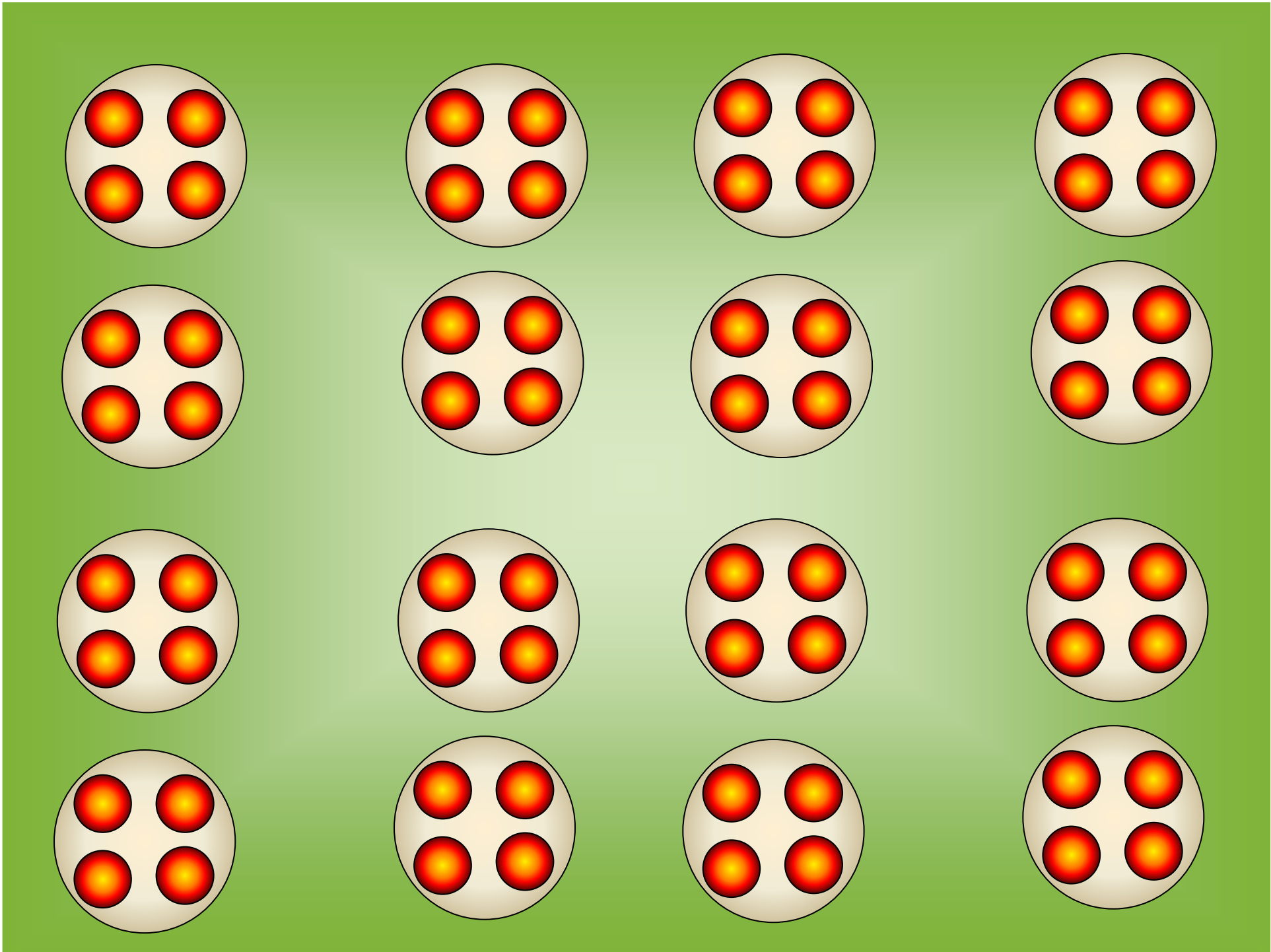


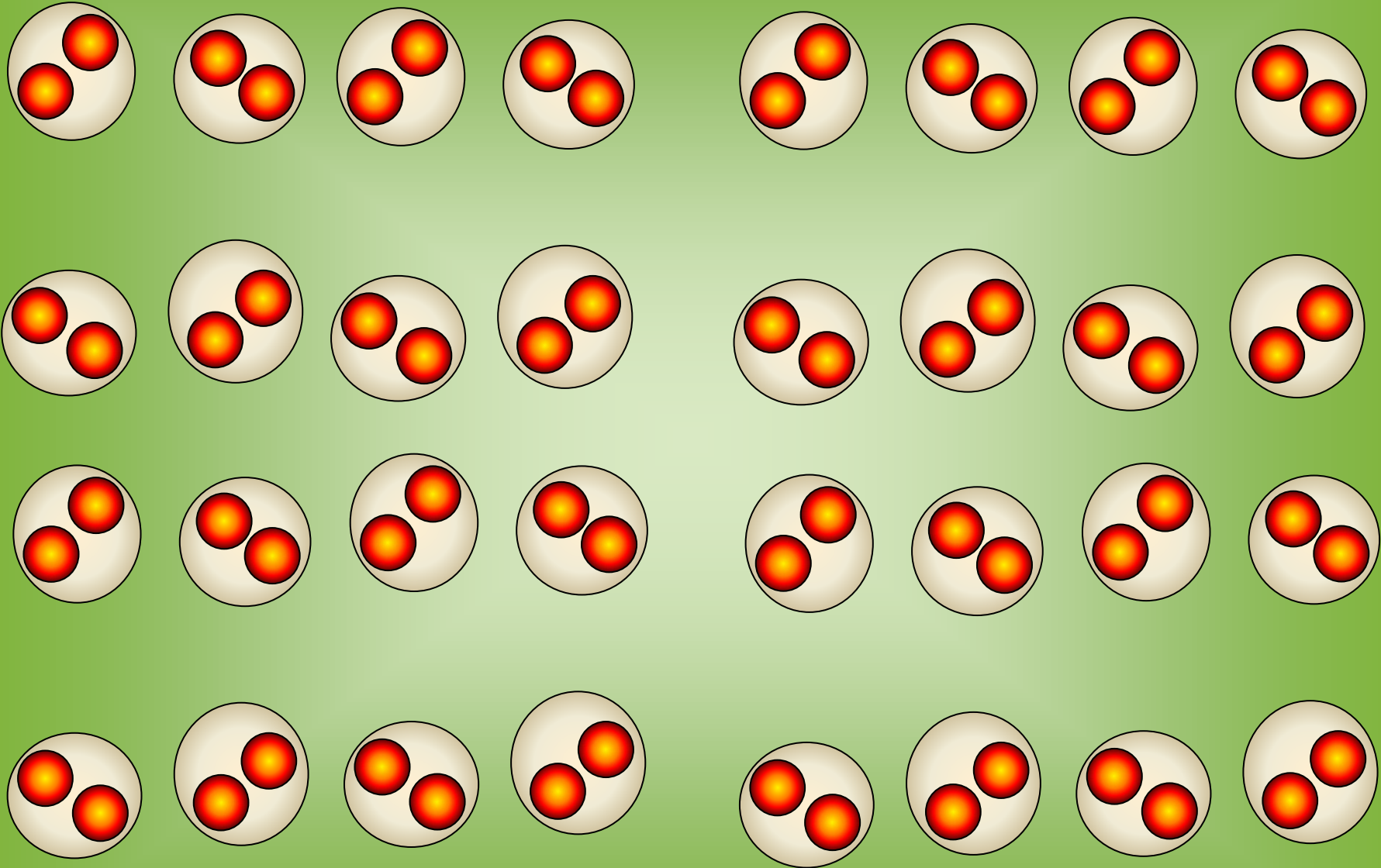


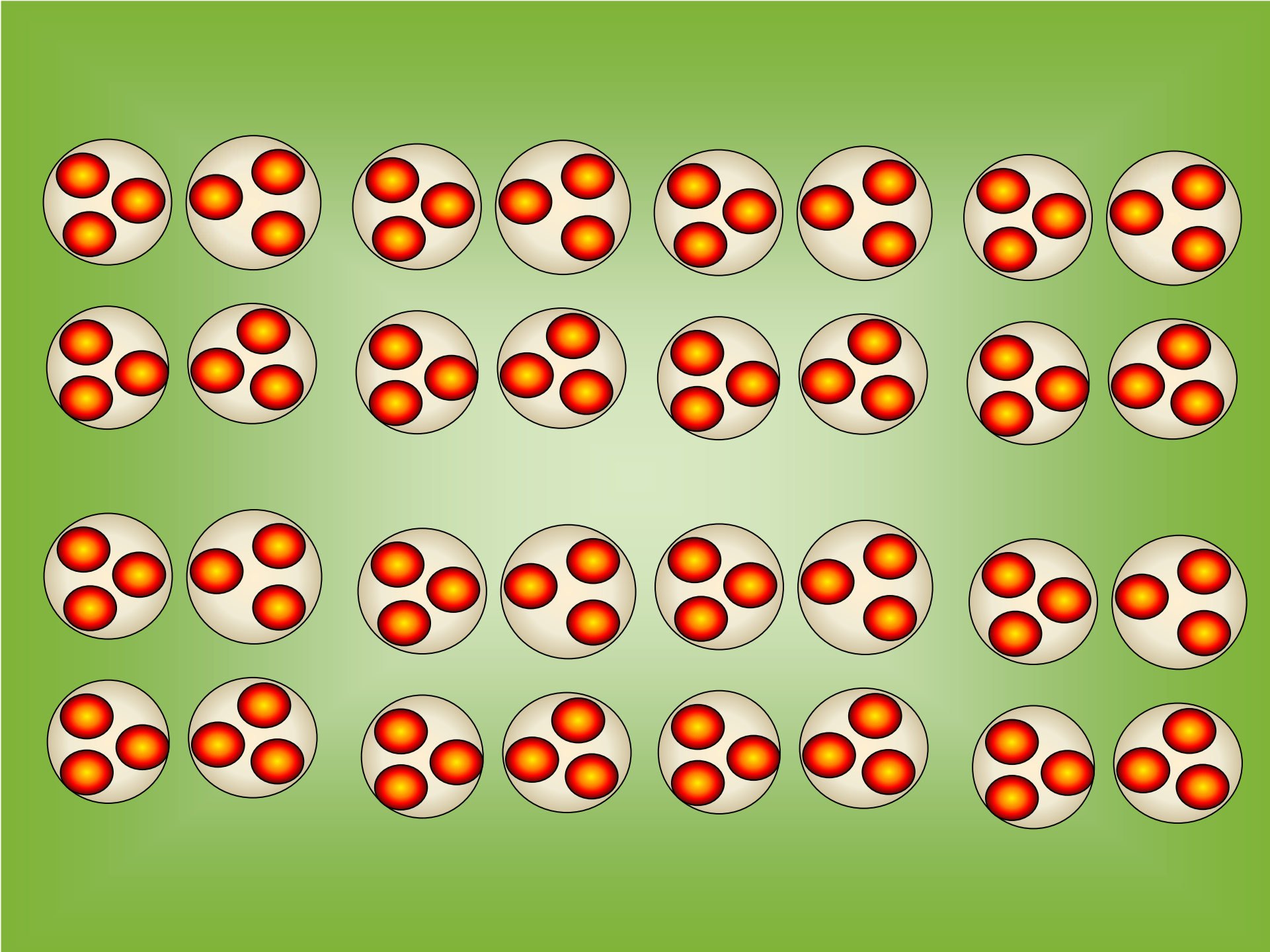


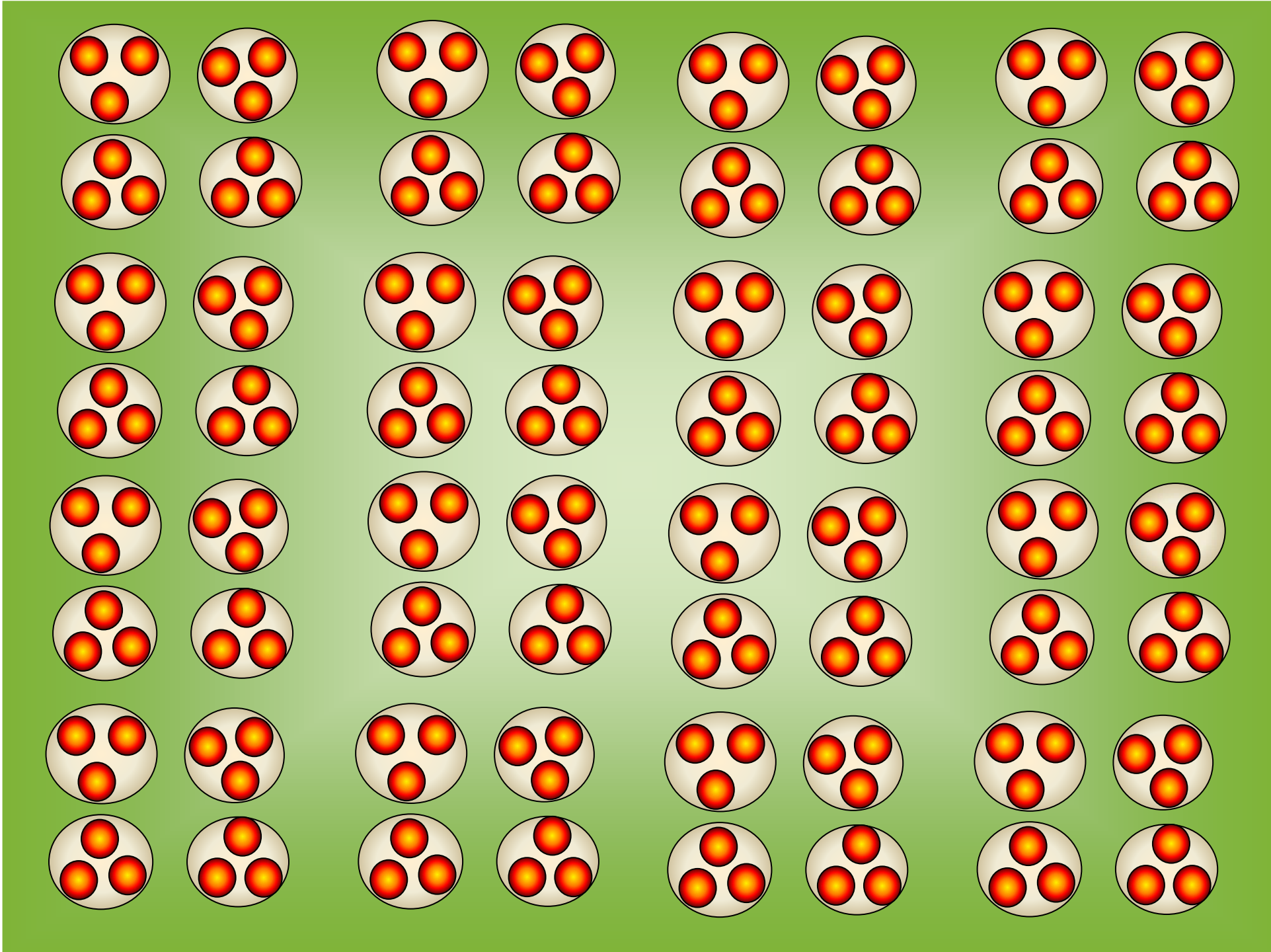


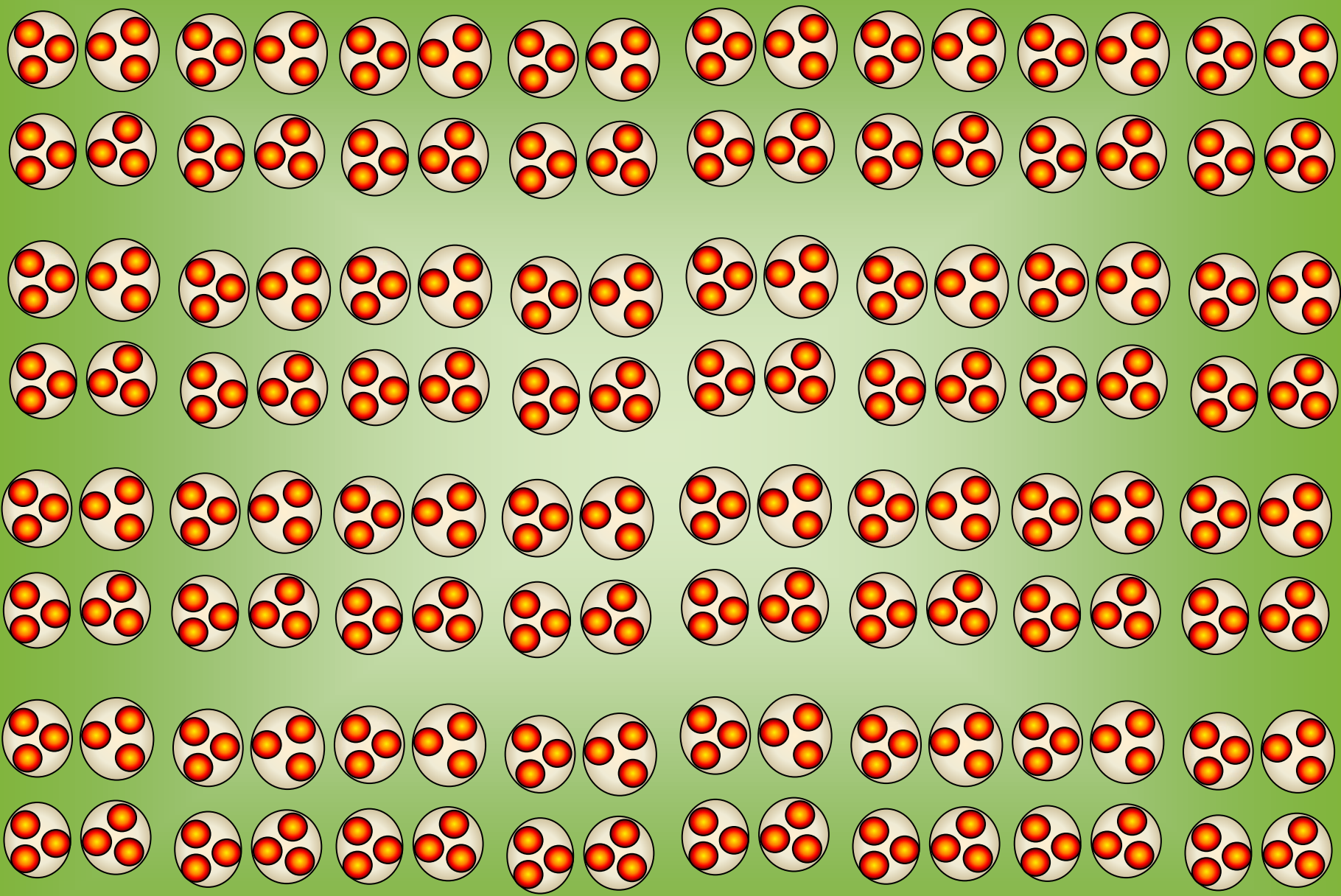


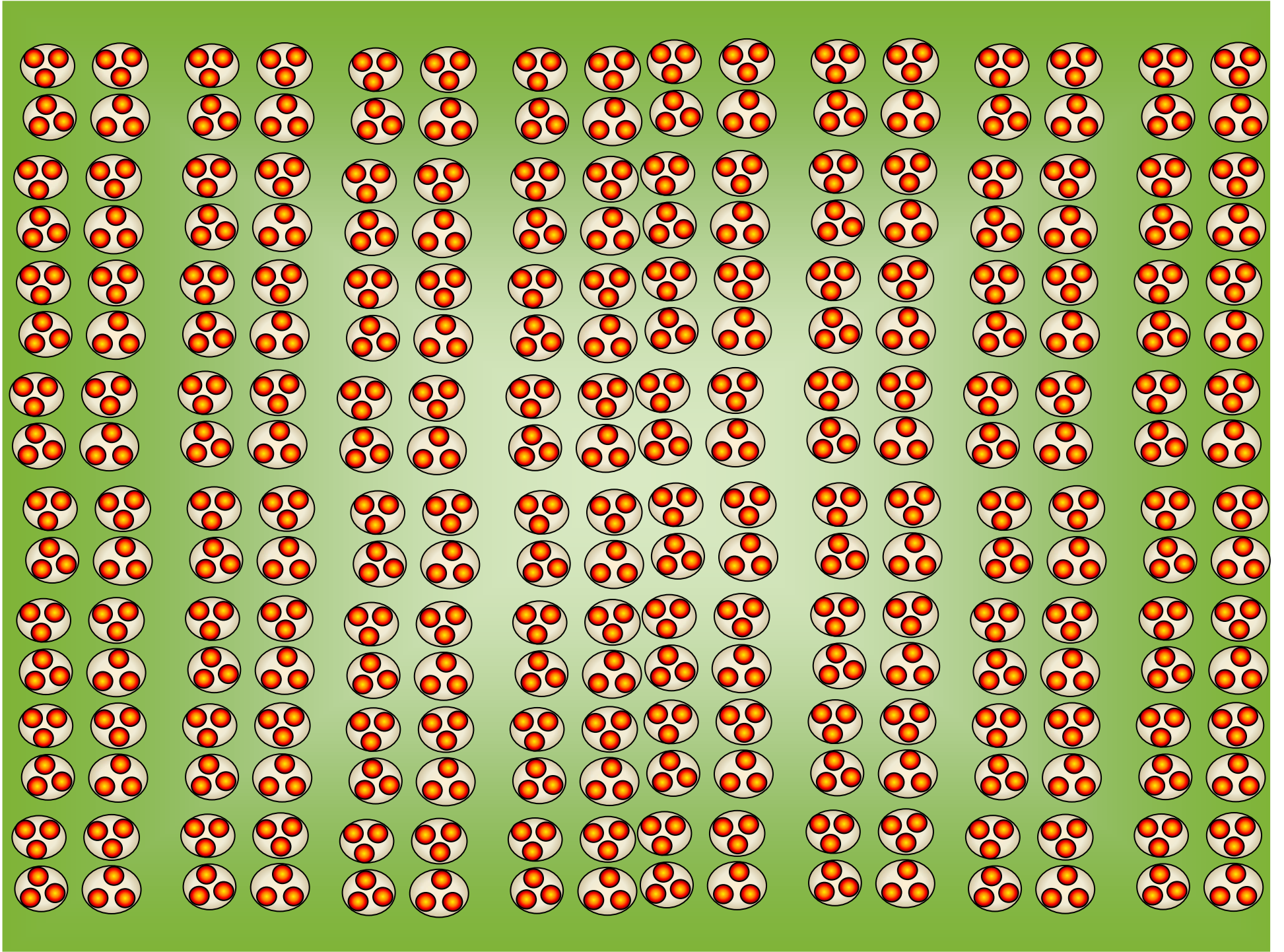


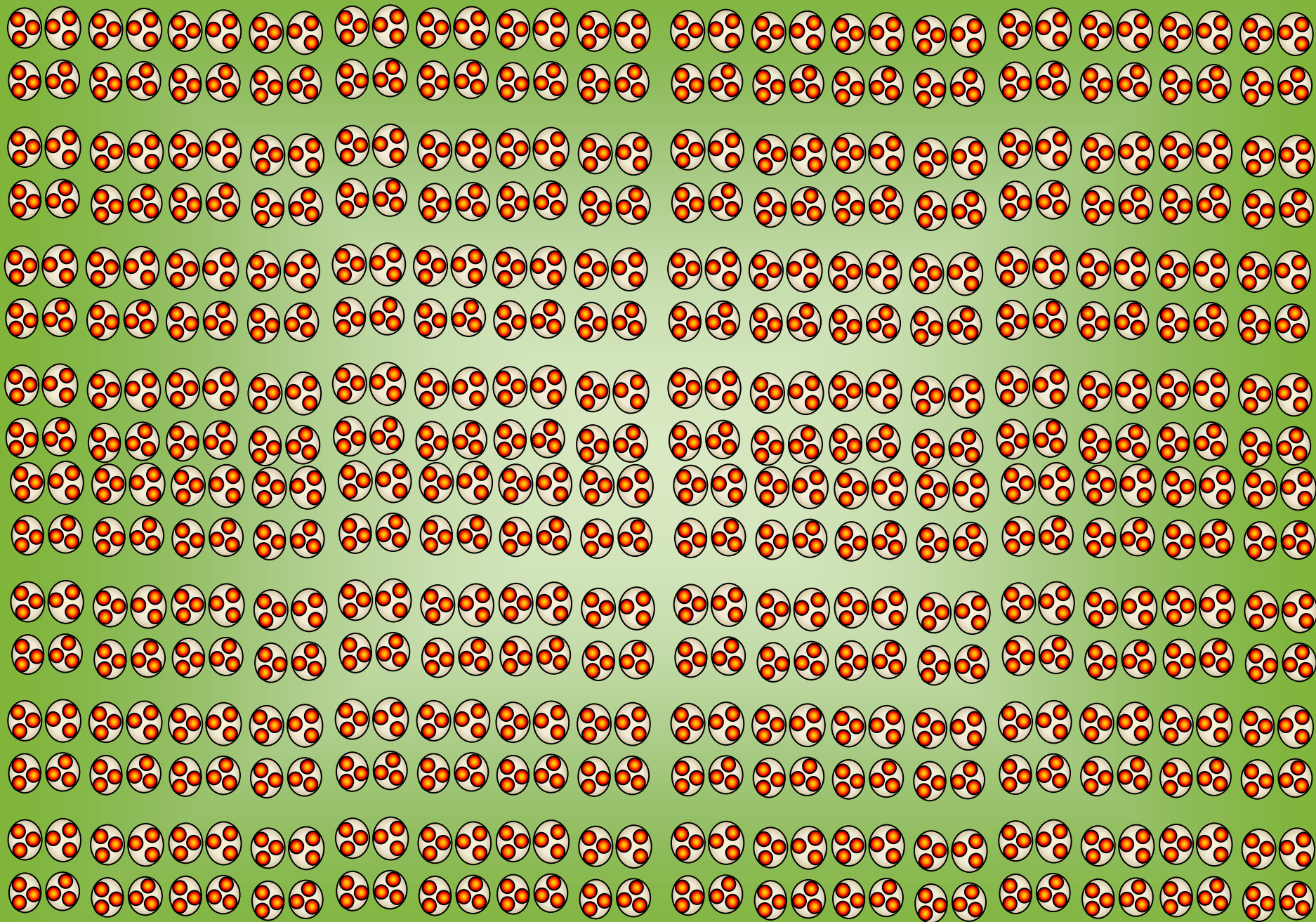












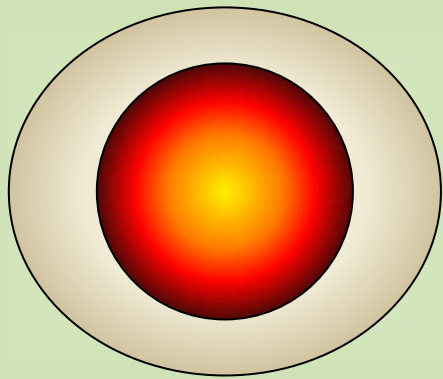


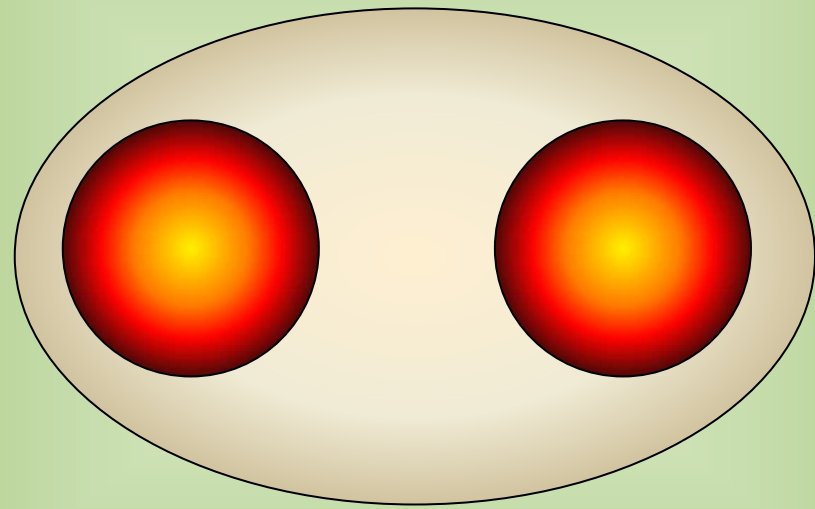
Cellular Growth and Replication

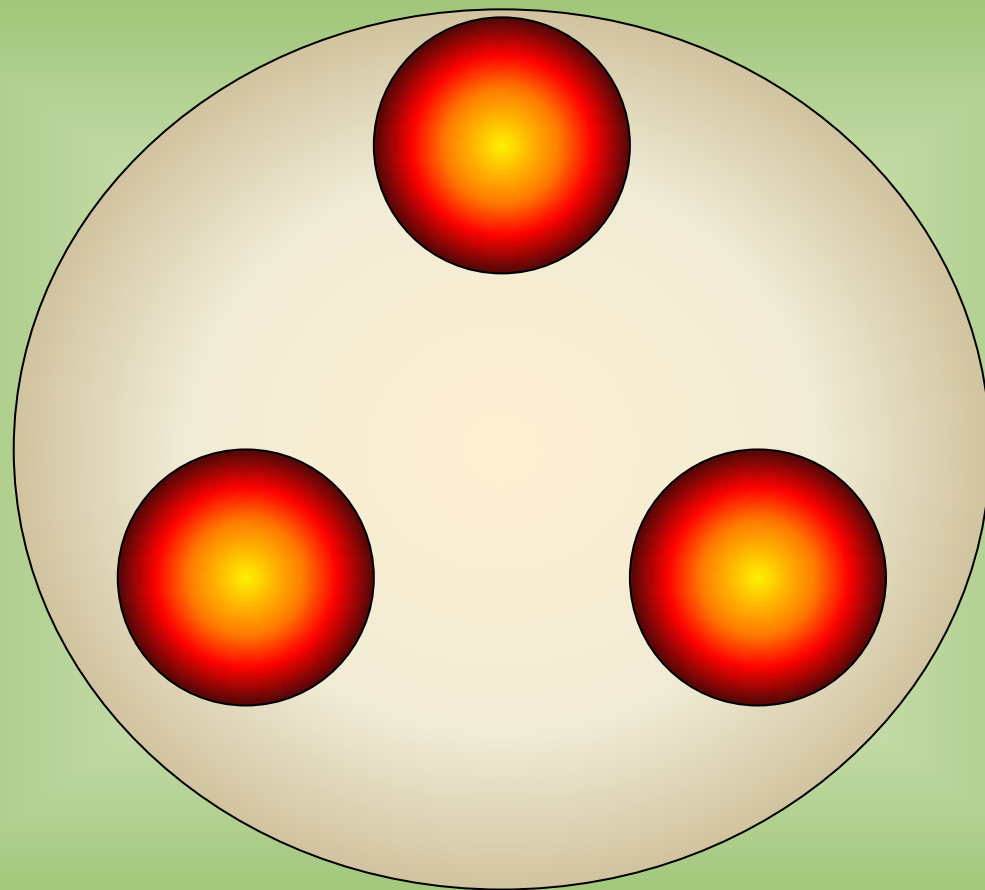
By: (A) New Start (B) Budding (C) Pairing

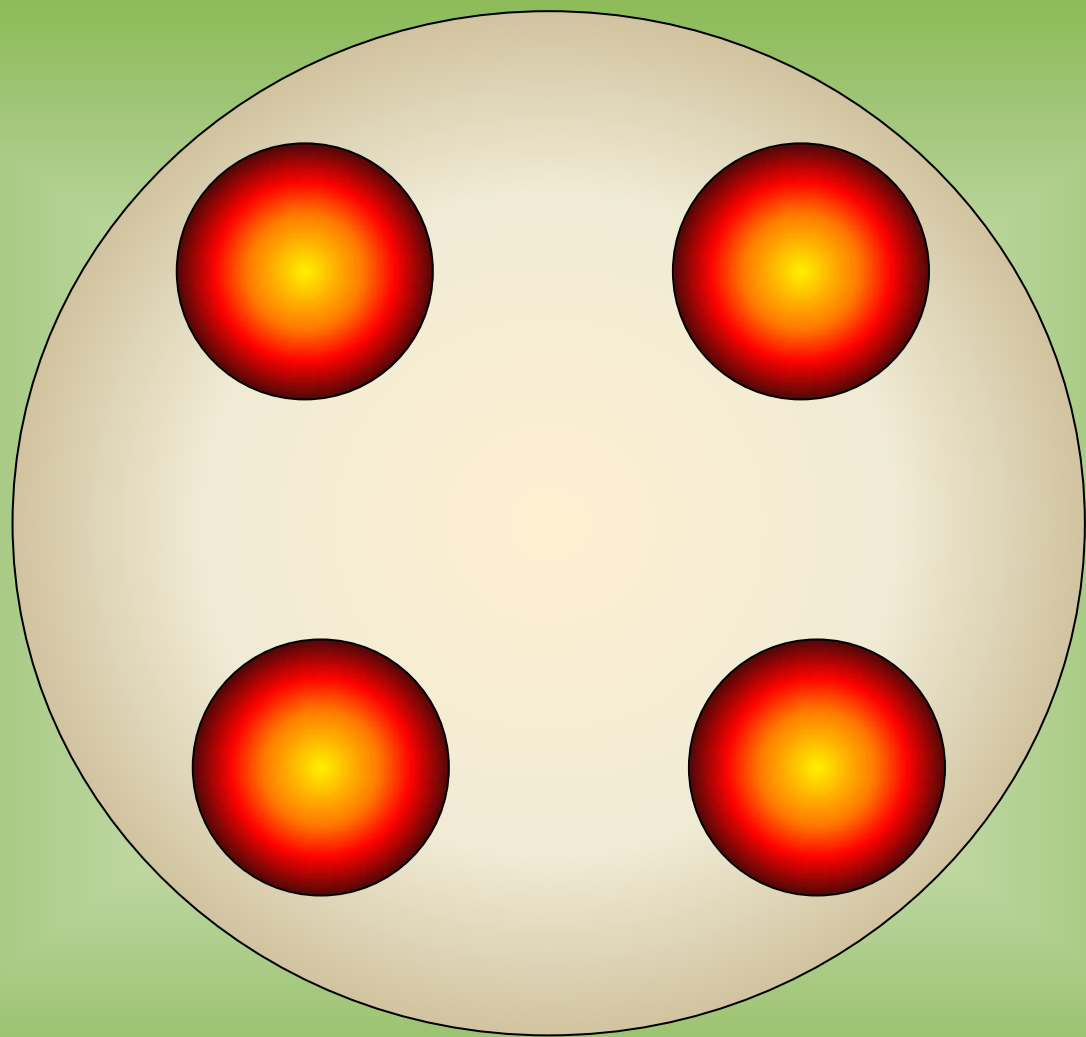
Cellular Growth and Replication

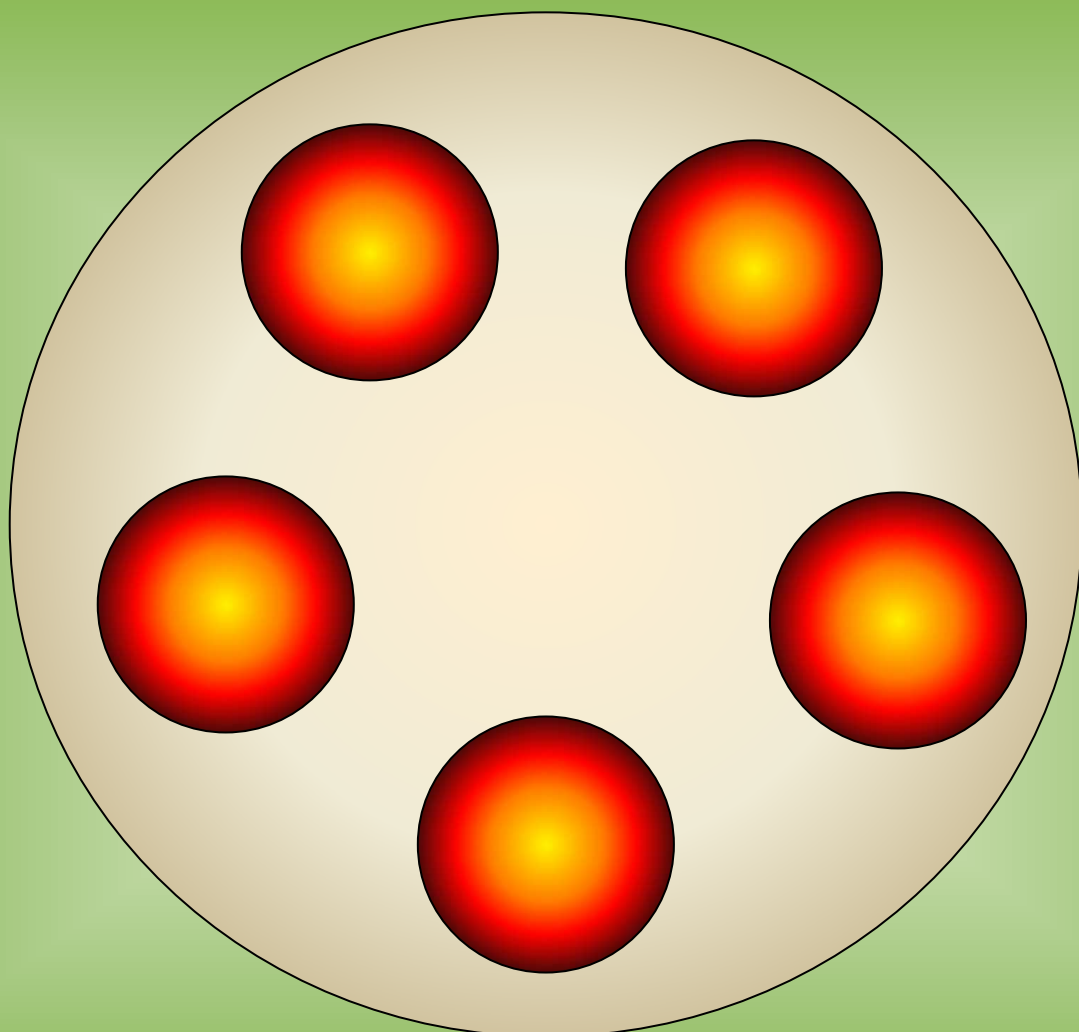
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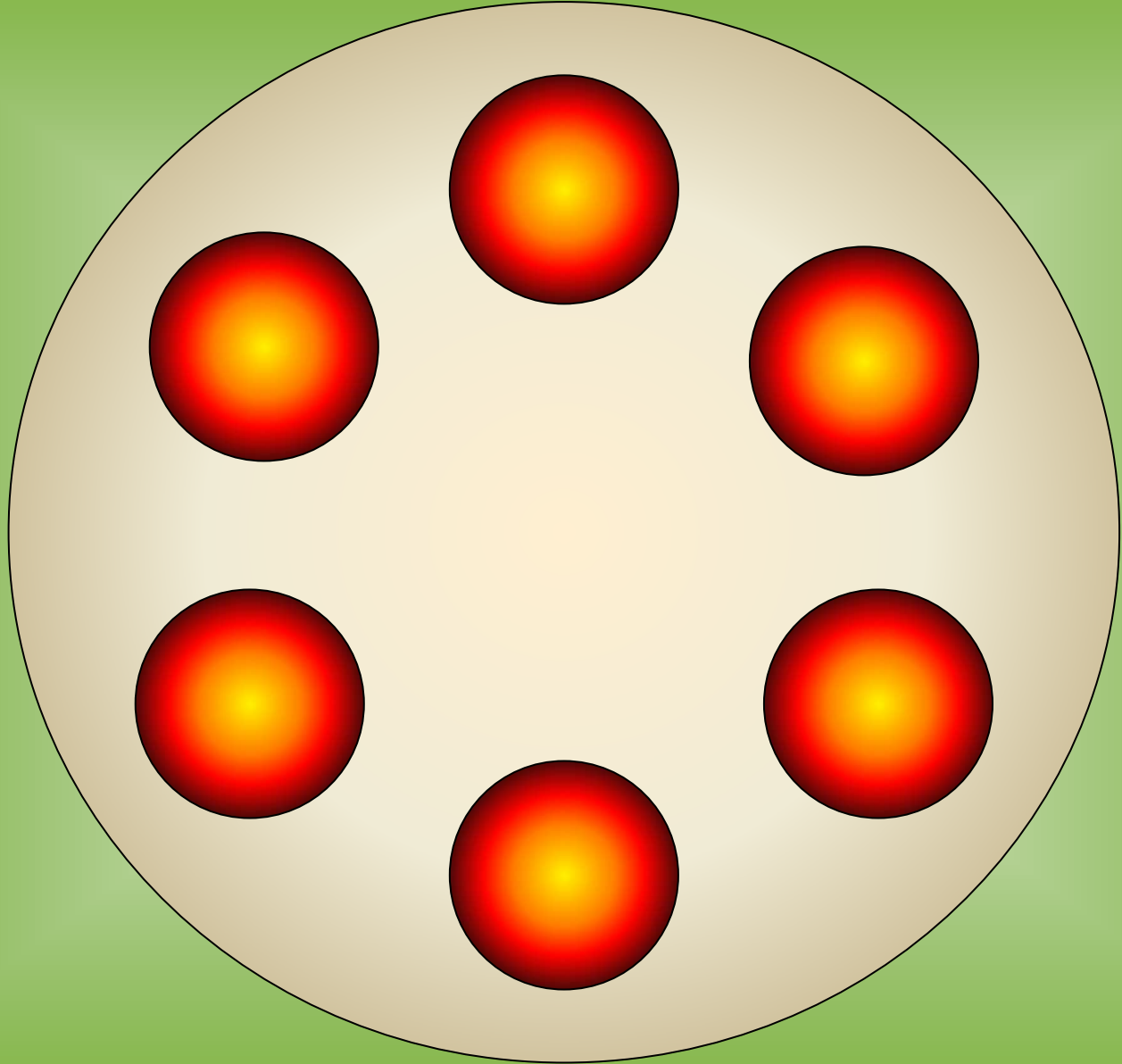


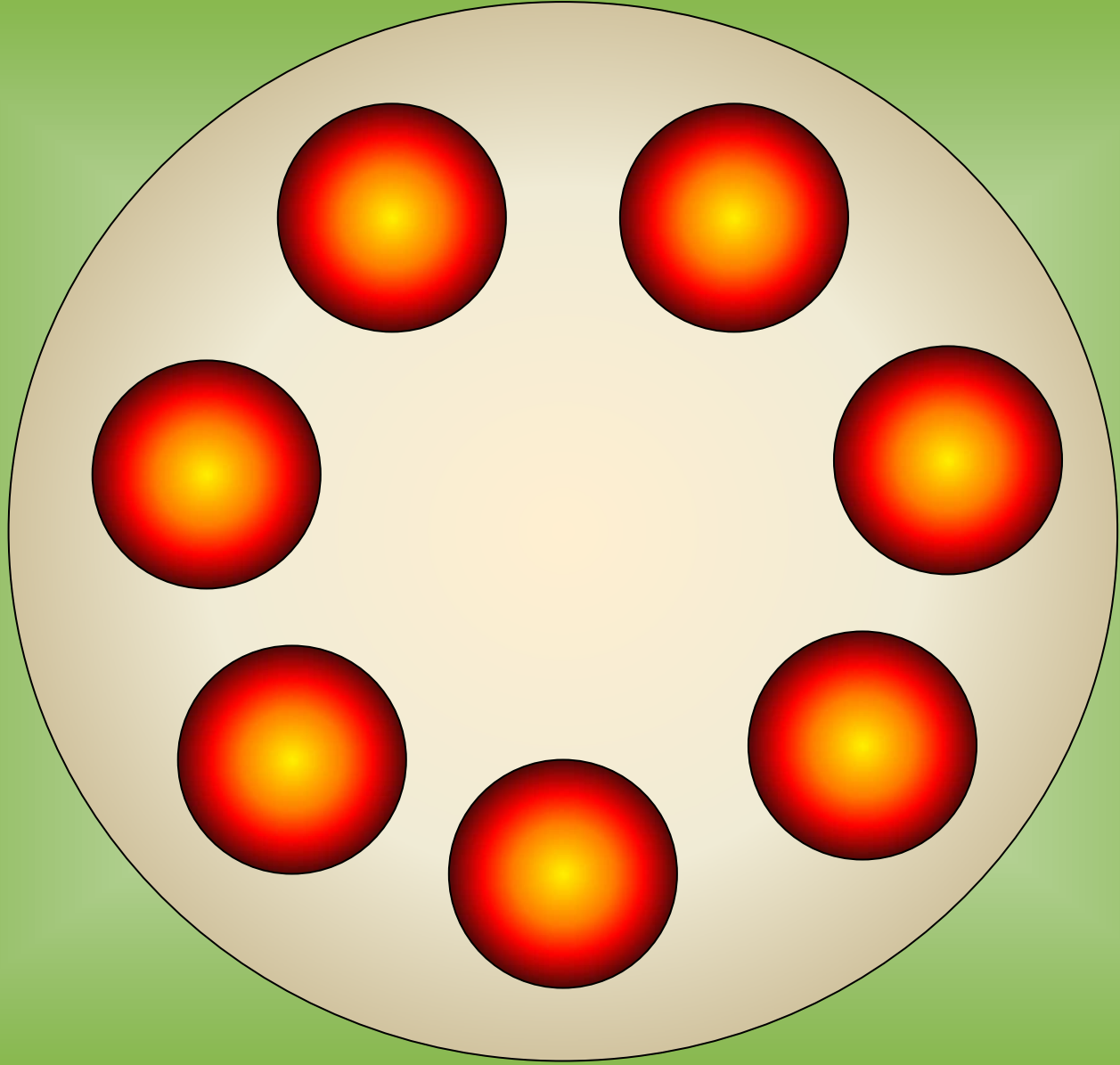


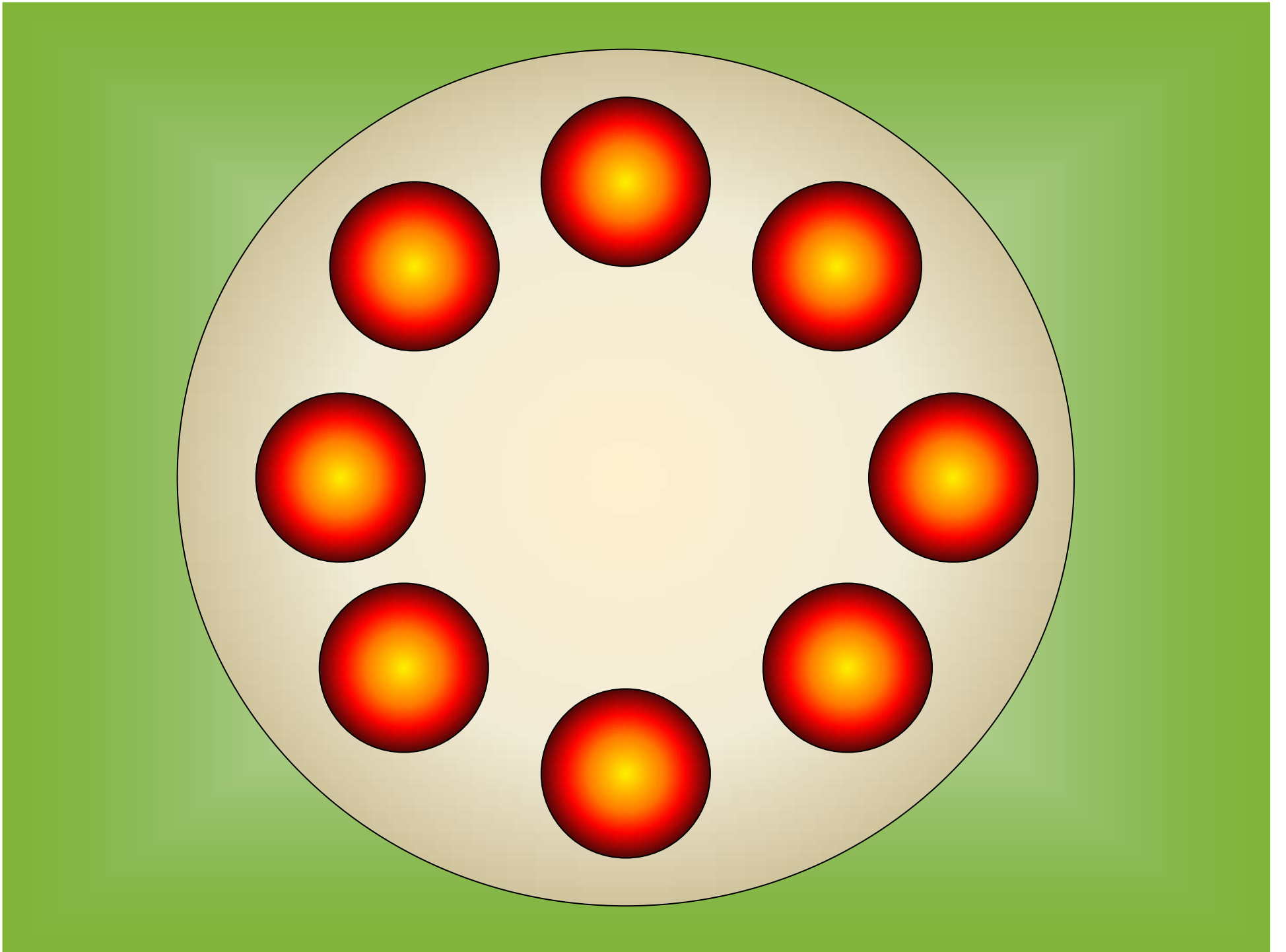


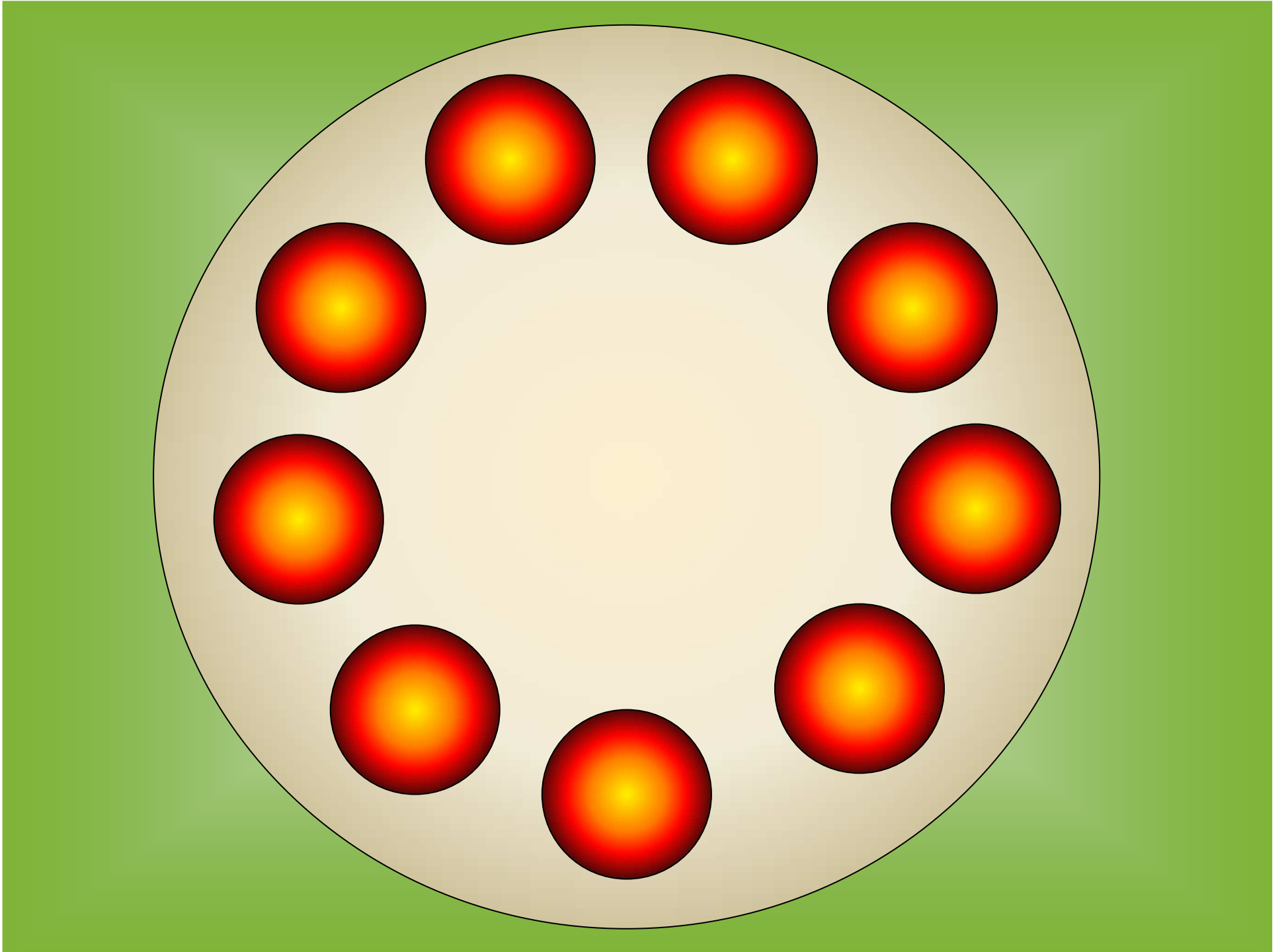






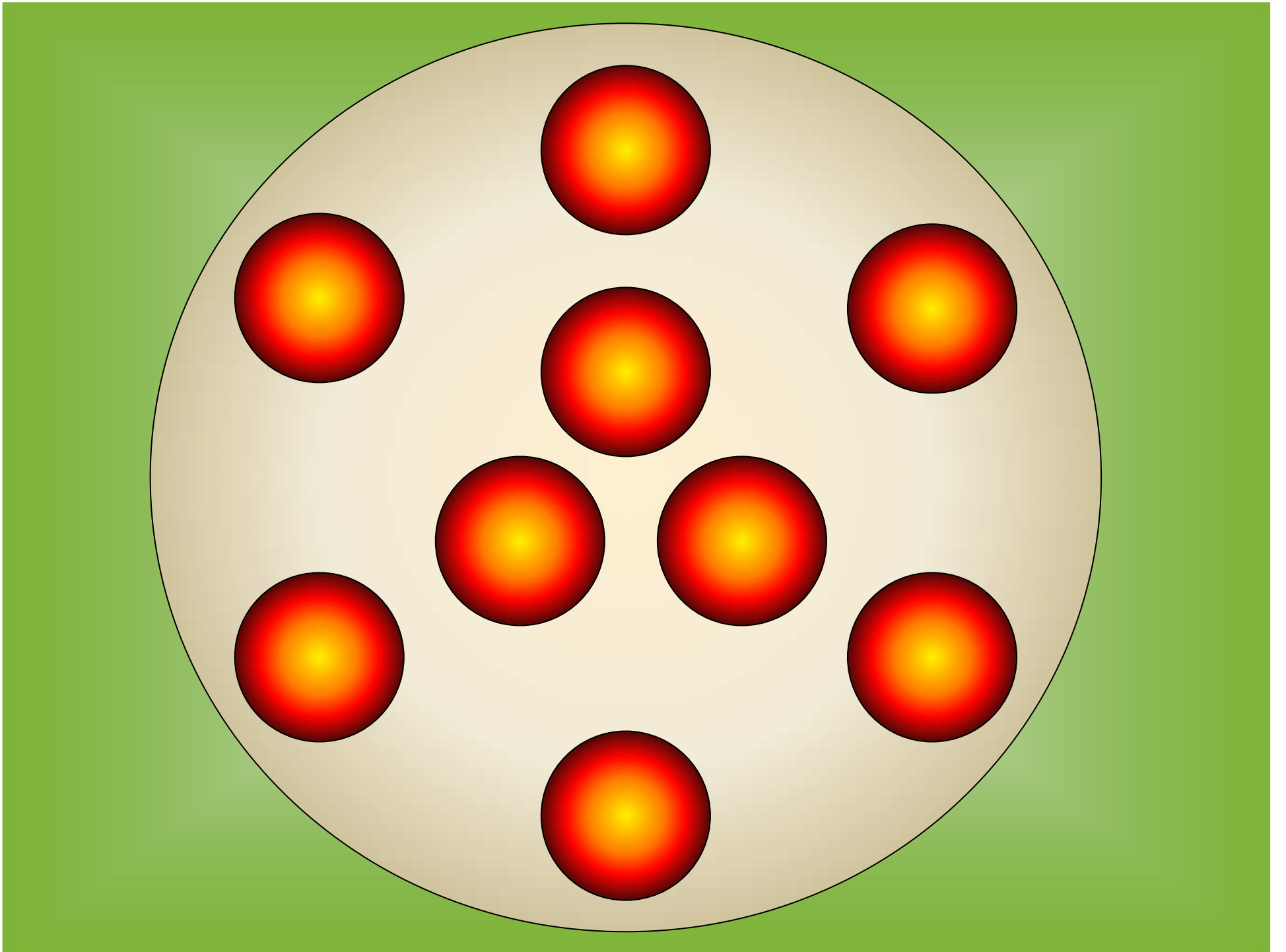


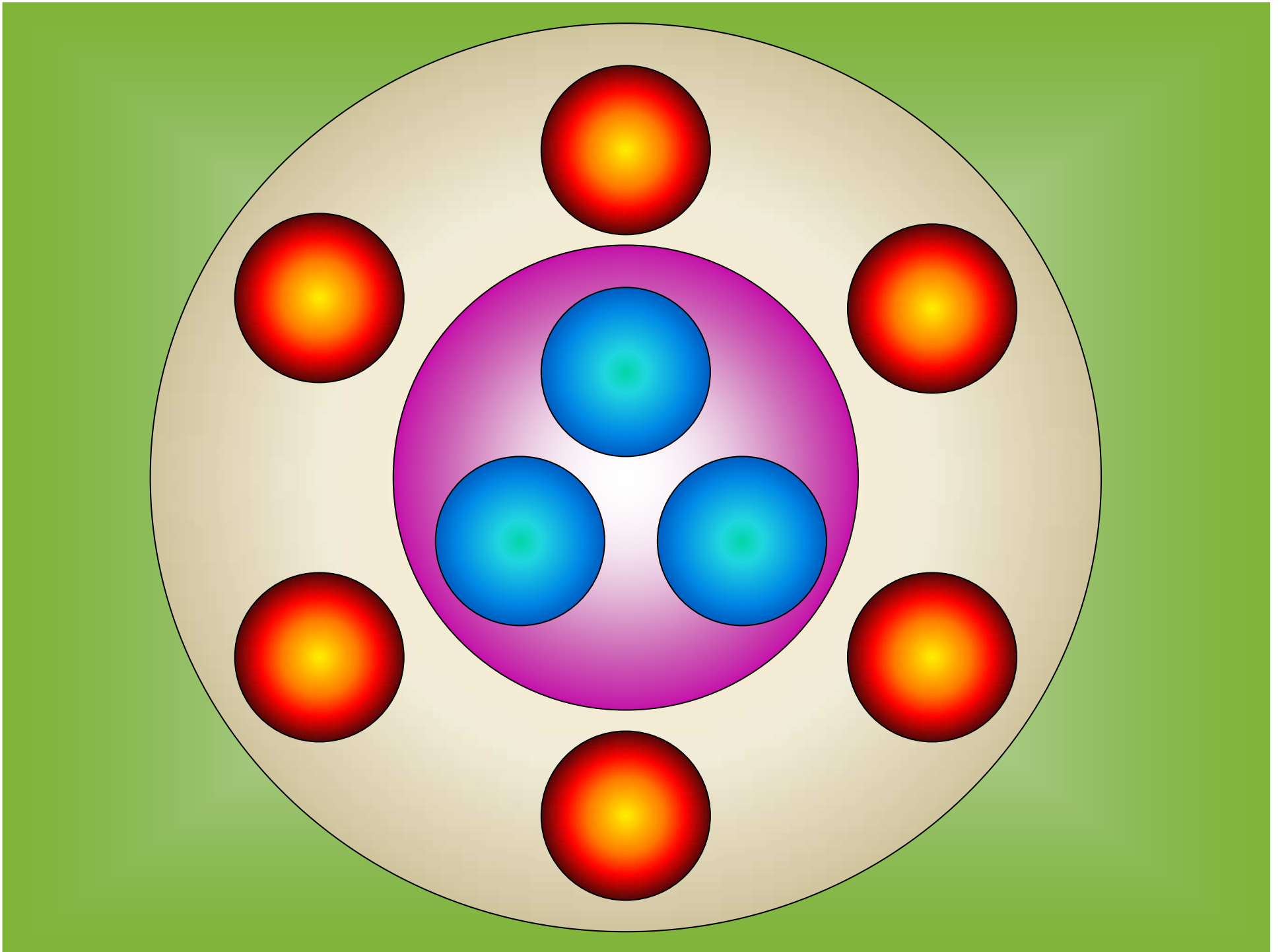


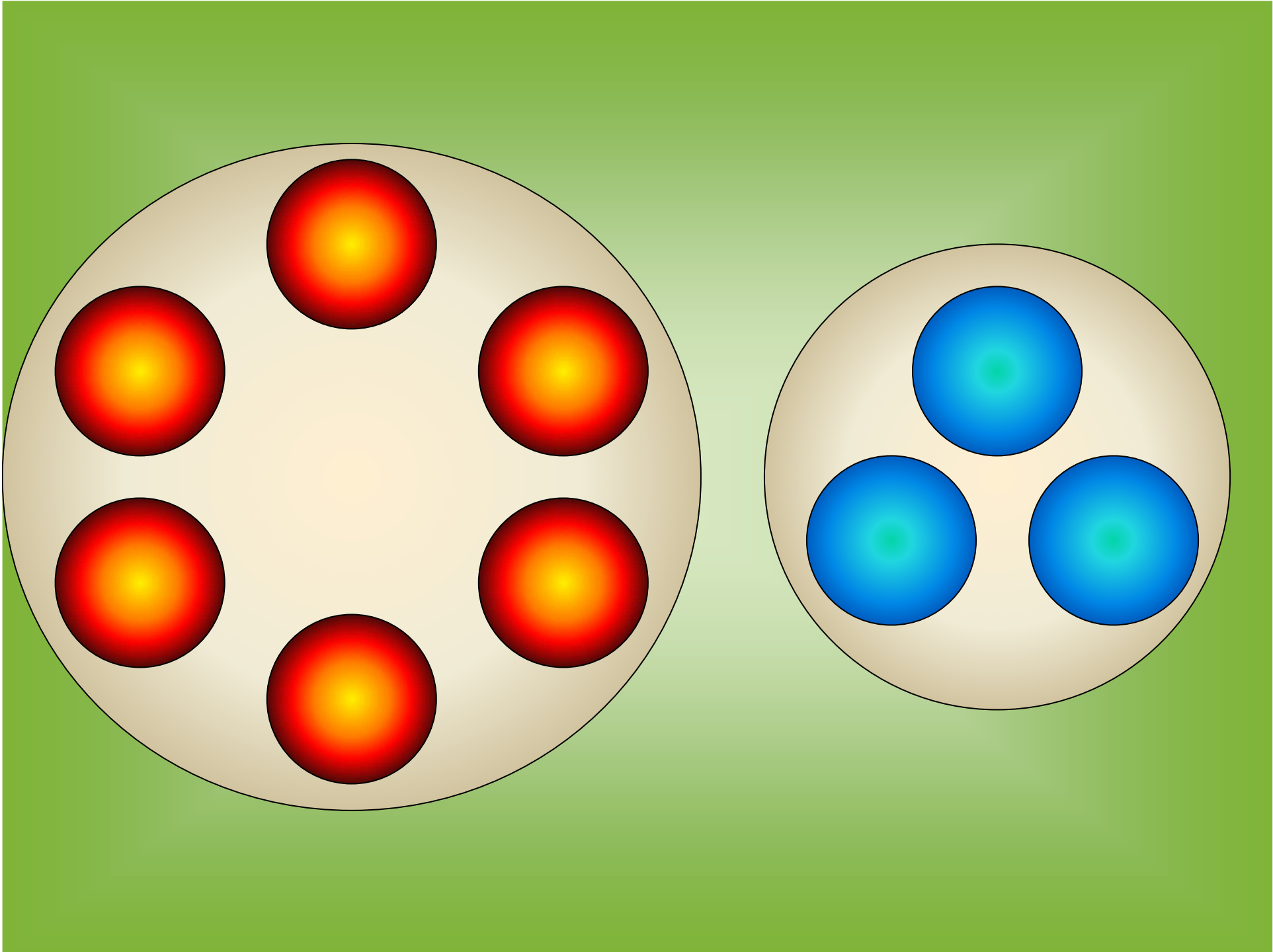


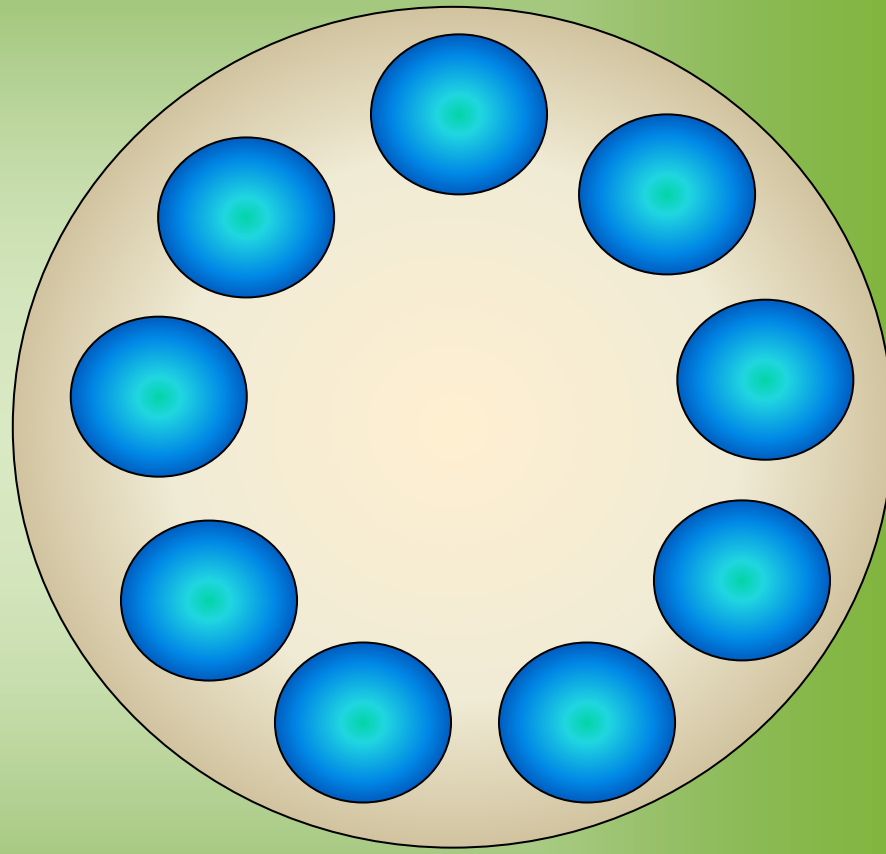
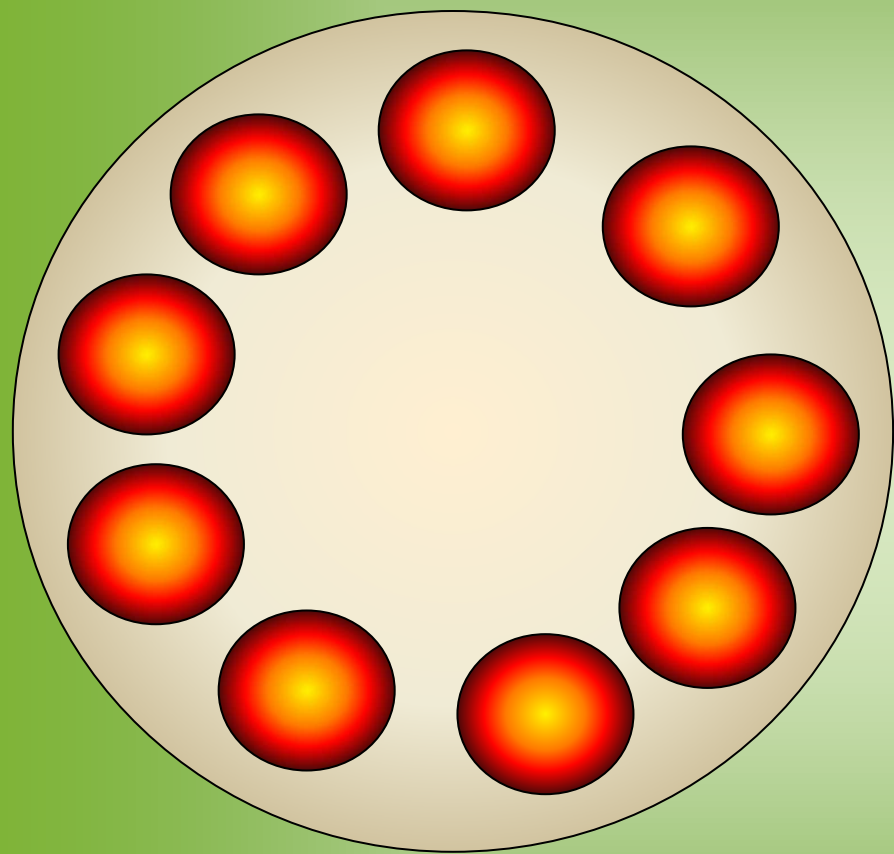
Cellular Growth and Replication

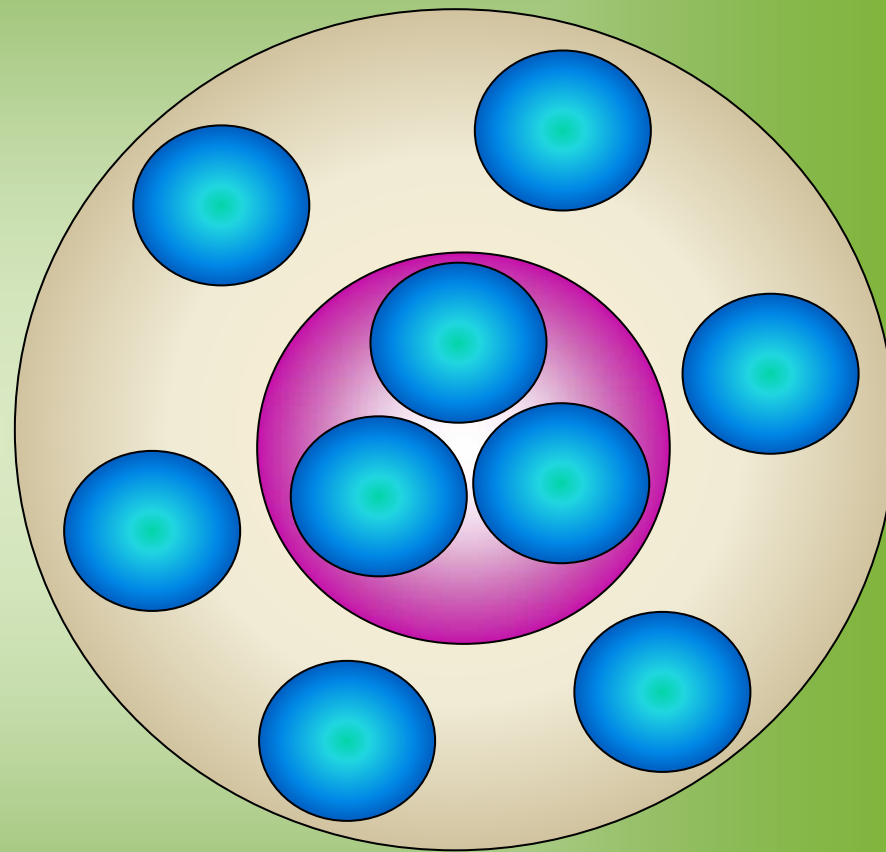
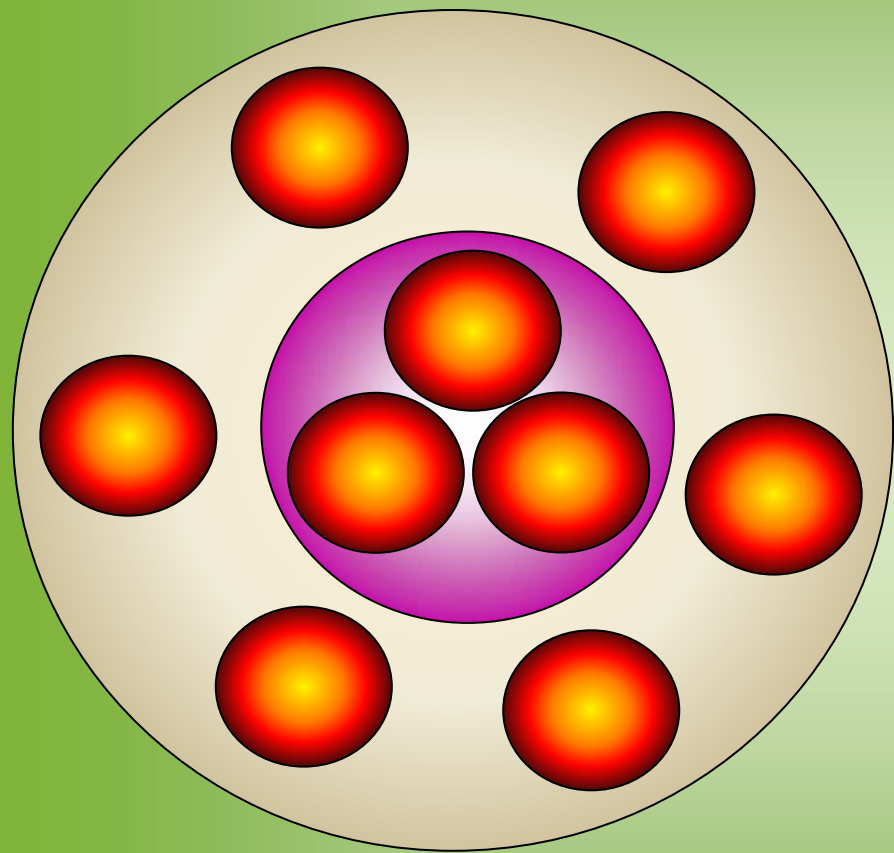
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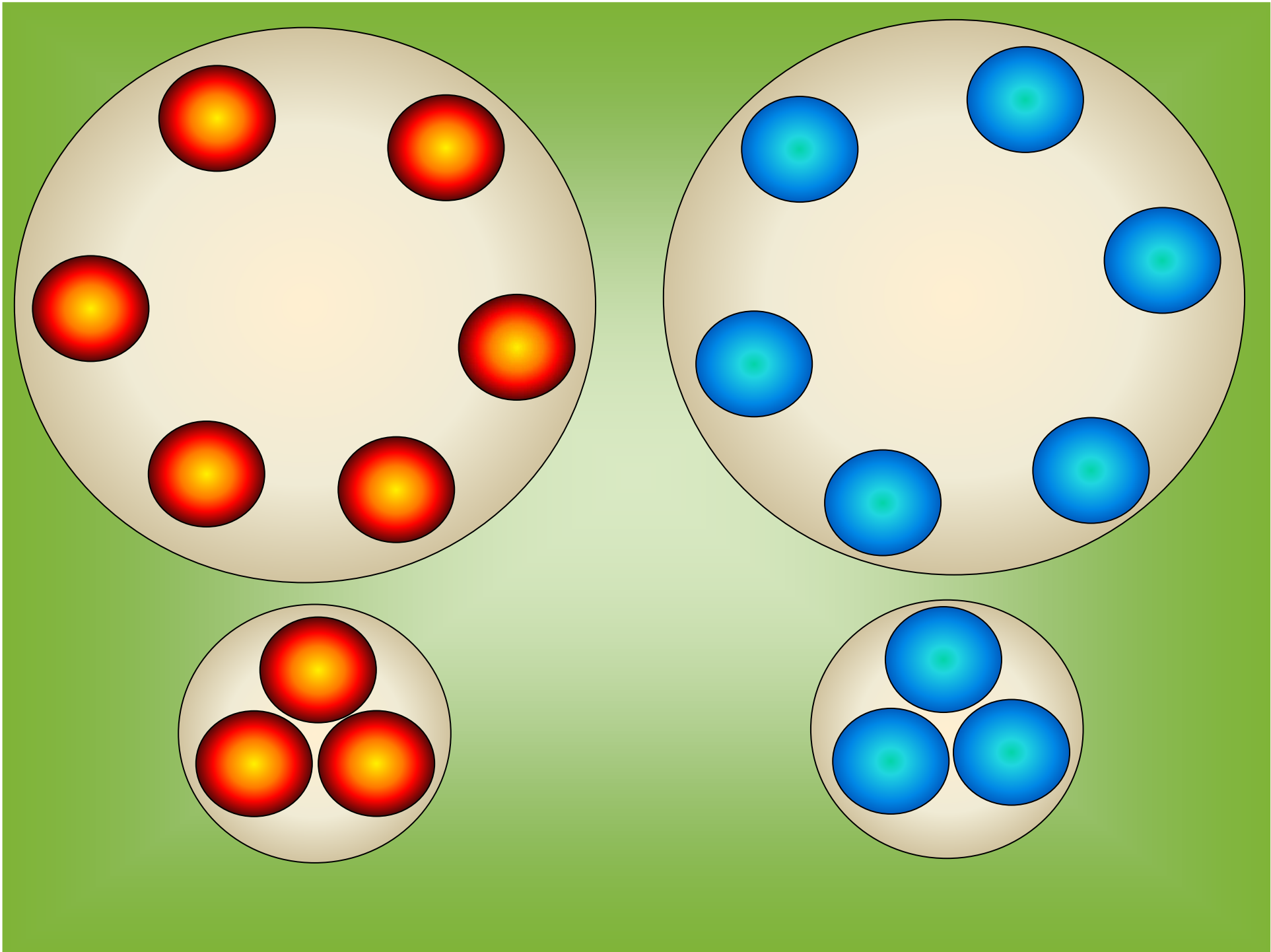


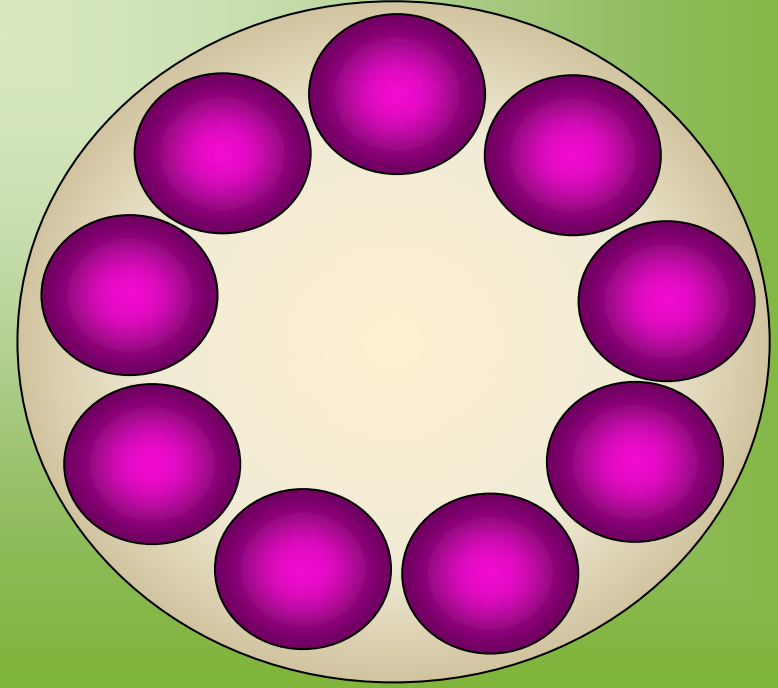
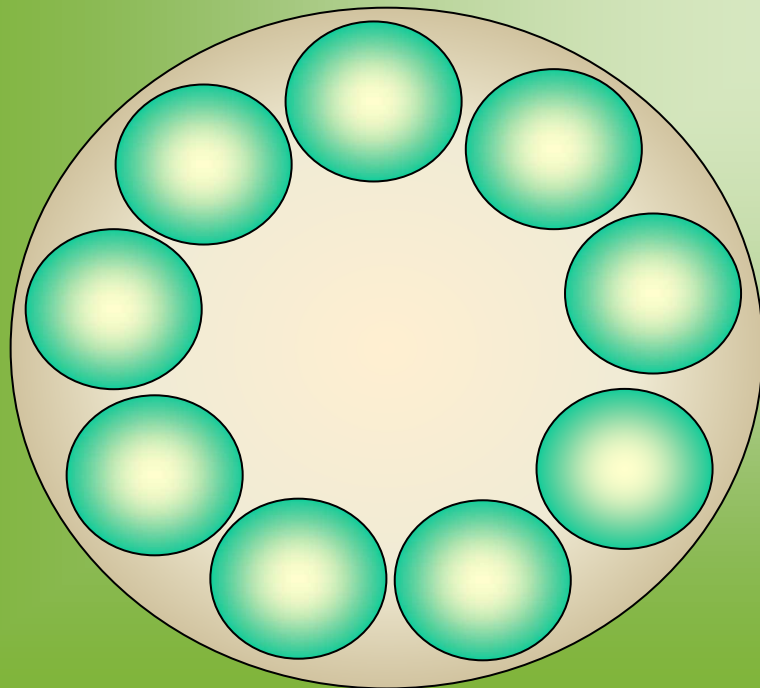
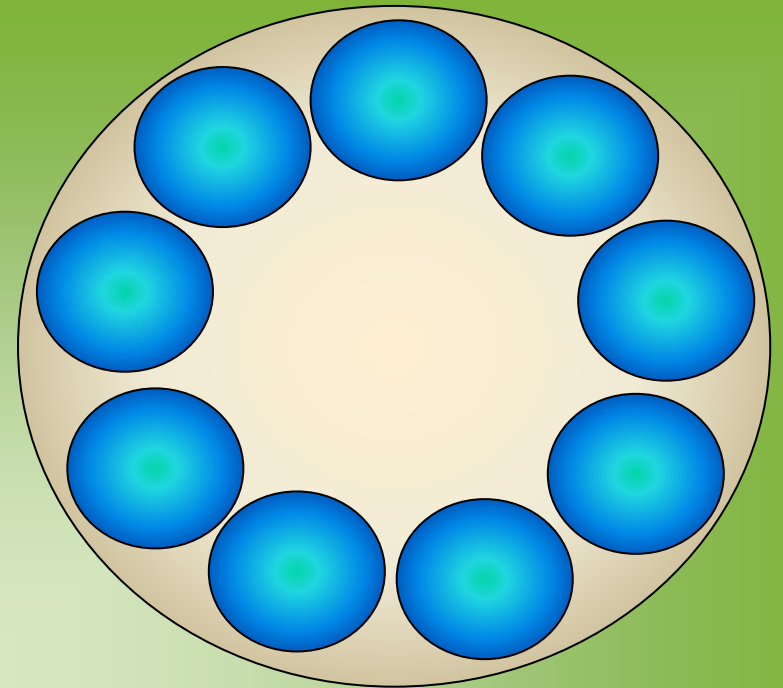
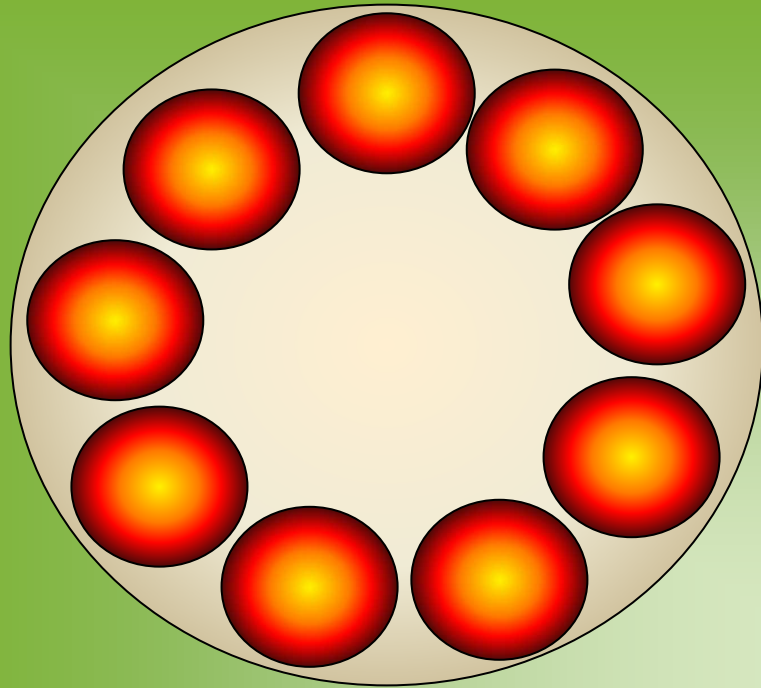


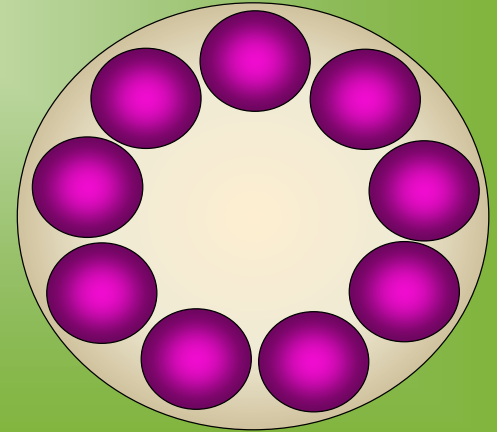
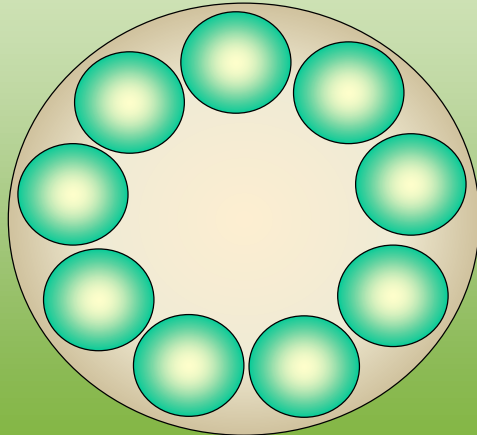
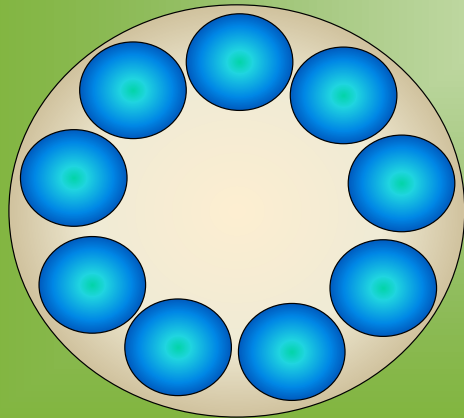
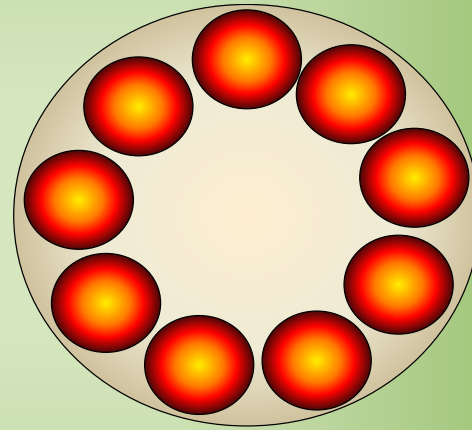
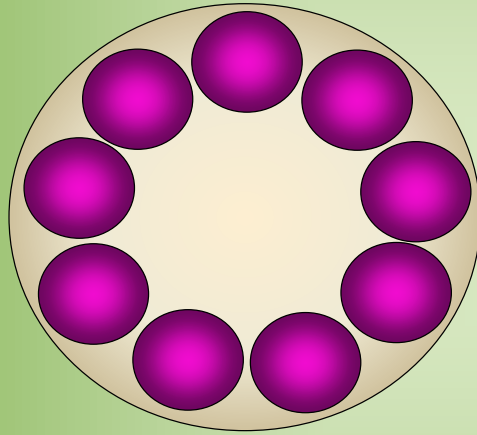
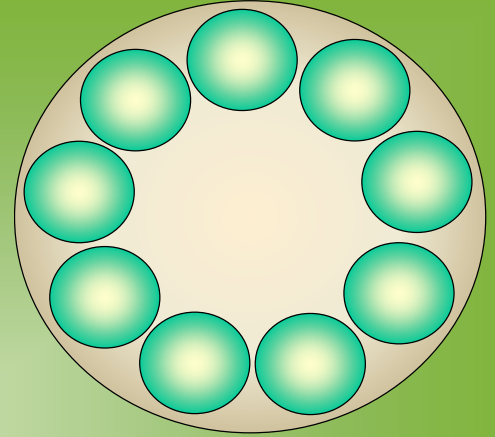
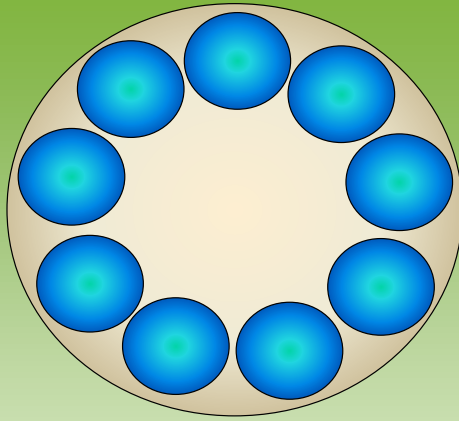
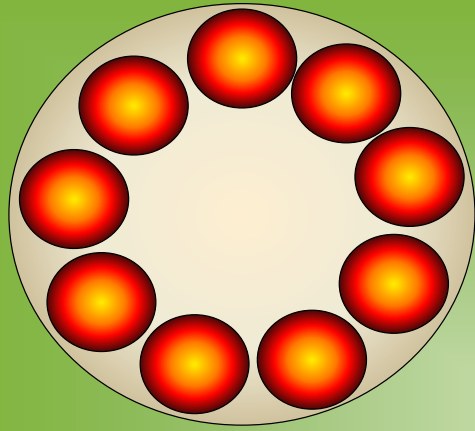


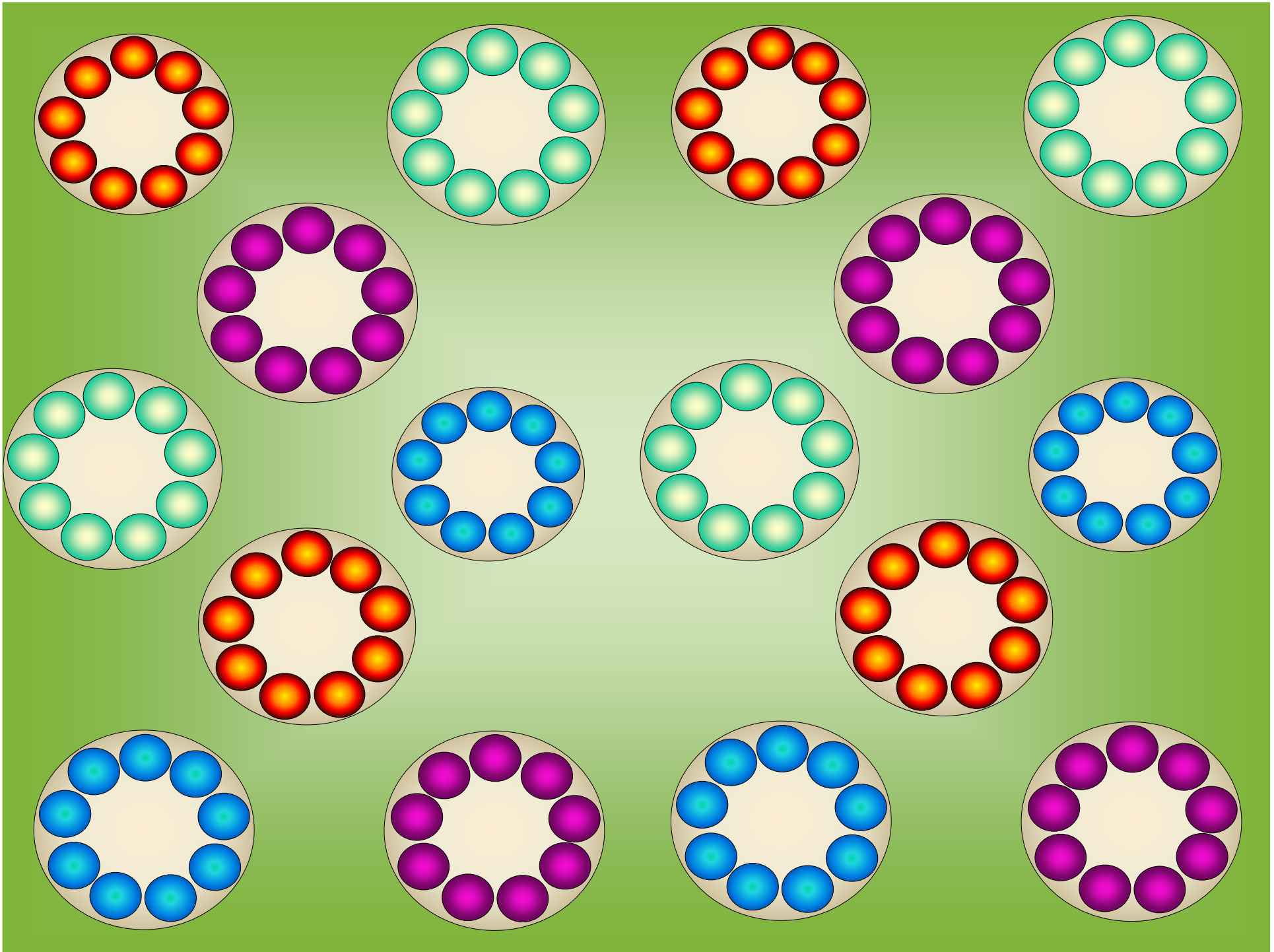


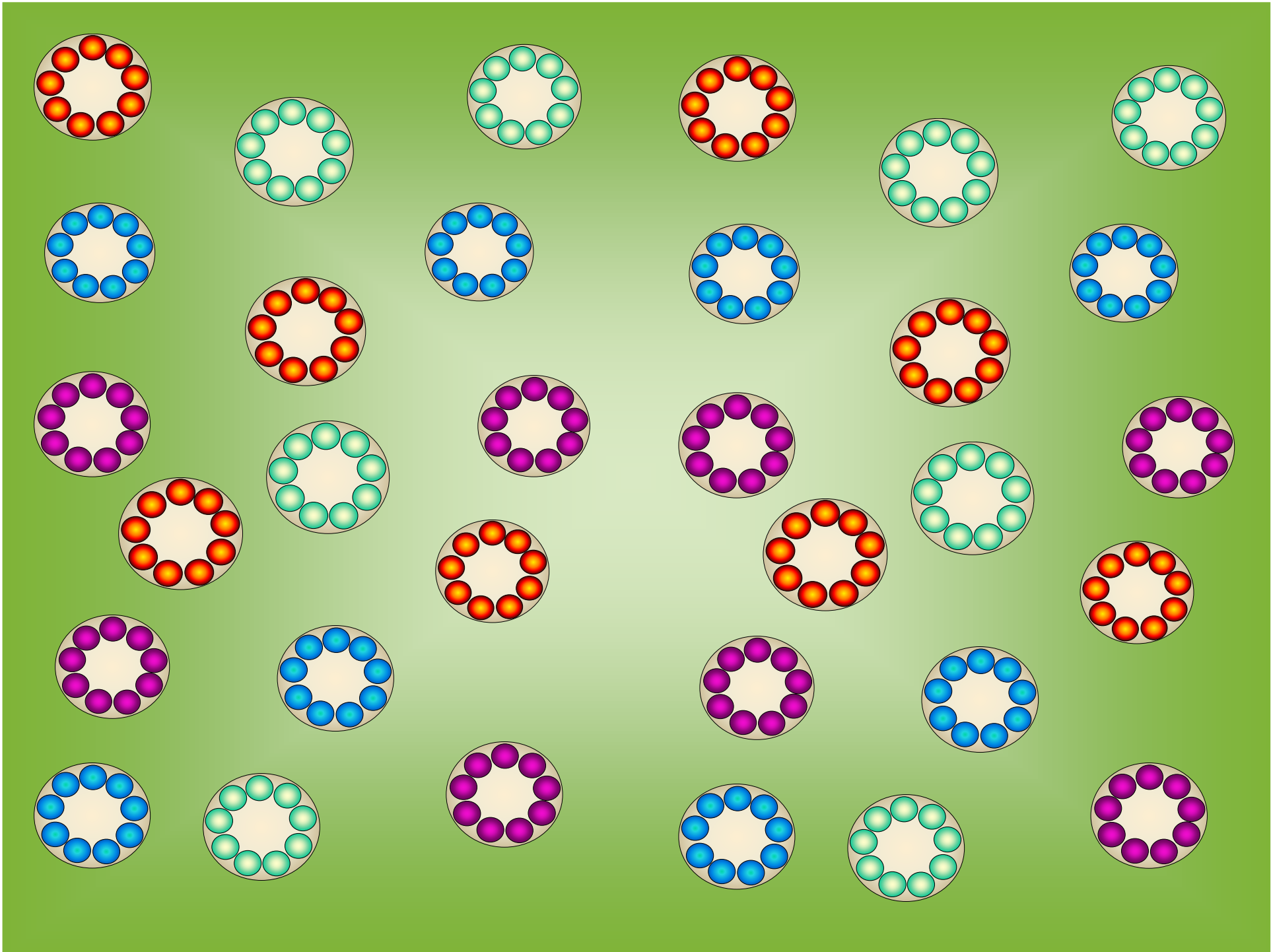






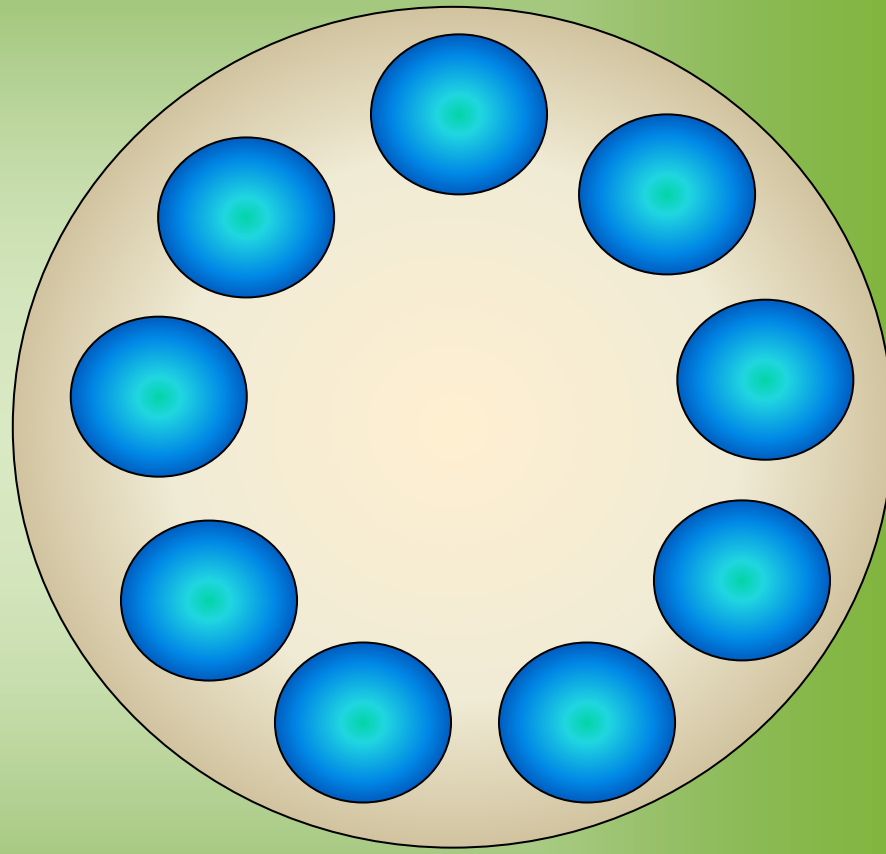
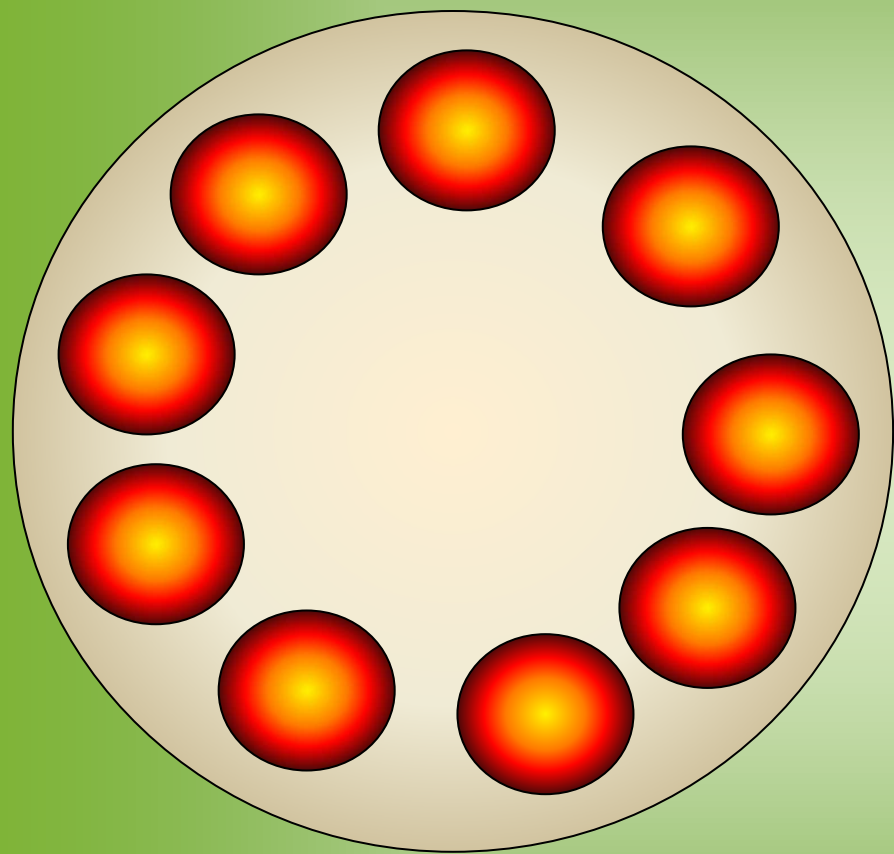


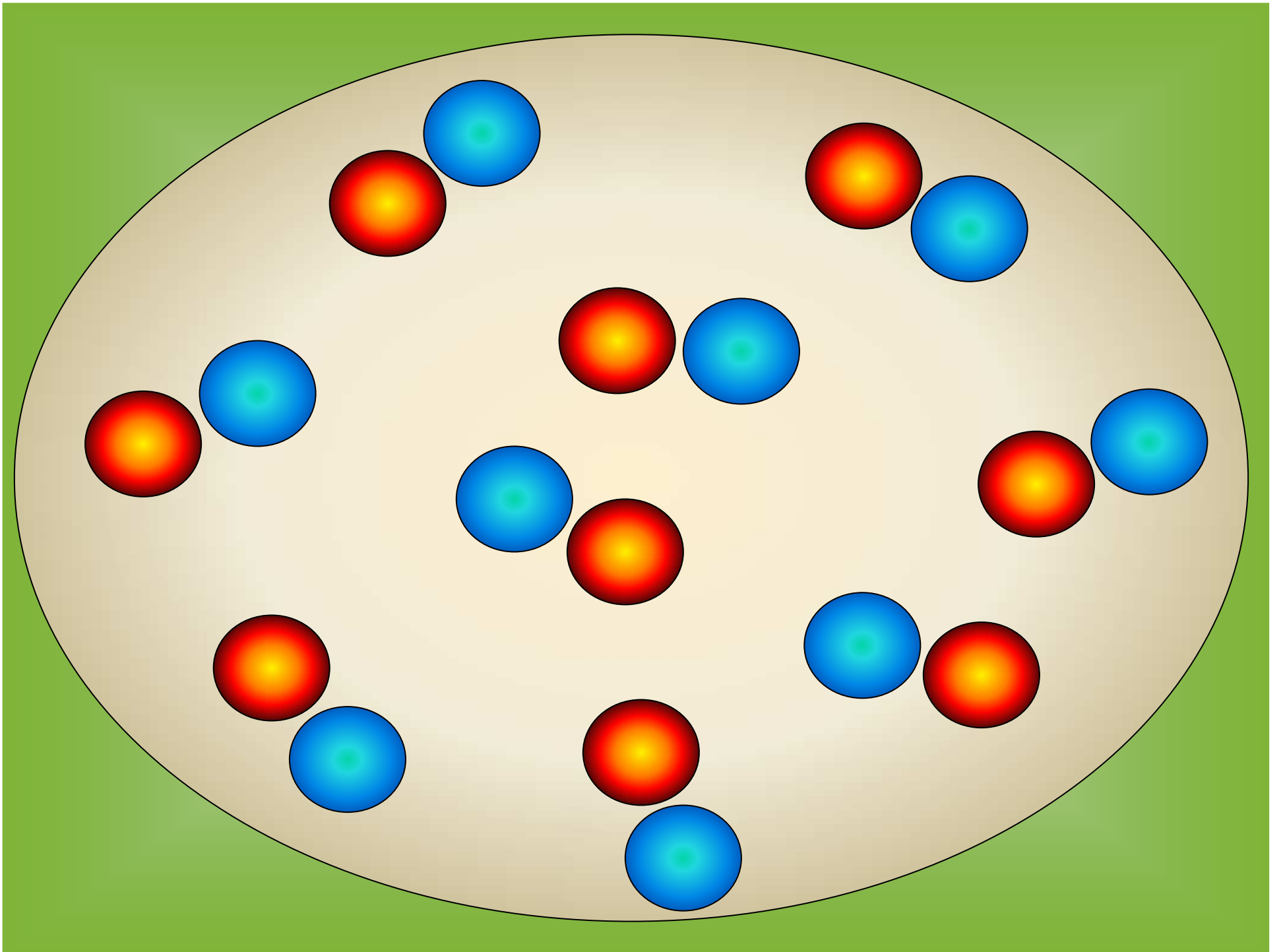


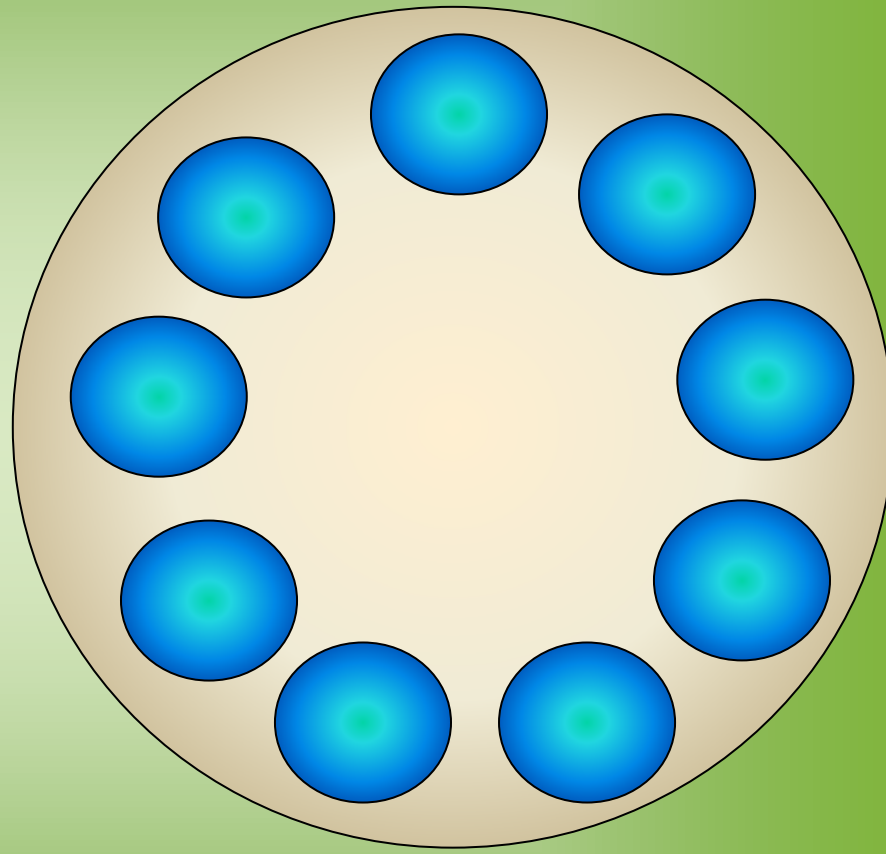
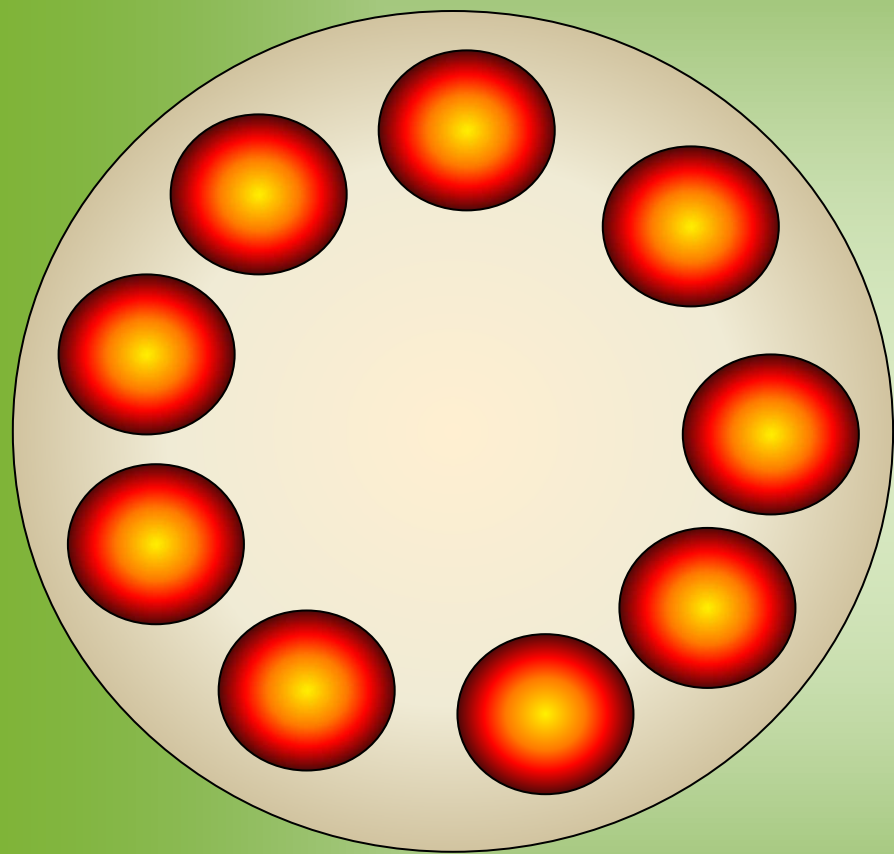


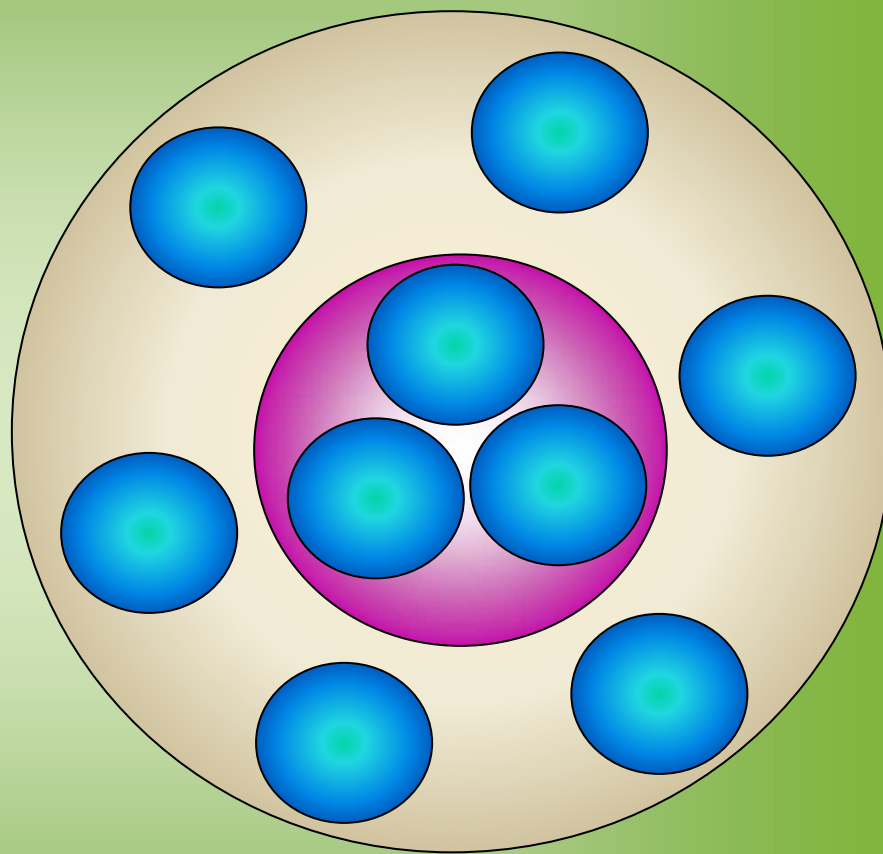
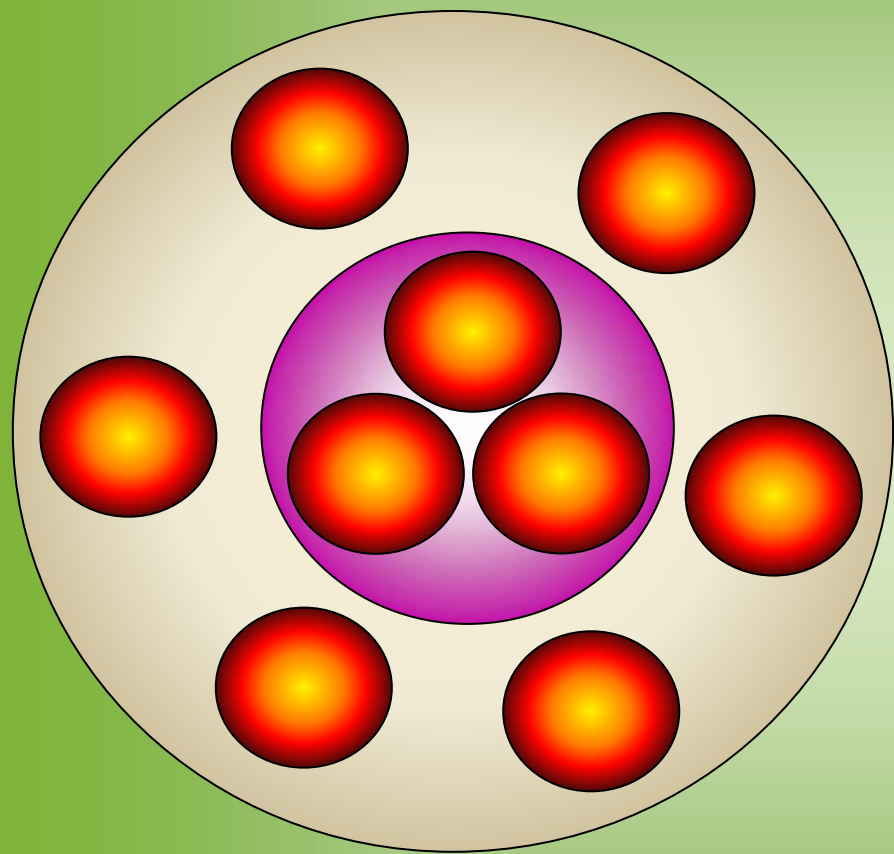
Cellular Growth and Replication

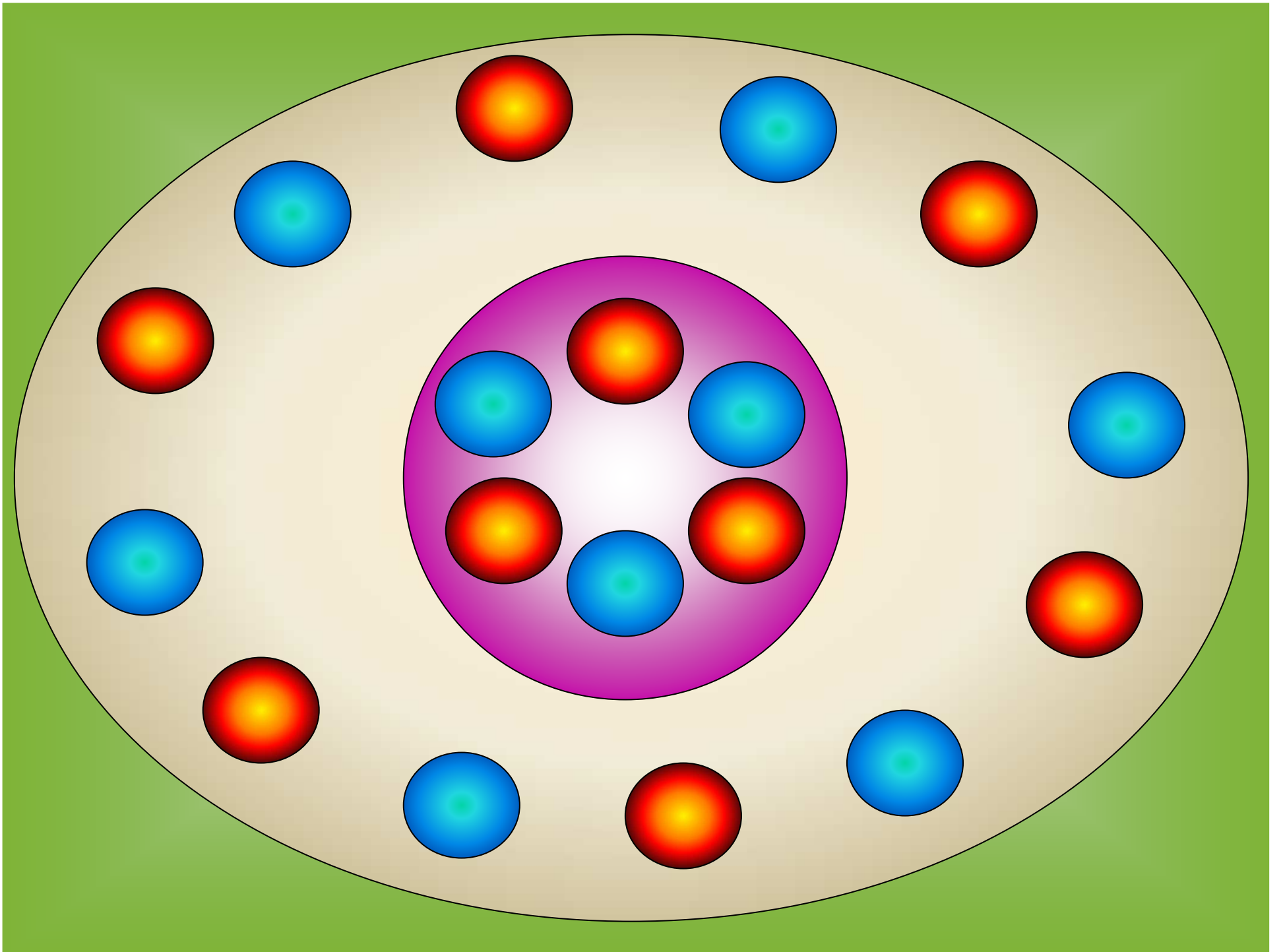
C. Pairing

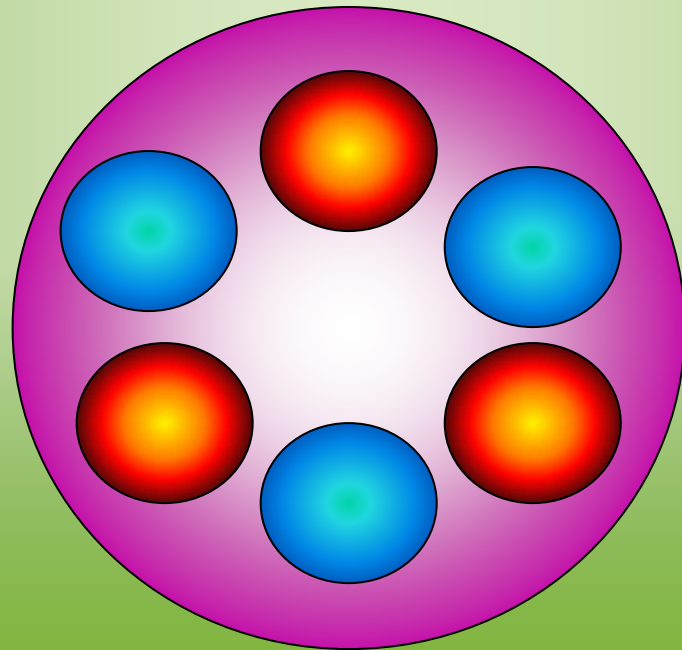
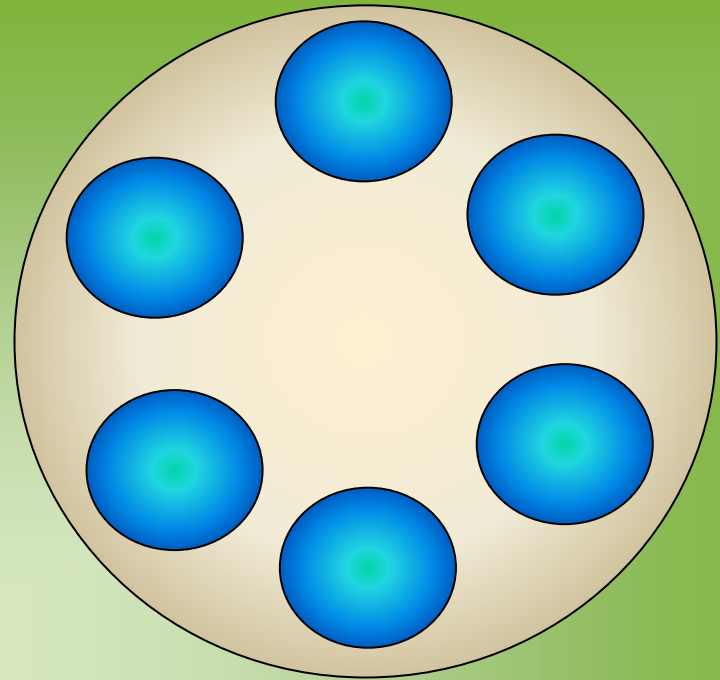
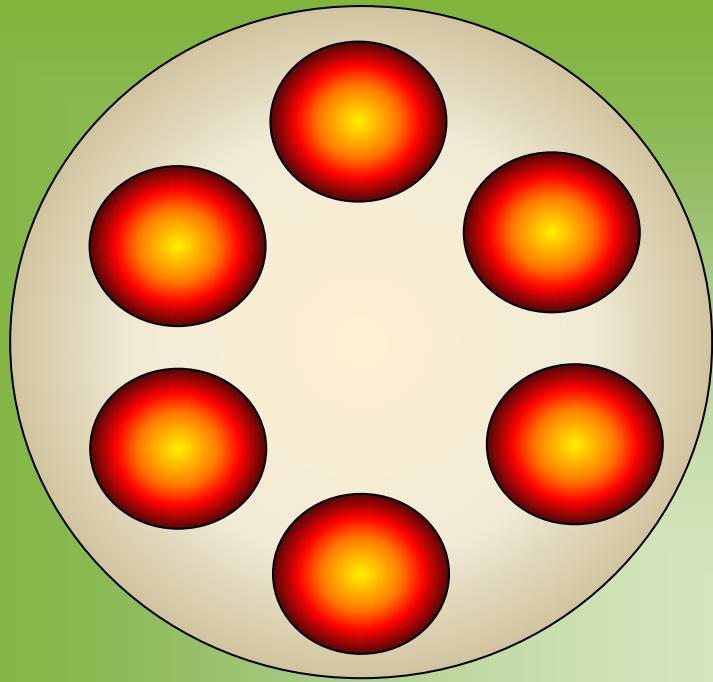


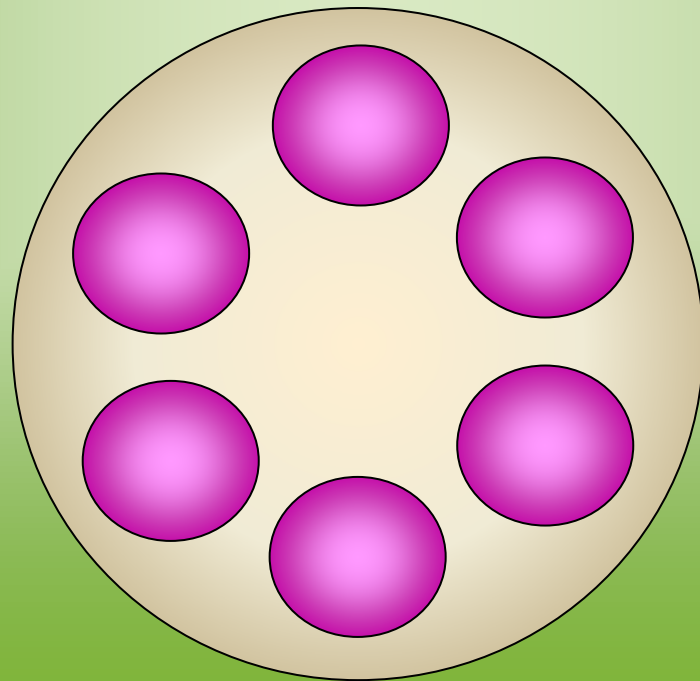
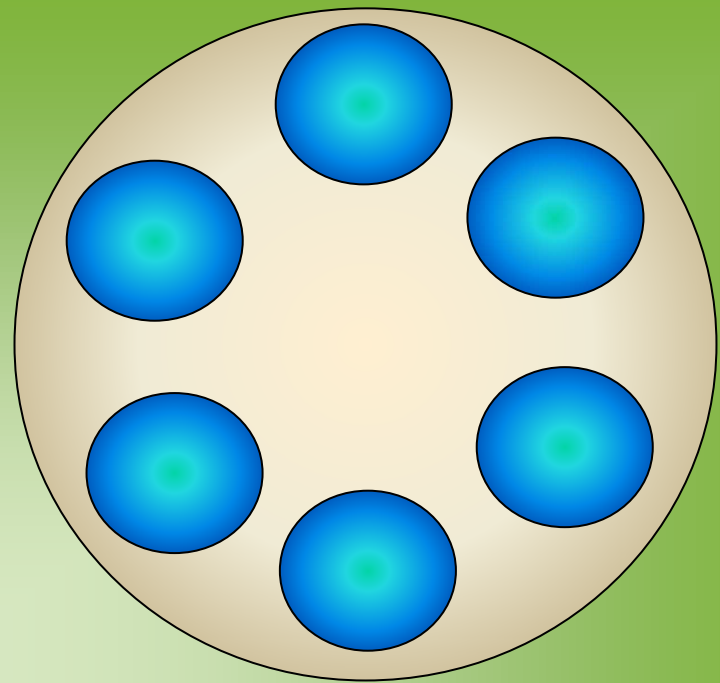
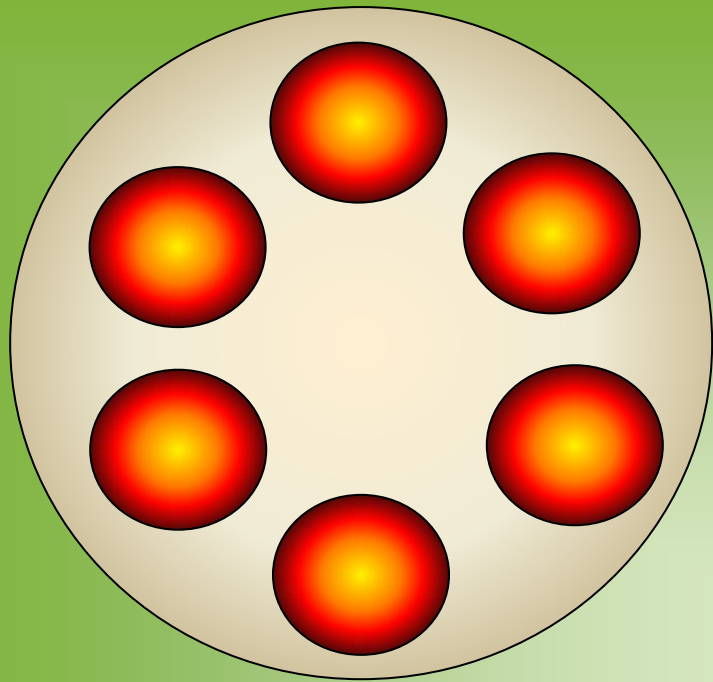


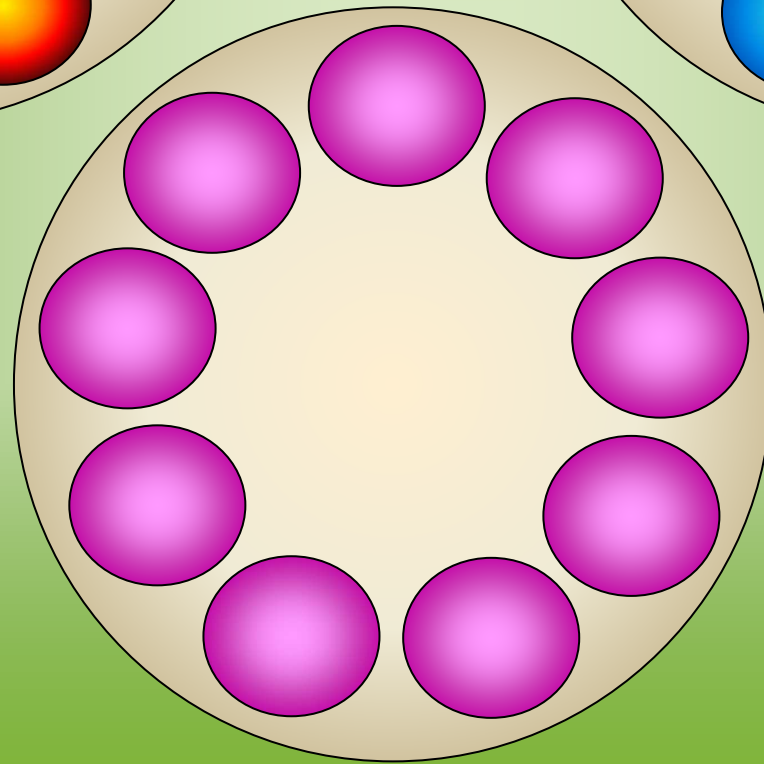
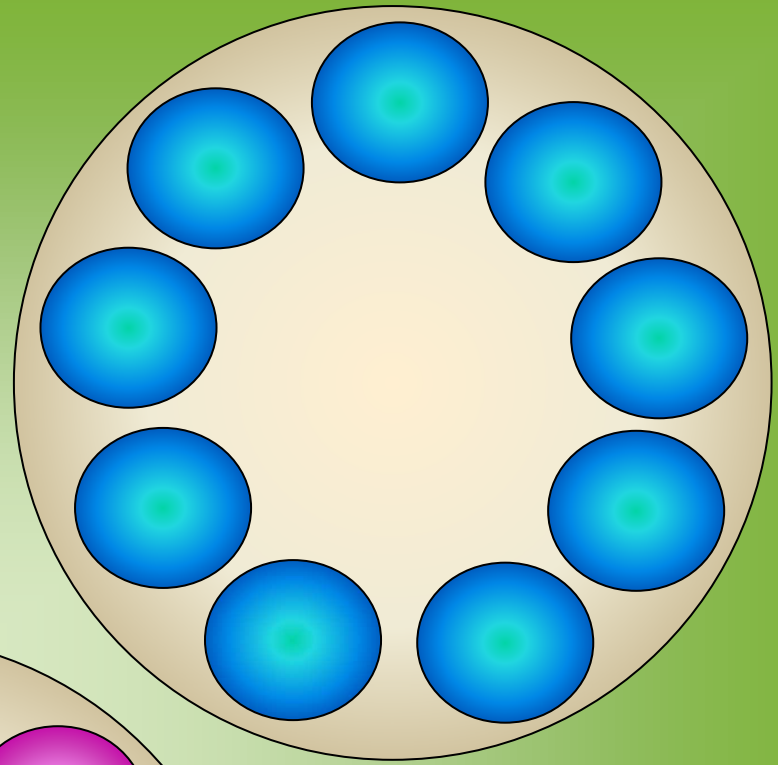
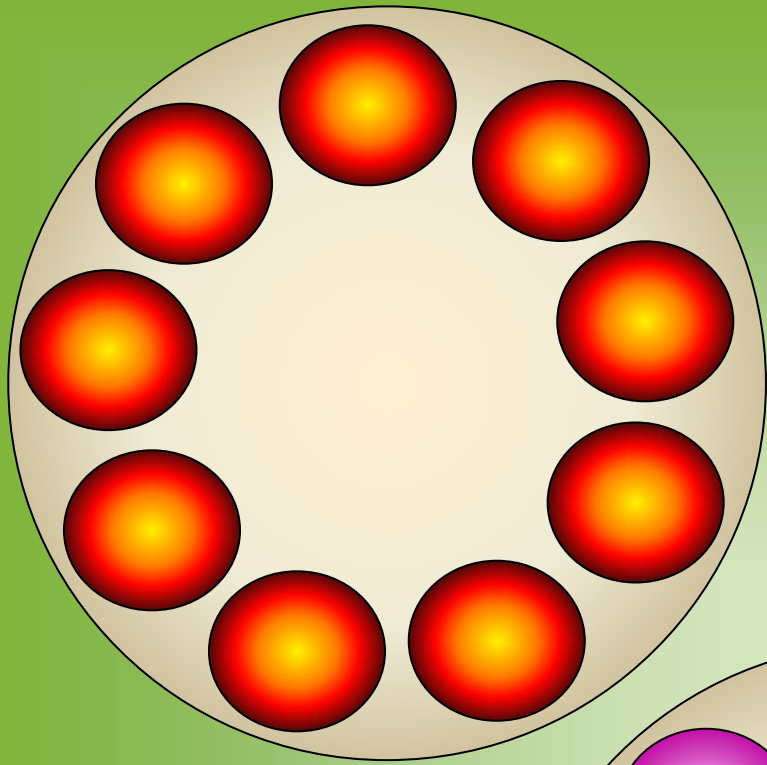


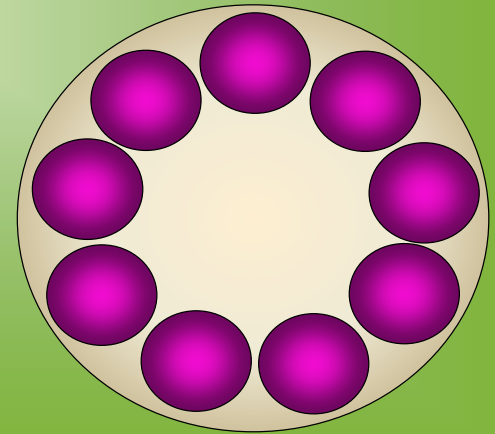
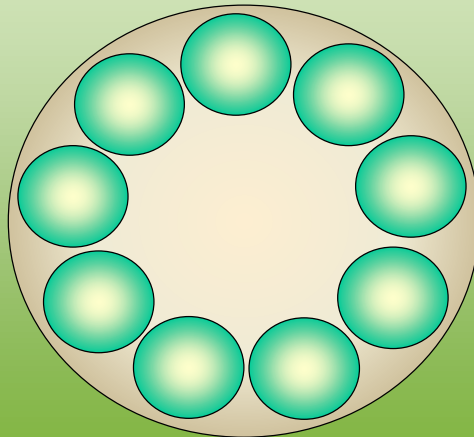
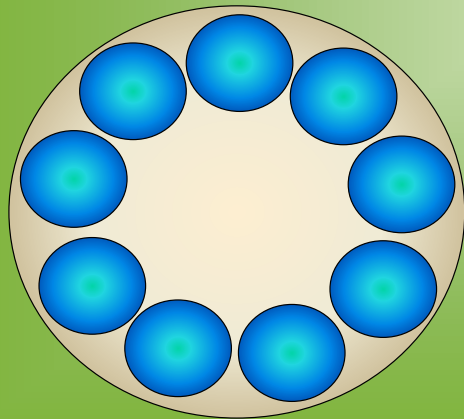
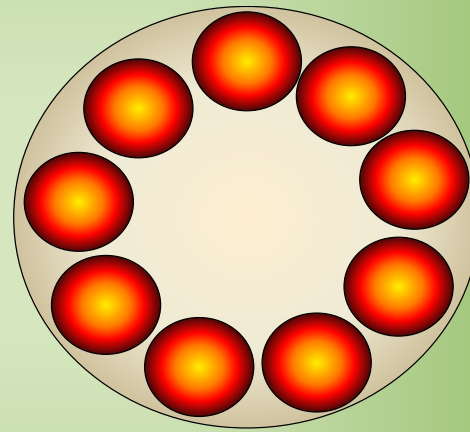
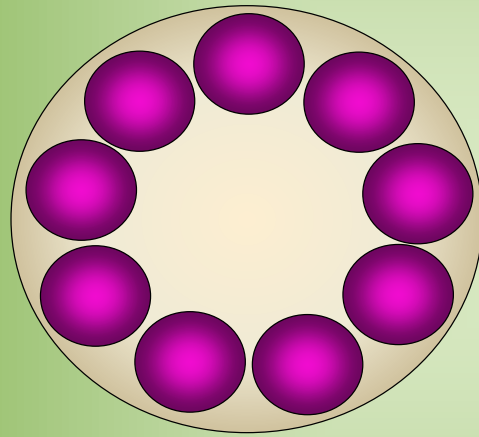
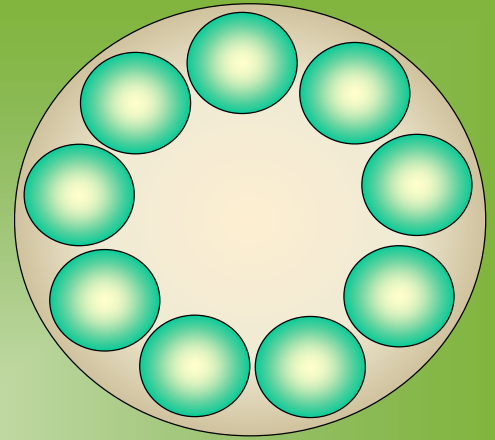
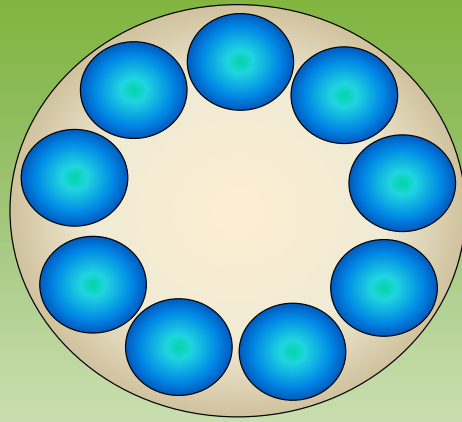
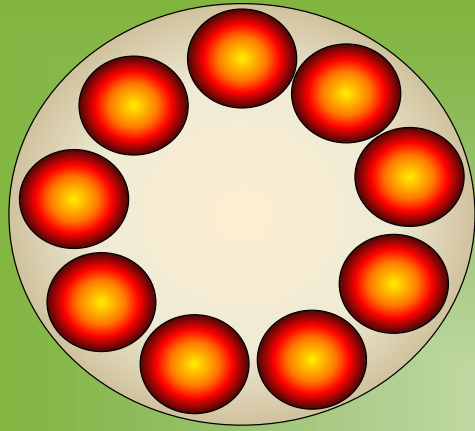


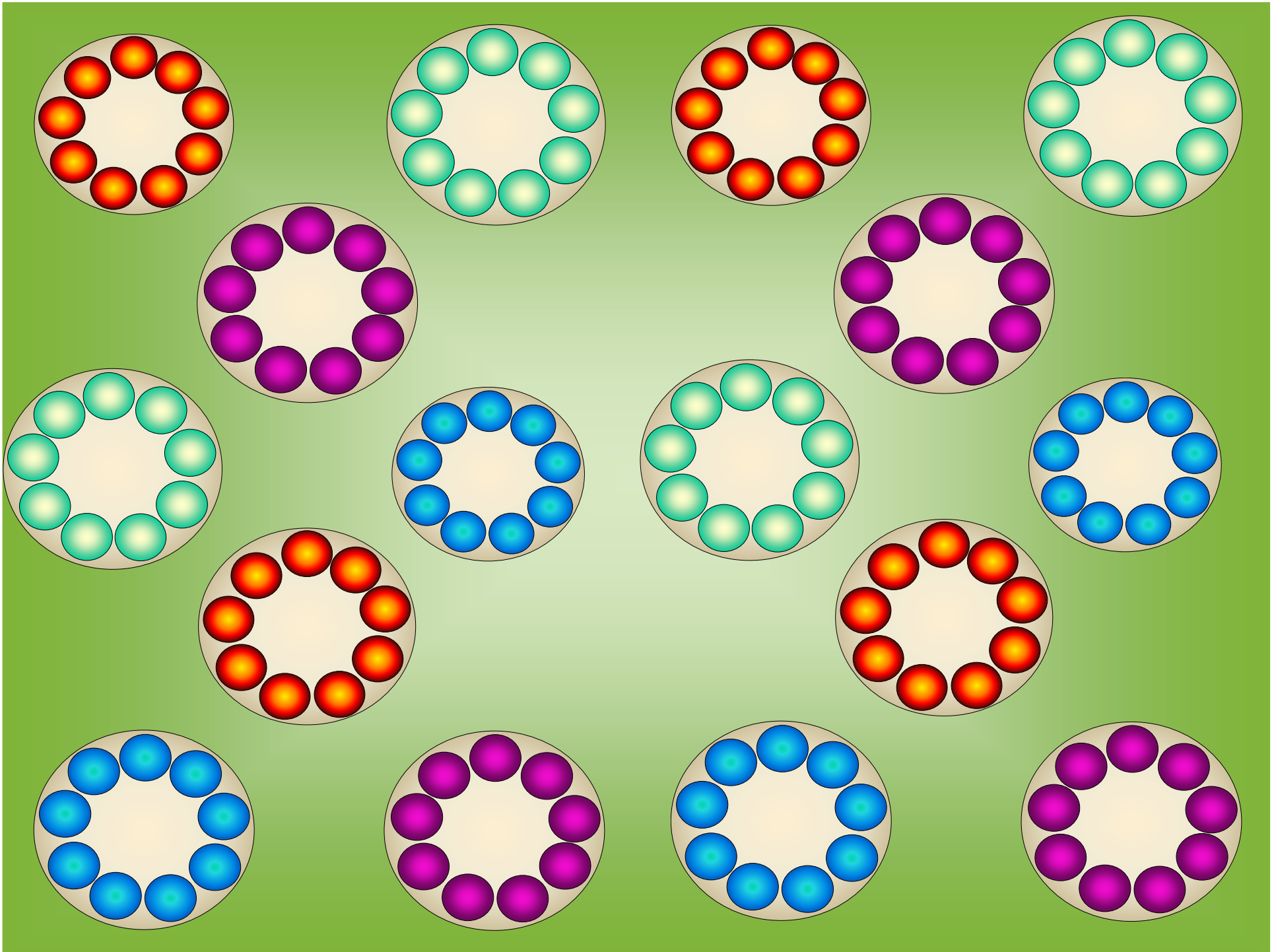


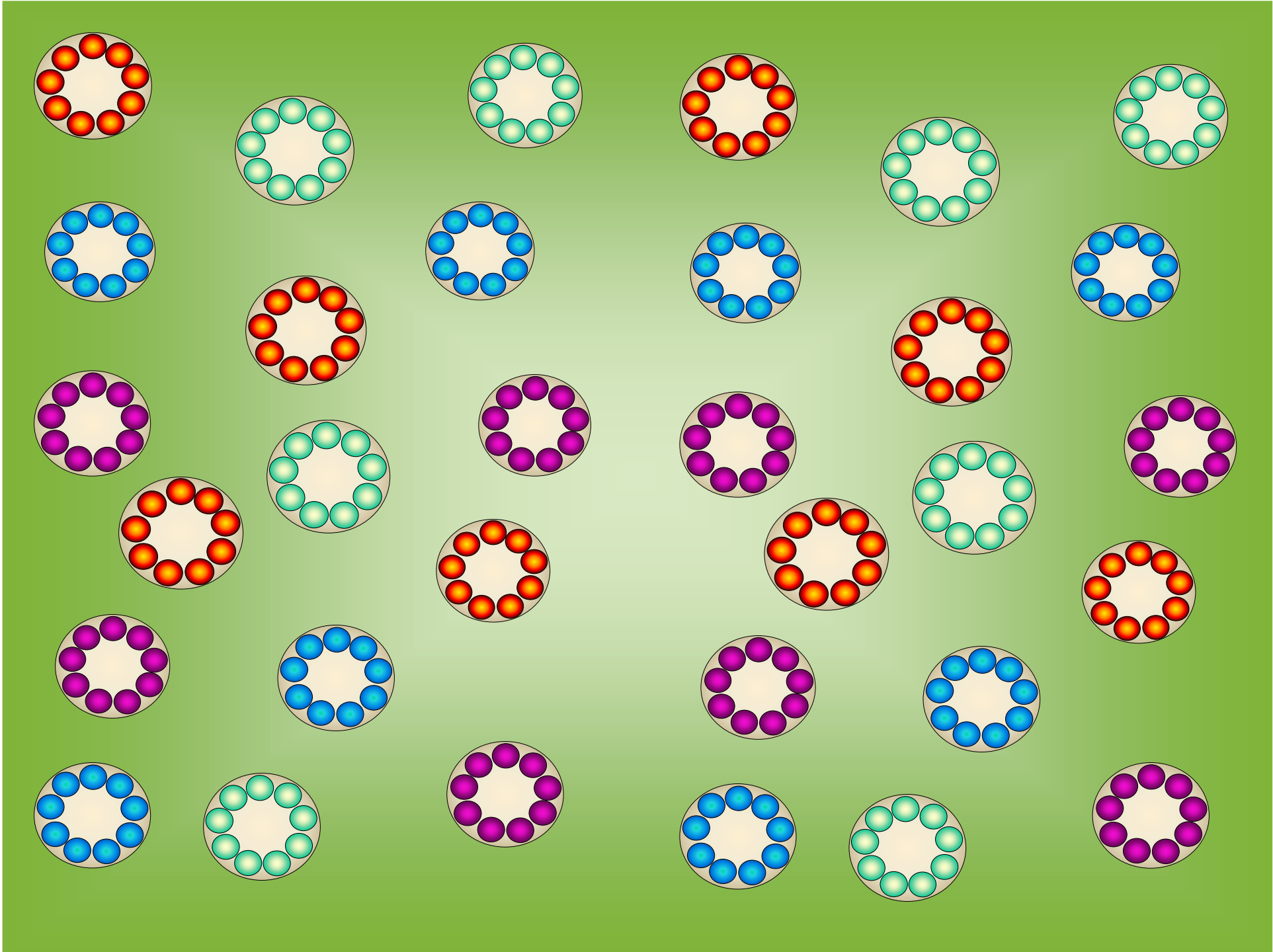


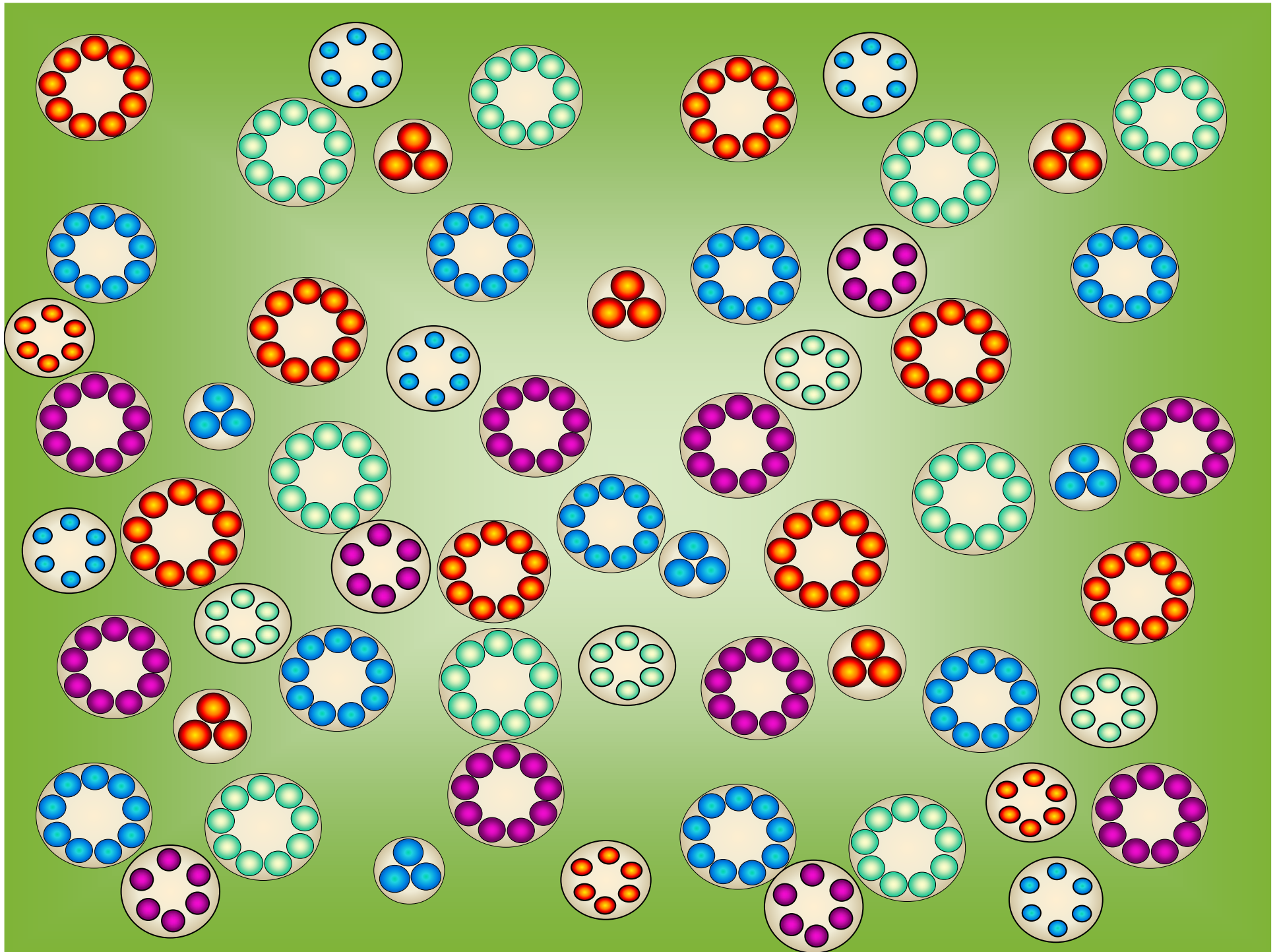


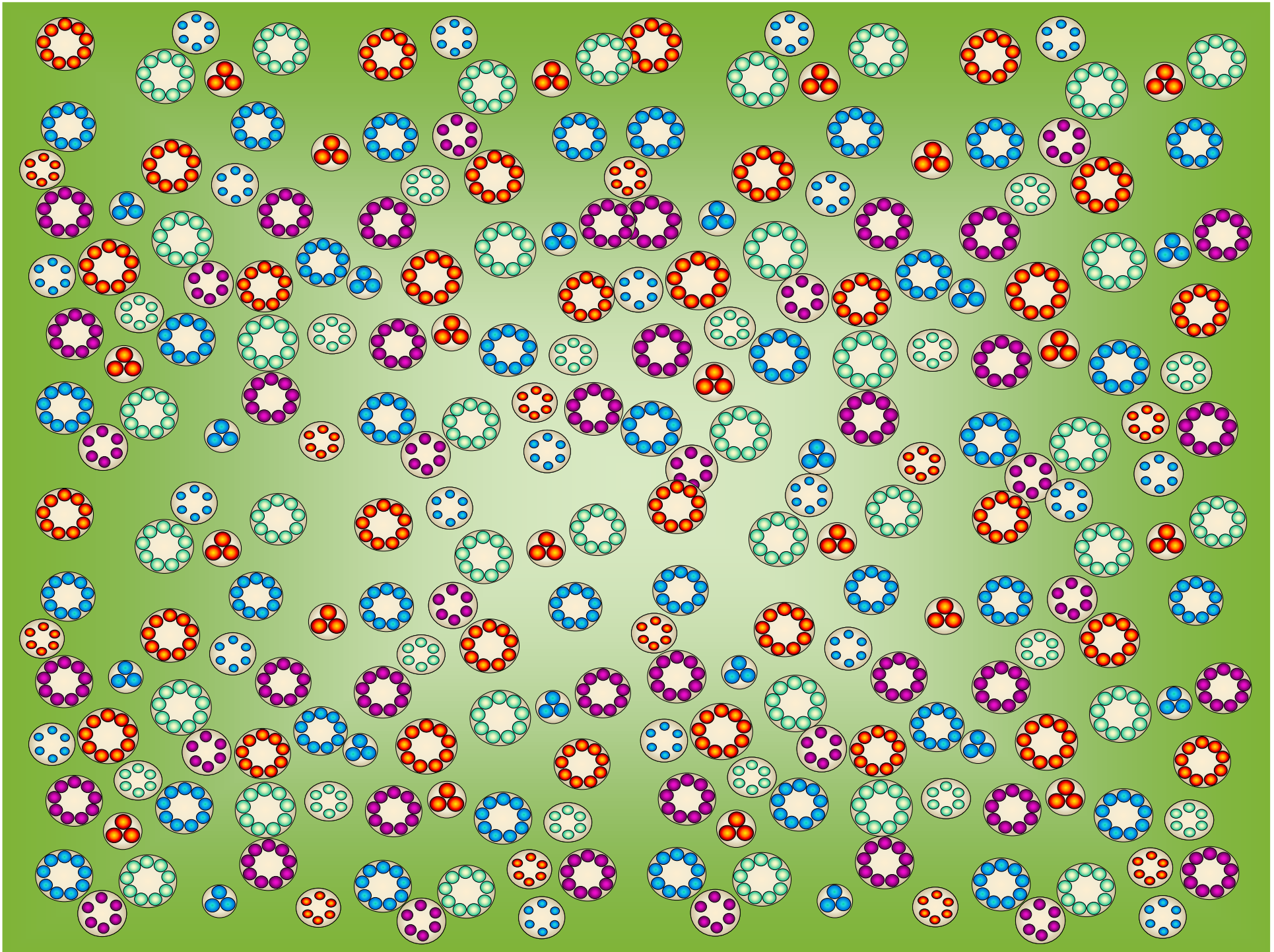








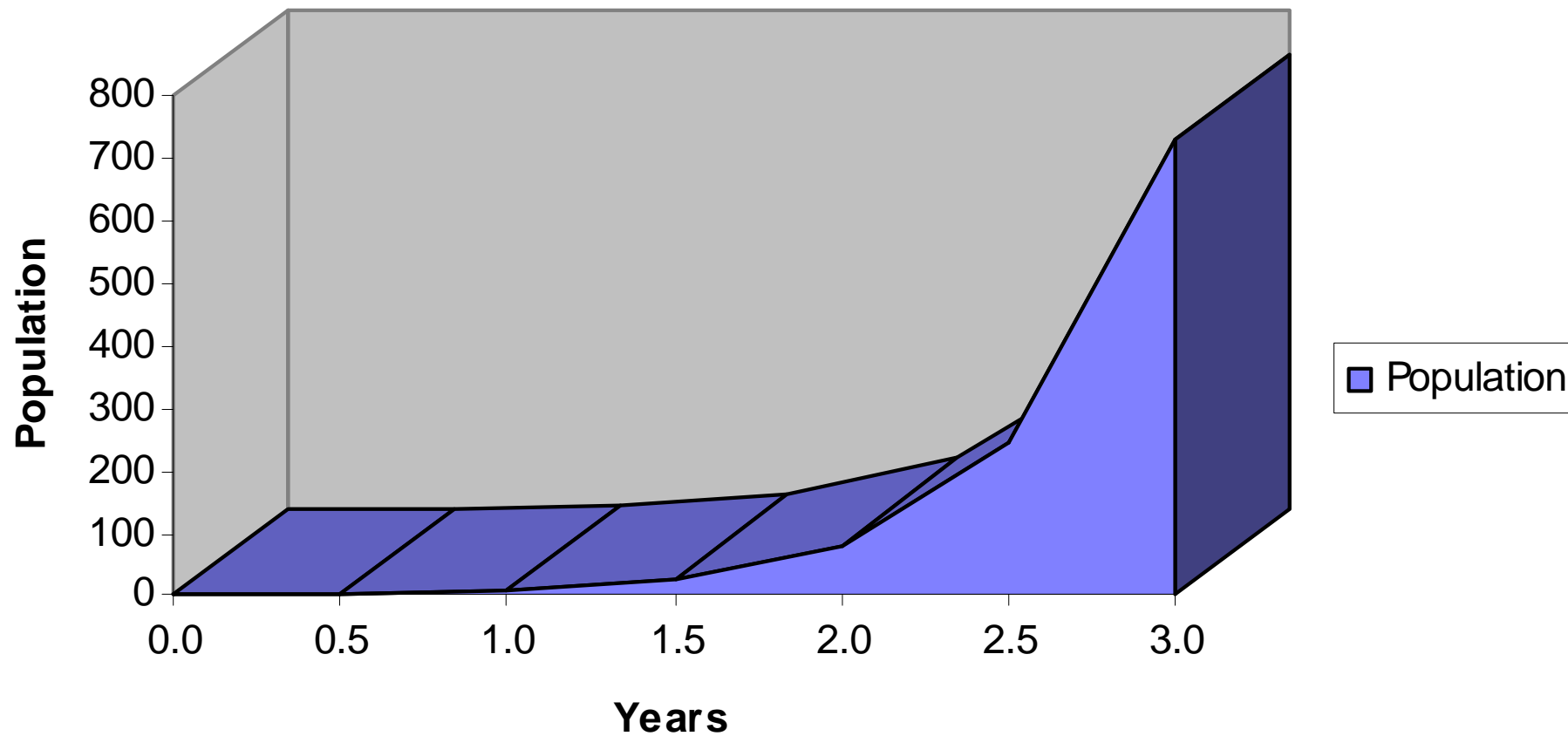




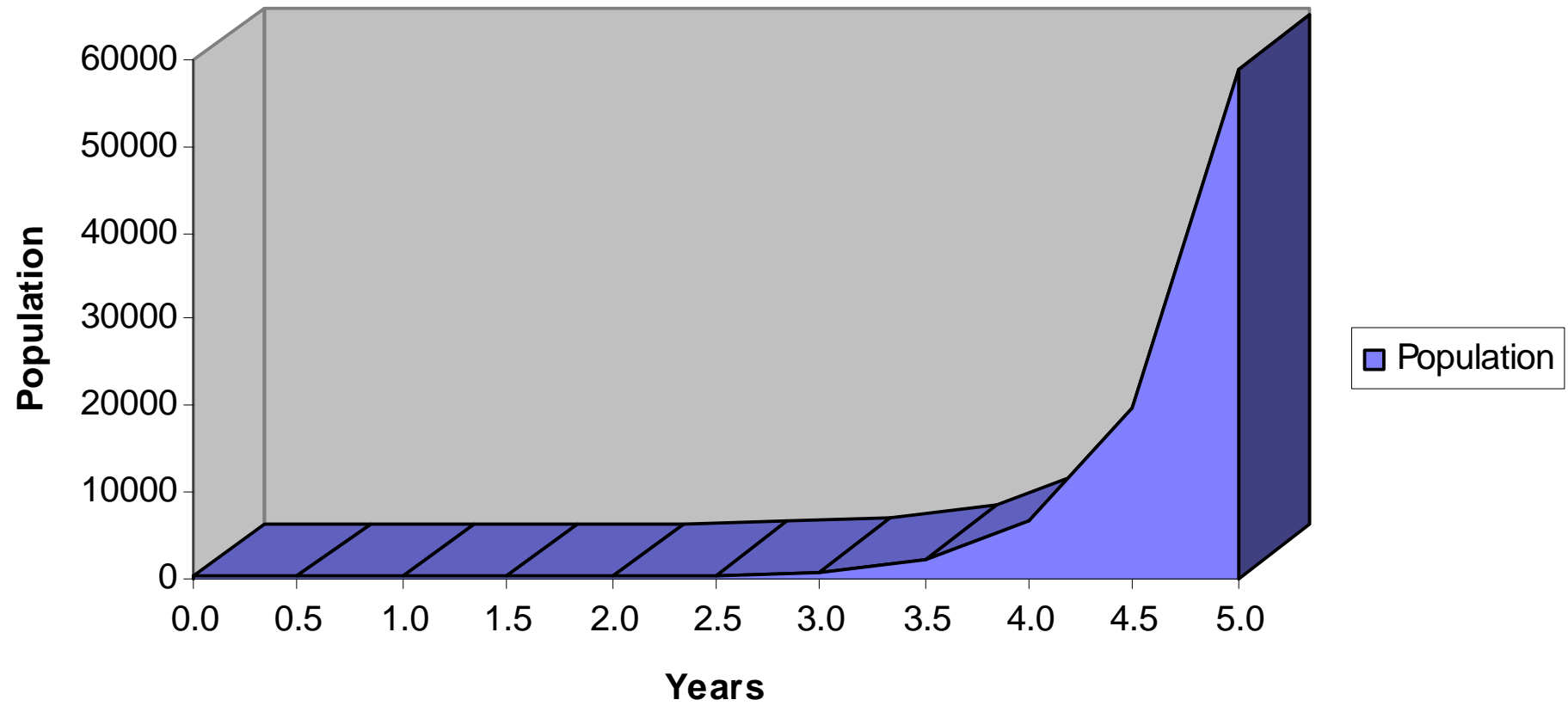
**Growth profile of
Biological System of
Replicating Cells**

Year	Population
0.0	1
0.5	3
1.0	9
1.5	27
2.0	81
2.5	243
3.0	729
3.5	2187
4.0	6561
4.5	19683
5.0	59049
5.5	177147
6.0	531441
6.5	1594323
7.0	4782969
7.5	14348907
8.0	43046721
8.5	129140163
9.0	387420489
9.5	1162261467
10.0	3486784401

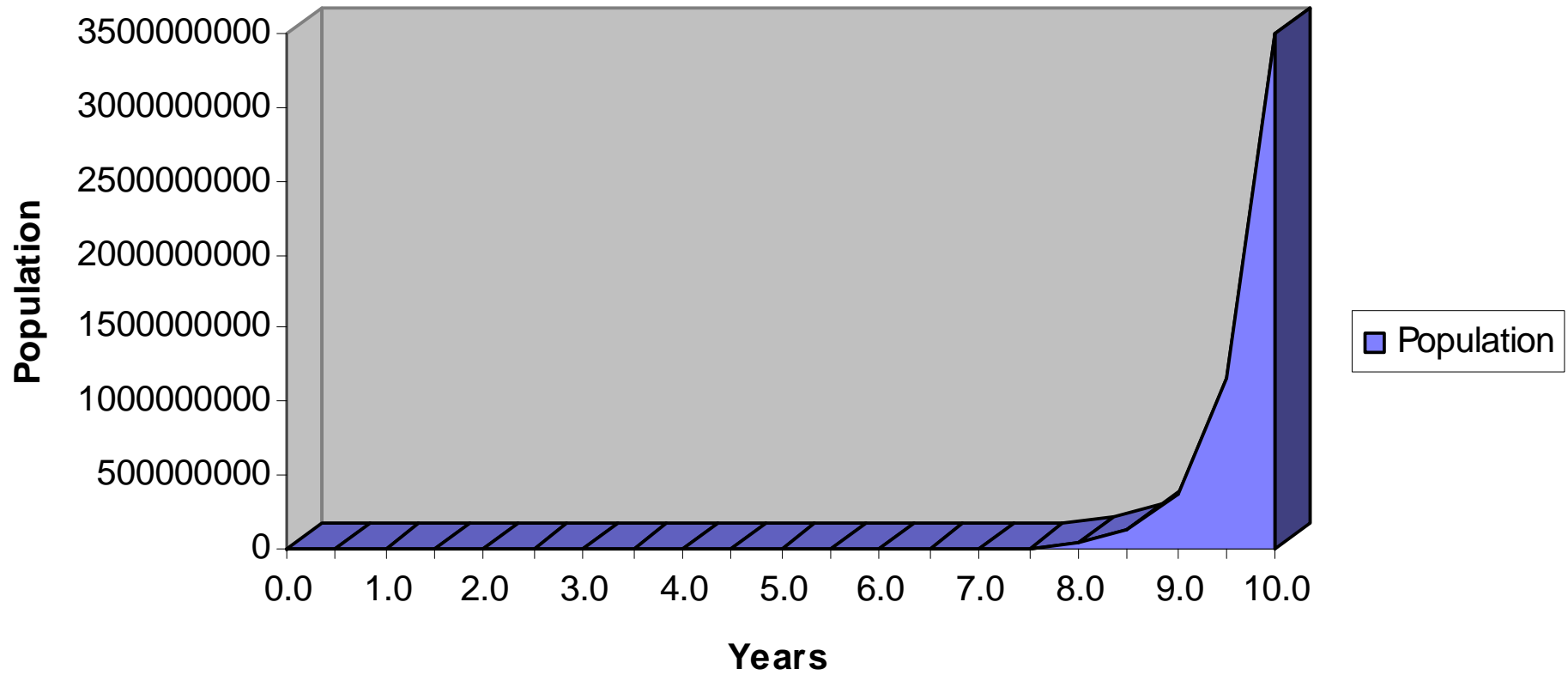
Growth Profile of Biological System



Growth Profile of Biological System



Growth Profile of Biological System



**Now is the Time
for all people
to come to the aid
of the planet**

**Working
Together for**



**the
Health of
the World**

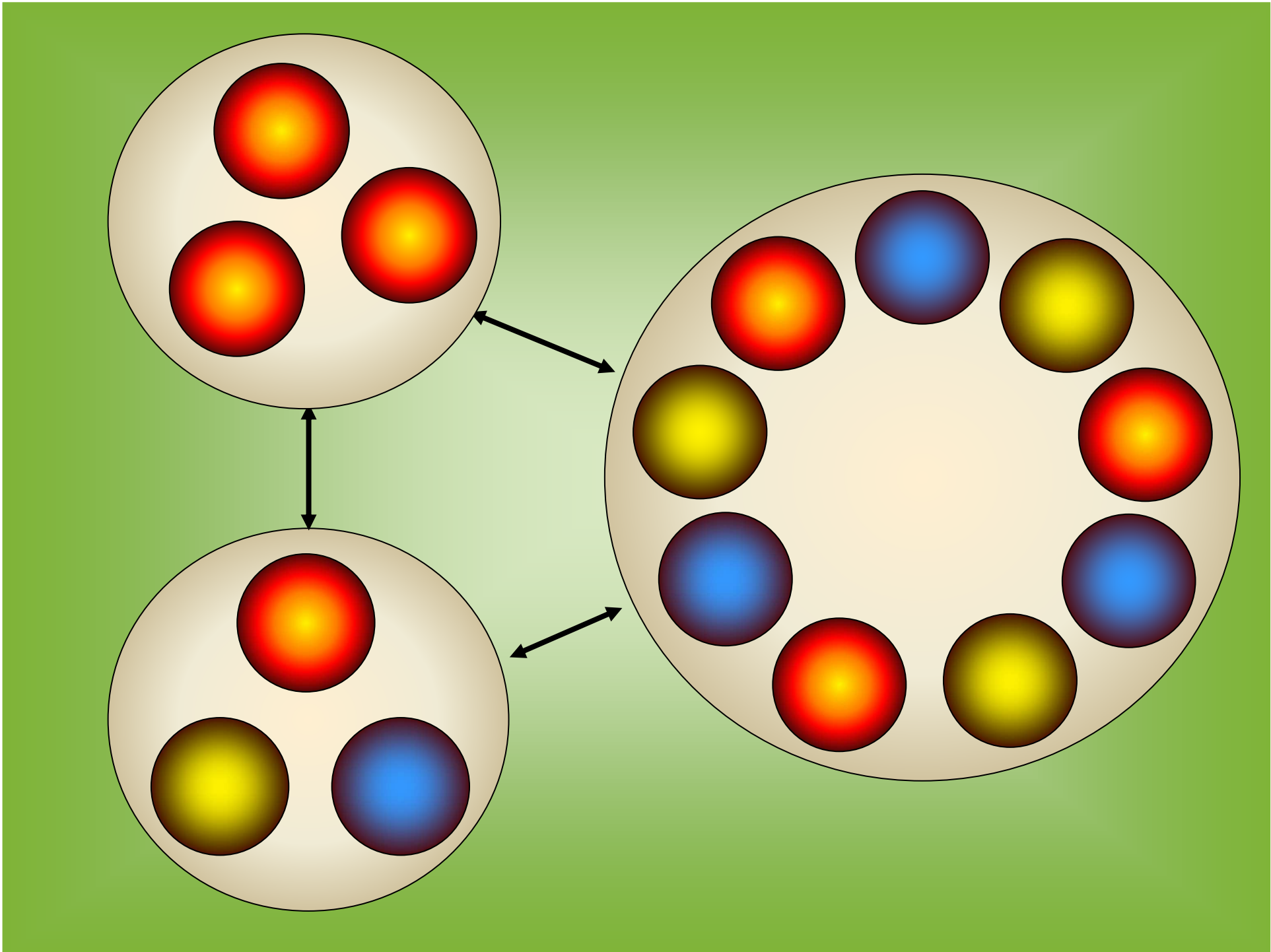




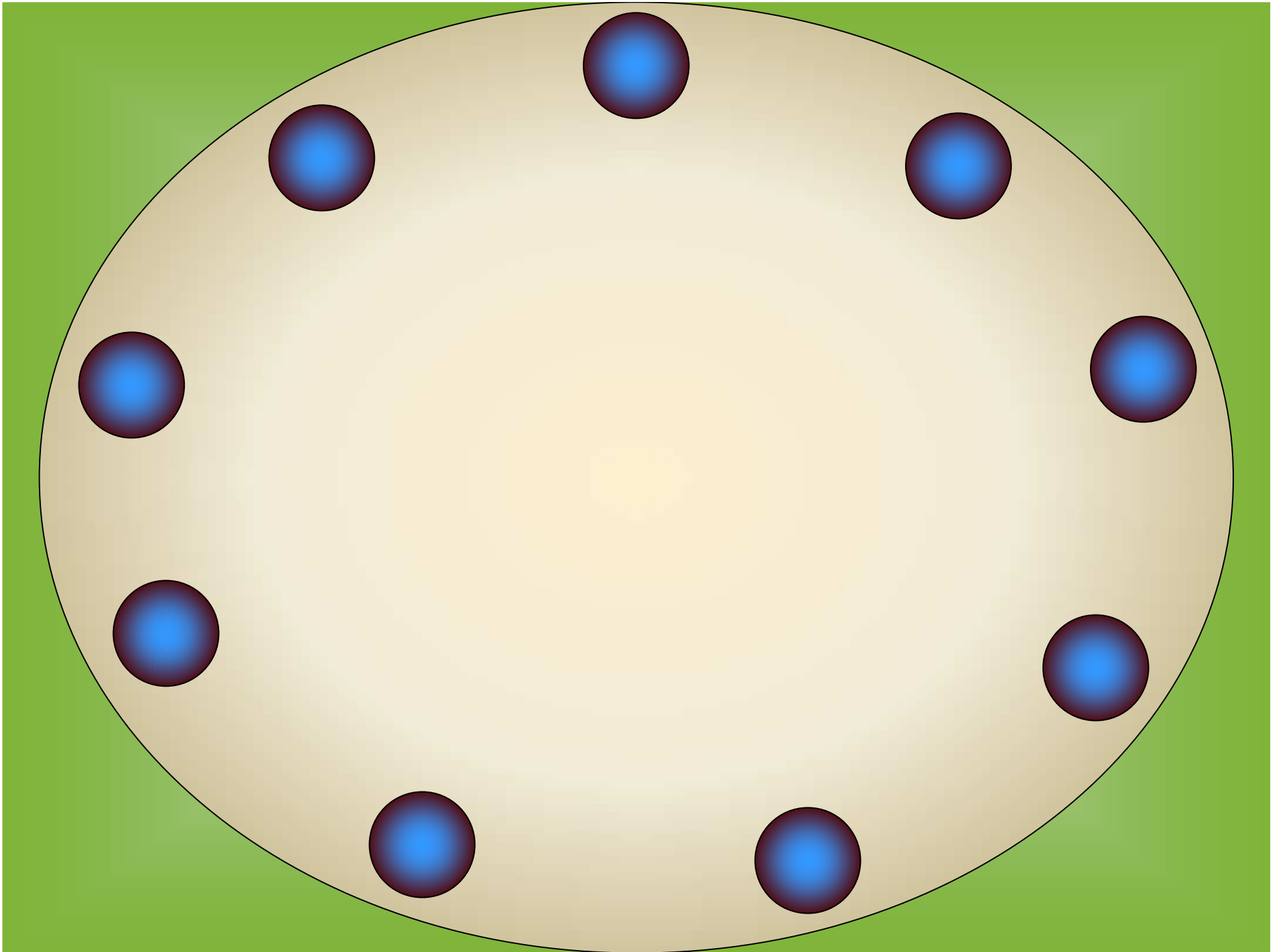
MERIDIAN CONGRESS

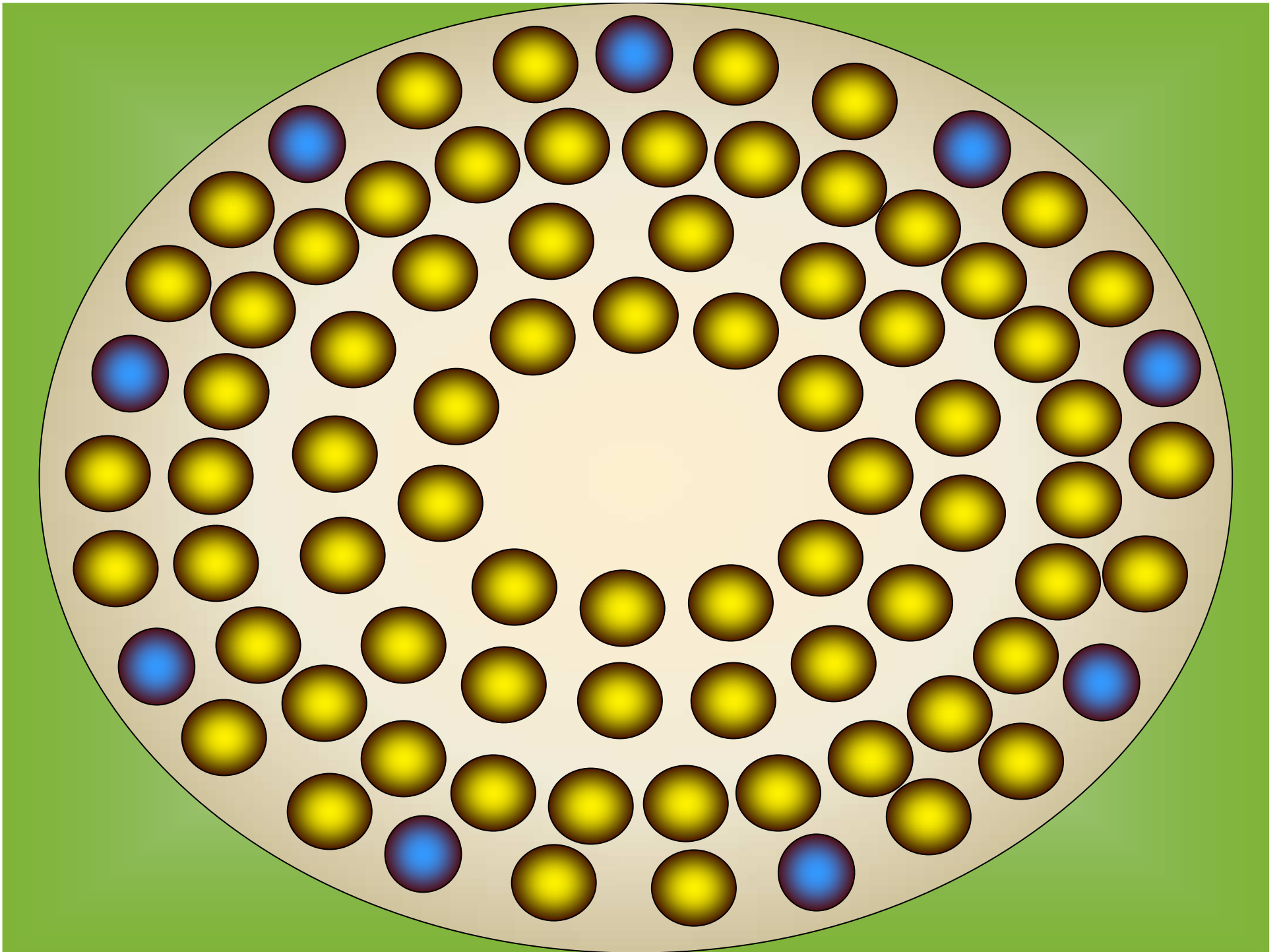
**Exploring the
Psychodynamics
of Complexity**

**The Congress starts with
a 3x3 Consultancy
Training Matrix
Lasting three days**

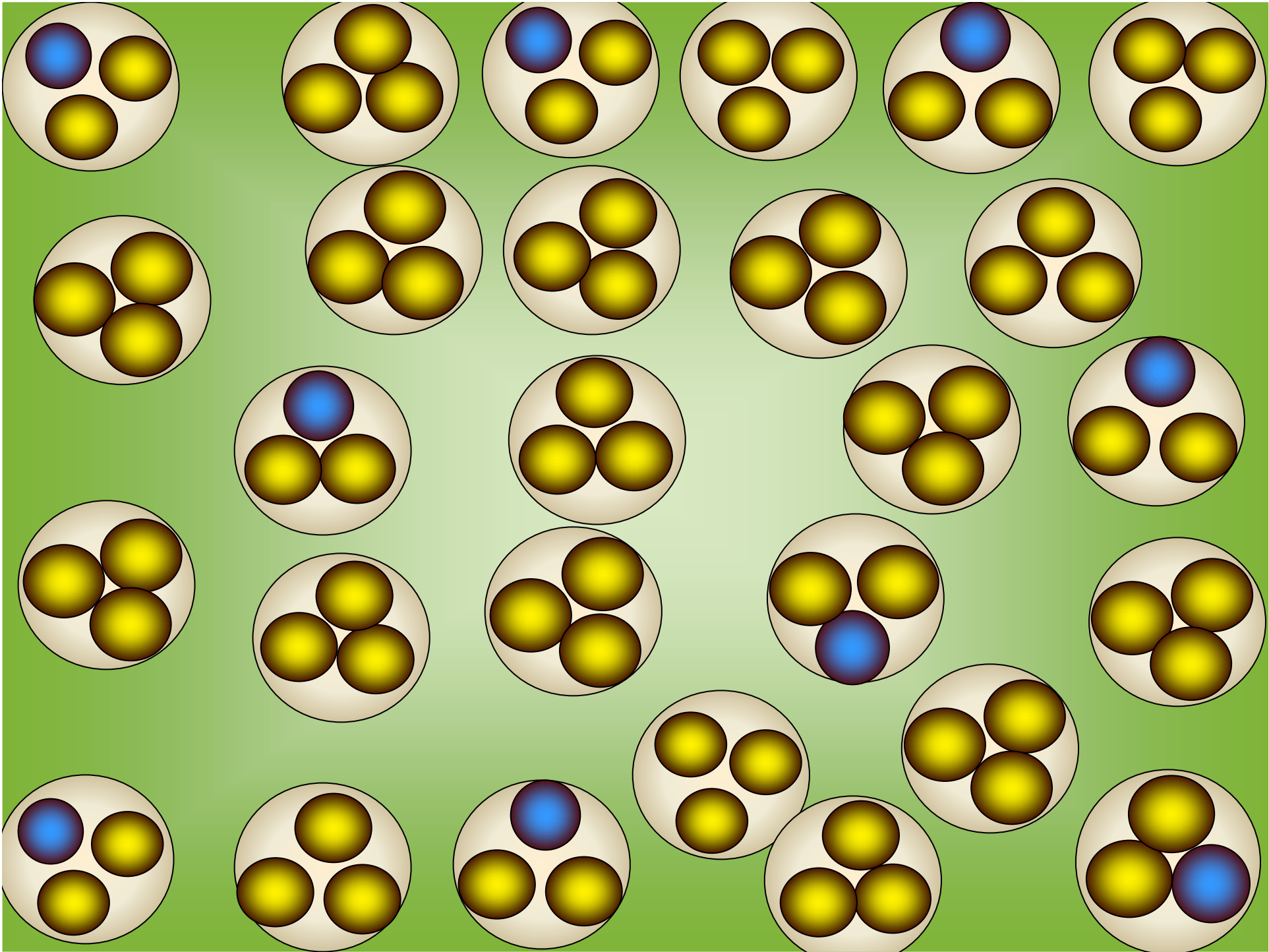


**This is Followed
by a five-day event
with a further
seventy-two places**

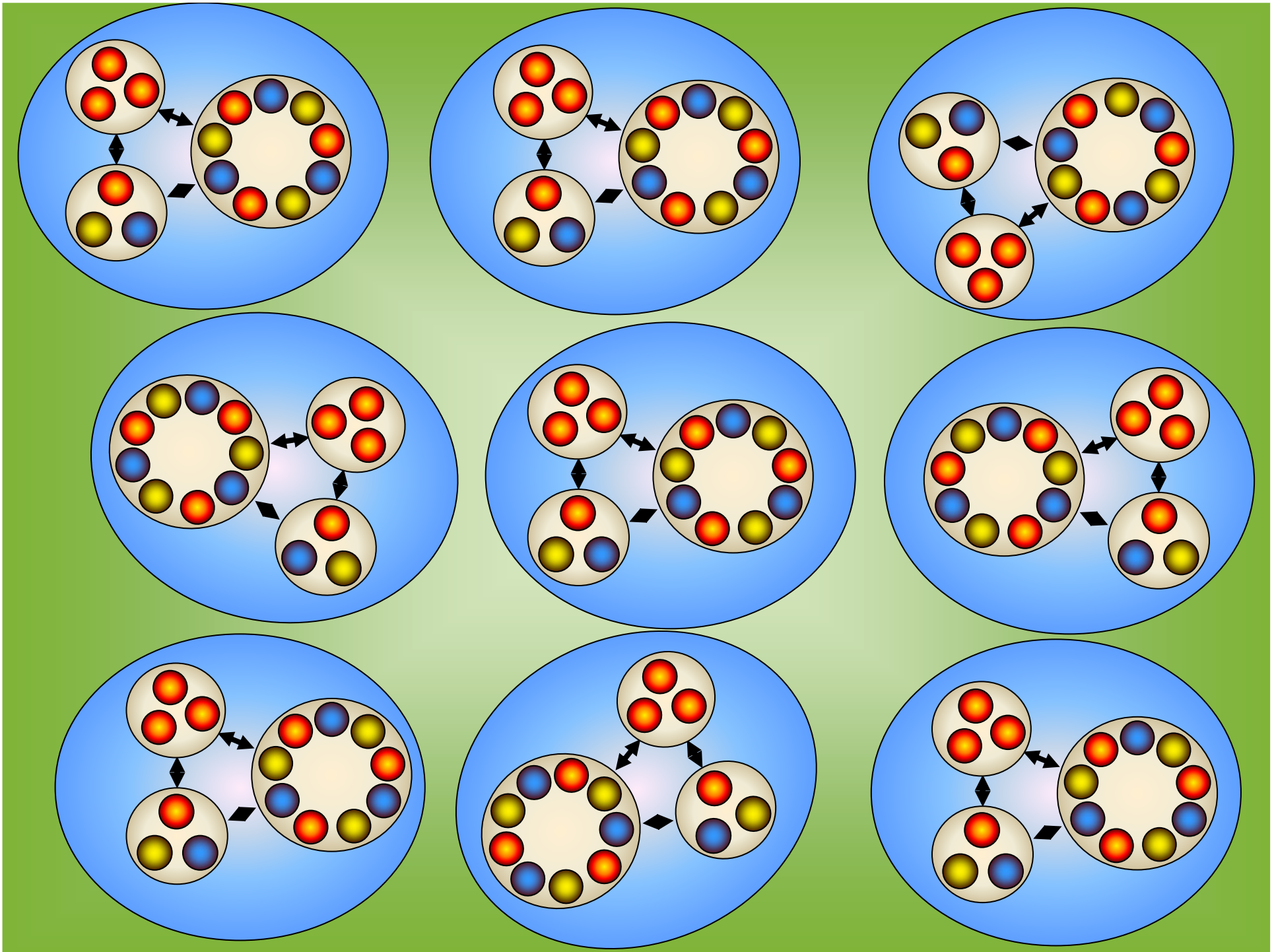




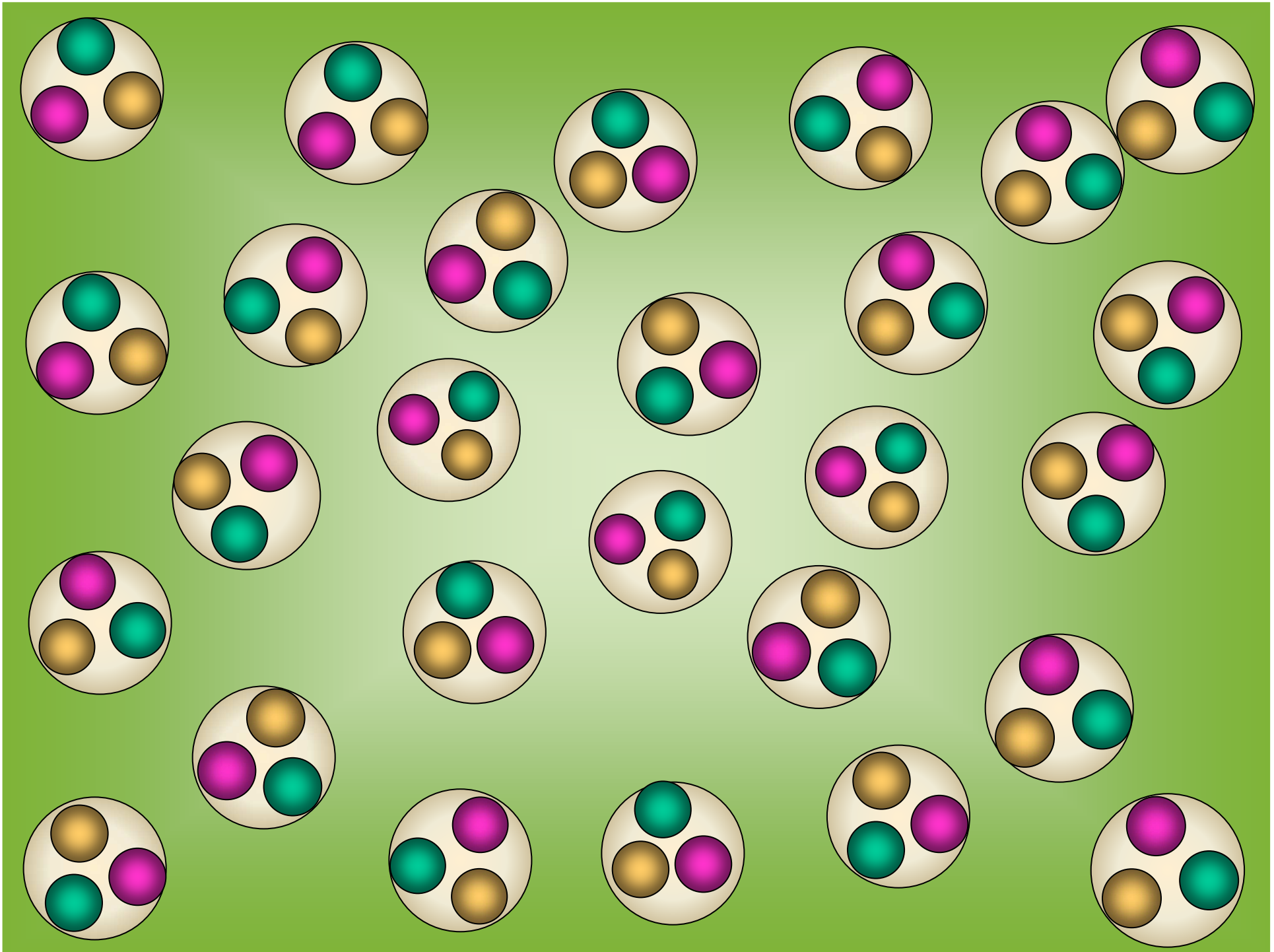
**Twenty-seven Triads are formed,
with not more
than one Consultant
in each**



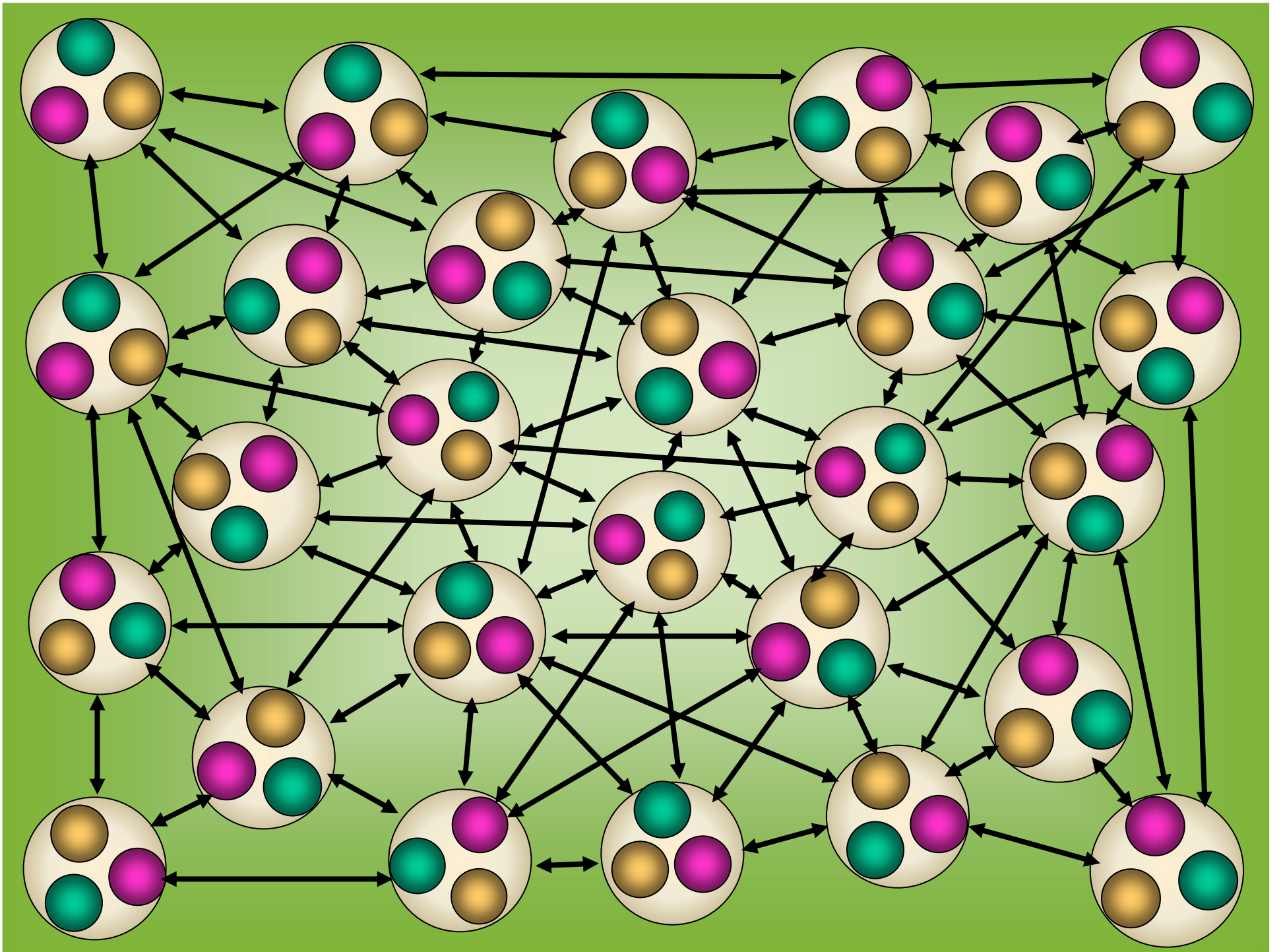
**Each Triad works with two
other Triads to form
Nine 3x3 Matrix cells
with one Consultant
per cell**



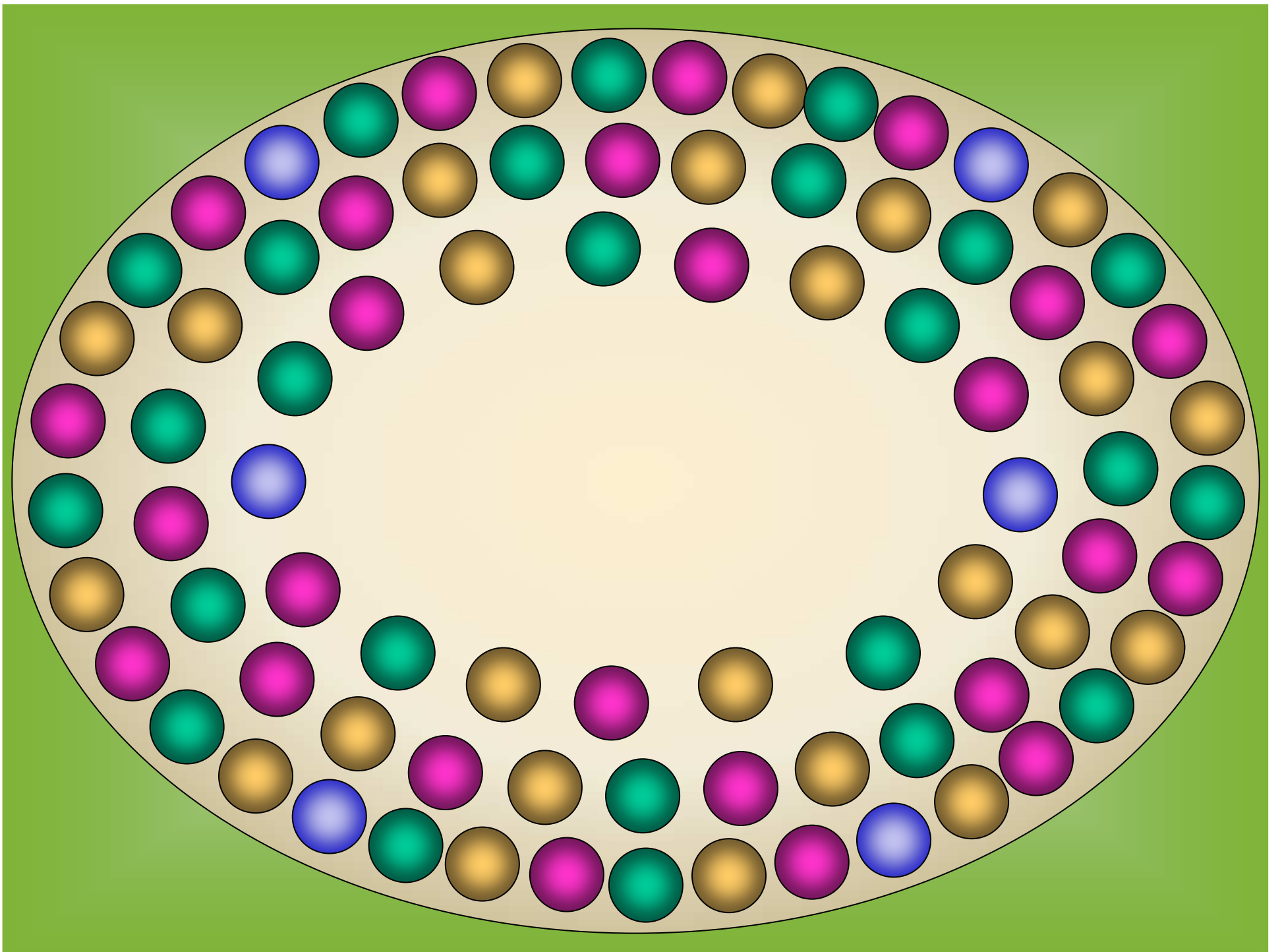
**For the Complexity Event
one person from each sector
works with one person
from each of two other sectors
forming inter-sector Triads**



Inter-sector Triads
also explore
Relationships with
each other



**All members also
work together
as a large group
with six consultants**



**The Congress concludes with
a further 3x3 Consultancy
Training and Review Matrix
Lasting two days**

