

# **F 604 Física Estatística**

*O objetivo do curso é estudar as leis e o comportamento das partículas – átomos, moléculas,... - que compõe os sistemas físicos e sua relação com as propriedades macroscópicas desses sistemas físicos, sendo capaz de deduzí-las.*

*A física estatística estabelece uma ponte entre o mundo microscópico e o mundo macroscópico.*

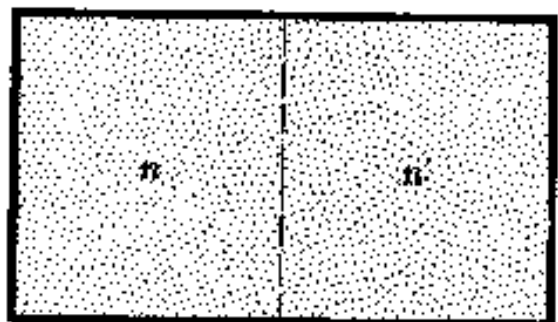
José A. Brum

Sala DFCEM 240

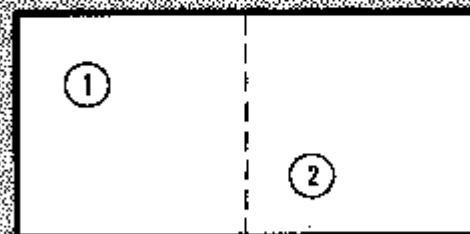
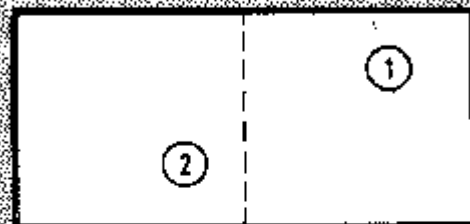
E-mail: [brum@ifi.unicamp.br](mailto:brum@ifi.unicamp.br)

<http://www.ifi.unicamp.br/~brum>

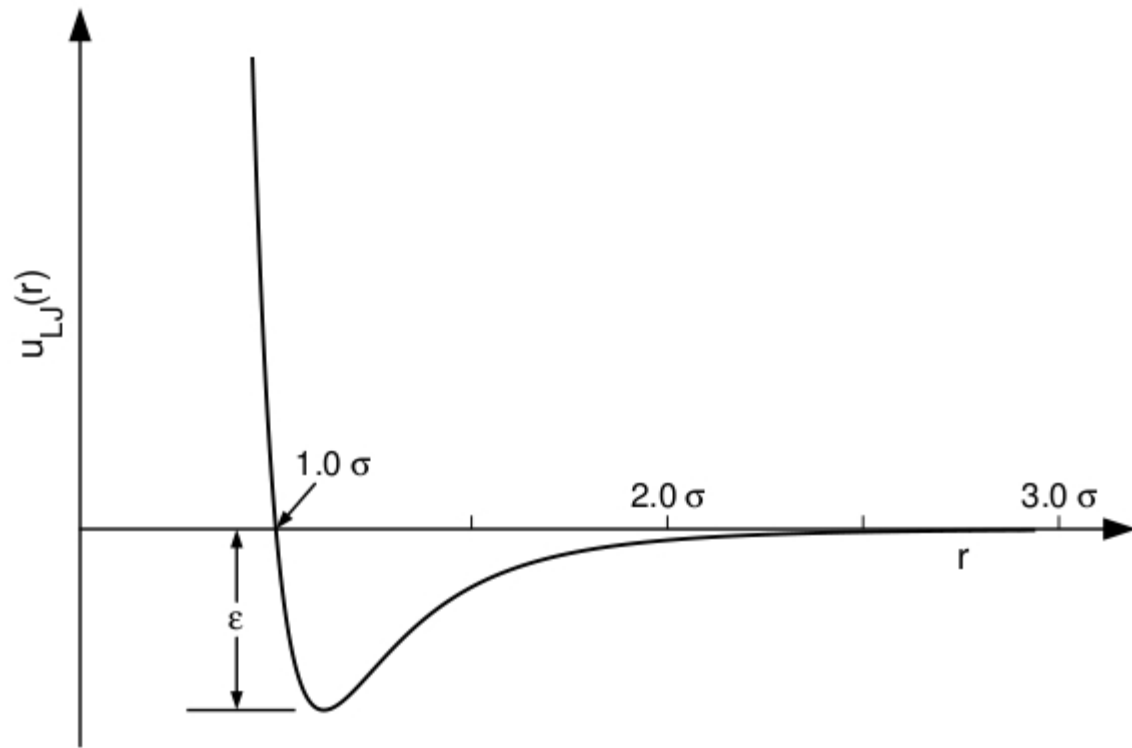
Partículas	Estado coletivo-Propriedade macroscópica	Ordens de grandeza típicas
moléculas	sólidos, líquidos, gases - pressão, densidade	sólidos- $10^{24}$ átomos/ $cm^3$
spins	magnetização	
elétrons	condutividade	Cu: $10^{23}$ elétrons/ $cm^3$
fótons	radiação eletromagnética	
neurônios	memória, cálculo	ser humano: $10^{10}$ neurônios, $10^4$ sinapses por neurônio
agentes financeiros	bolsa de ações	ação líquida $\sim 10^5 - 10^6$ transações por ação líquida/mês
DNA	comportamento da célula, vida	$3 \times 10^9$ pares de base, $\sim 2500$ gens

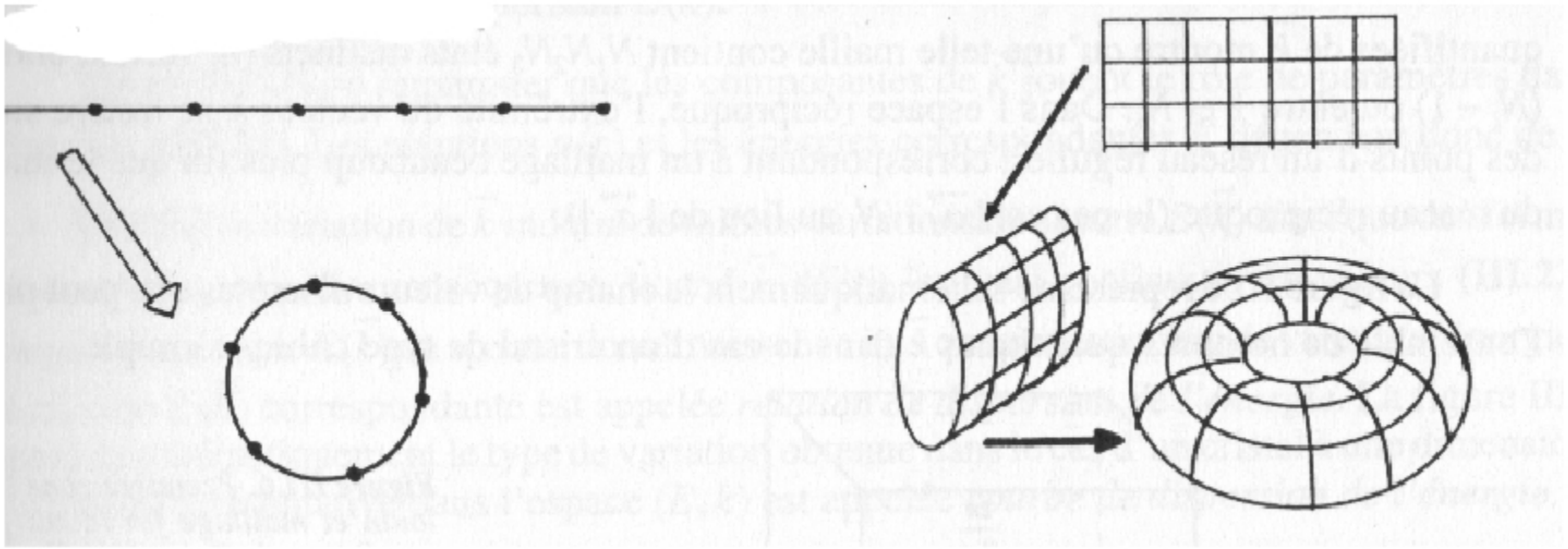


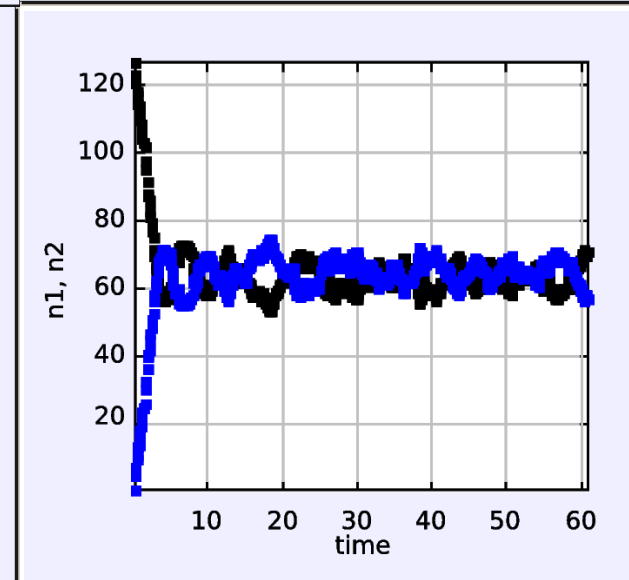
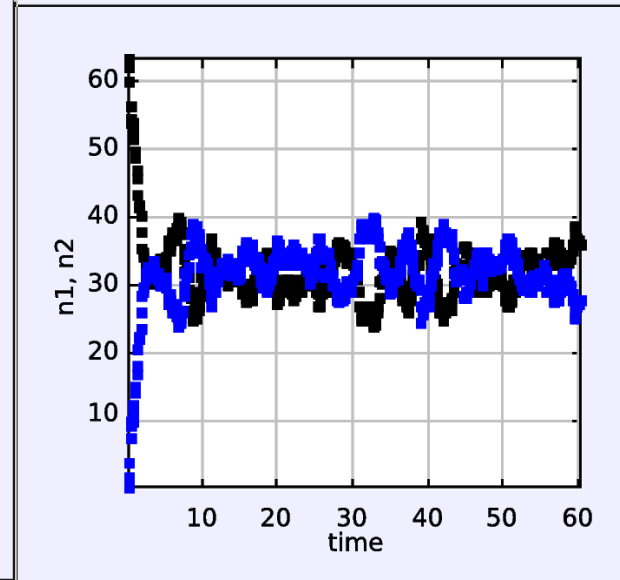
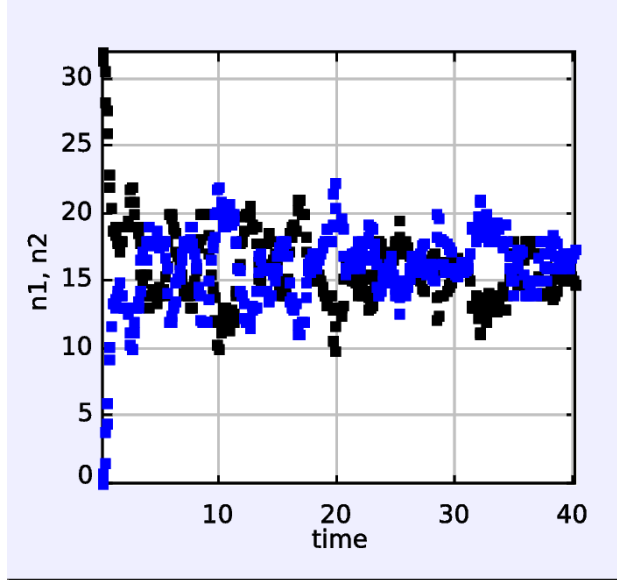
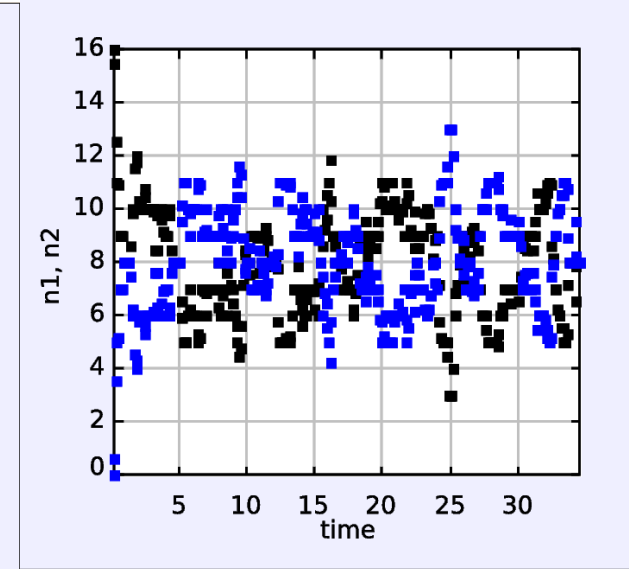
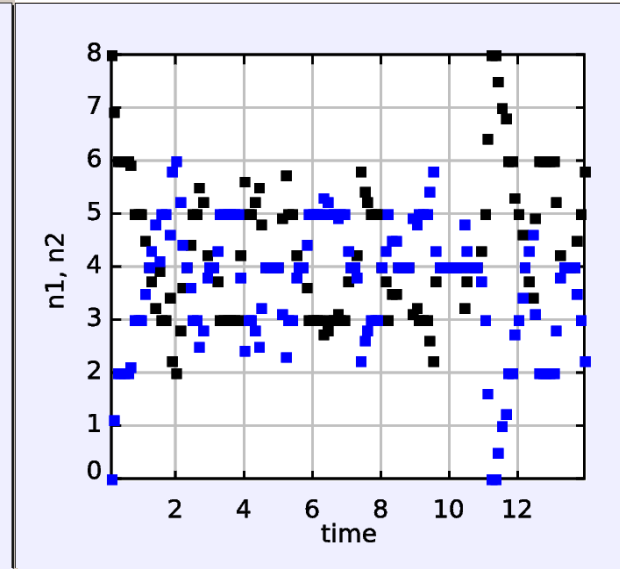
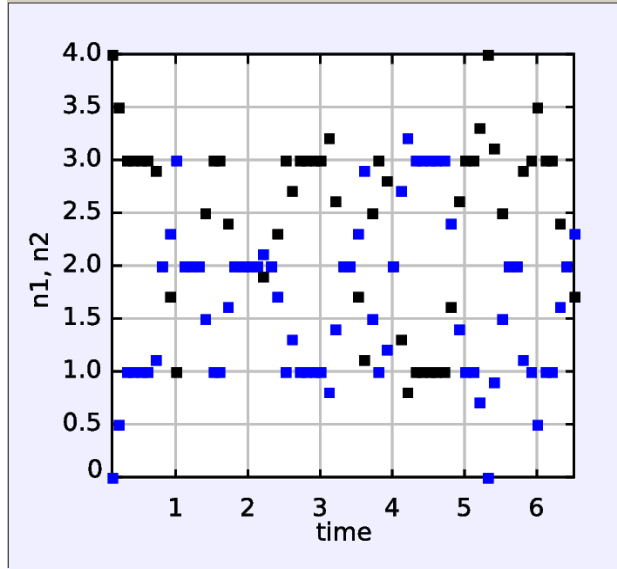
$$n + n' = N$$

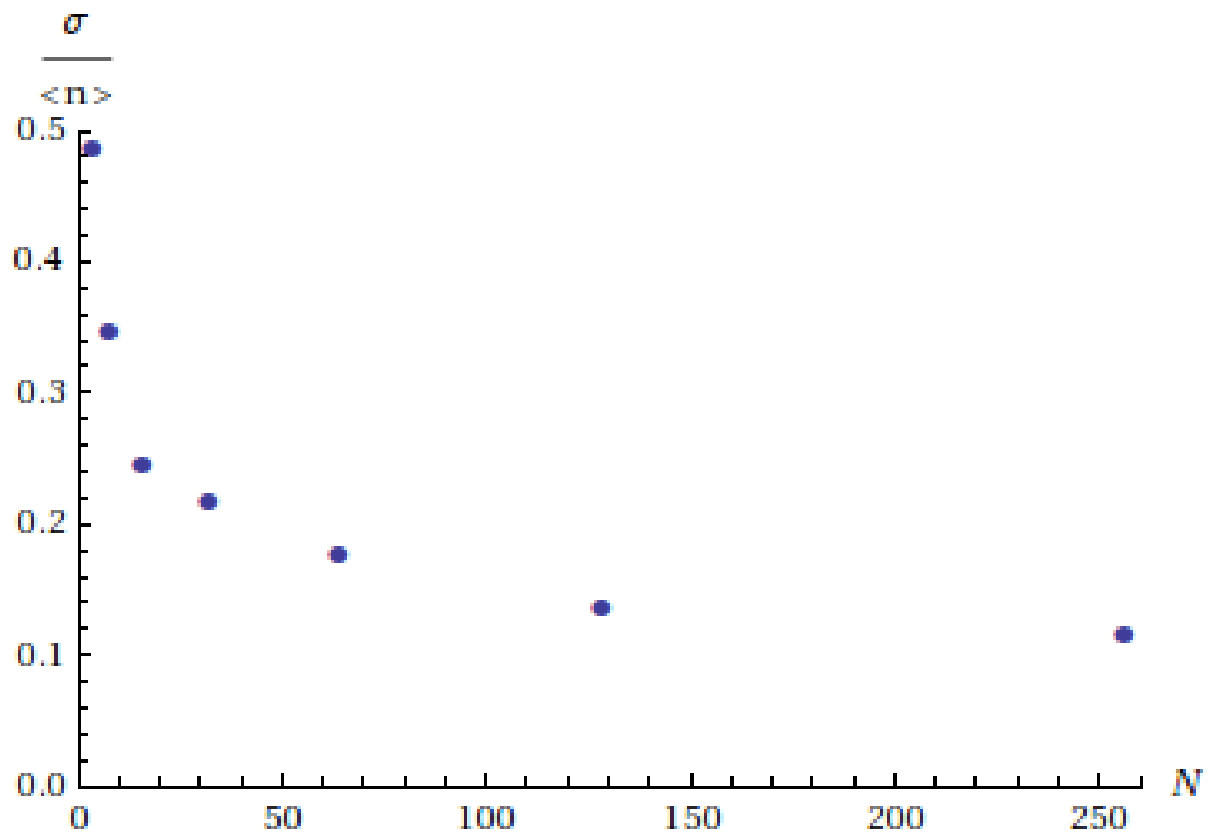


<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	$n$	$n'$	$C(n)$
E	E	E	E	4	0	1
E	E	E	D	3	1	4
E	E	D	E	3	1	
E	D	E	E	3	1	
D	E	E	E	3	1	
E	E	D	D	2	2	6
E	D	E	D	2	2	
E	D	D	E	2	2	
D	E	E	D	2	2	
D	E	D	E	2	2	
D	D	E	E	2	2	
E	D	D	D	1	3	4
D	E	D	D	1	3	
D	D	E	D	1	3	
D	D	D	E	1	3	
D	D	D	D	0	4	1

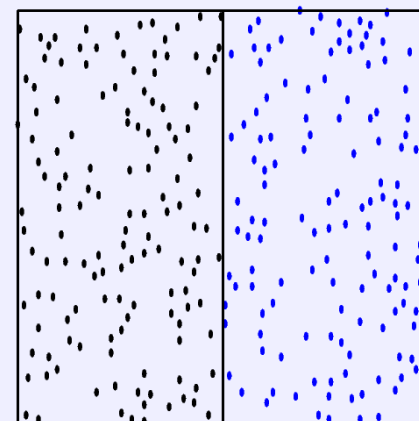
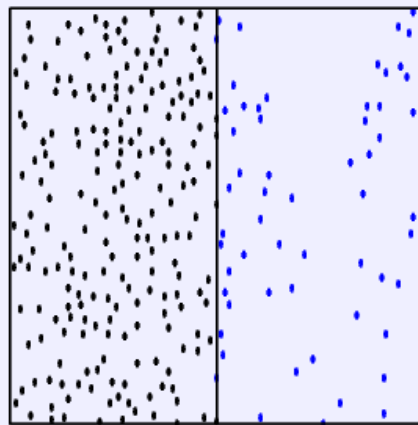
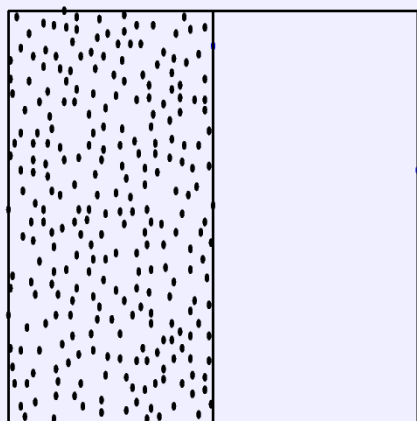
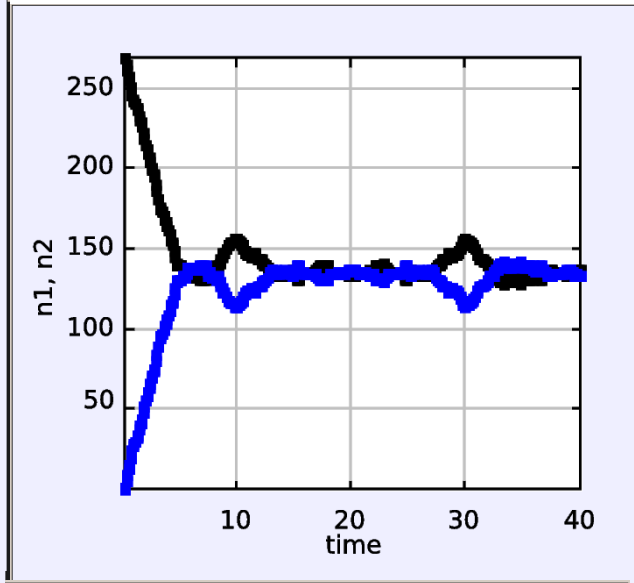
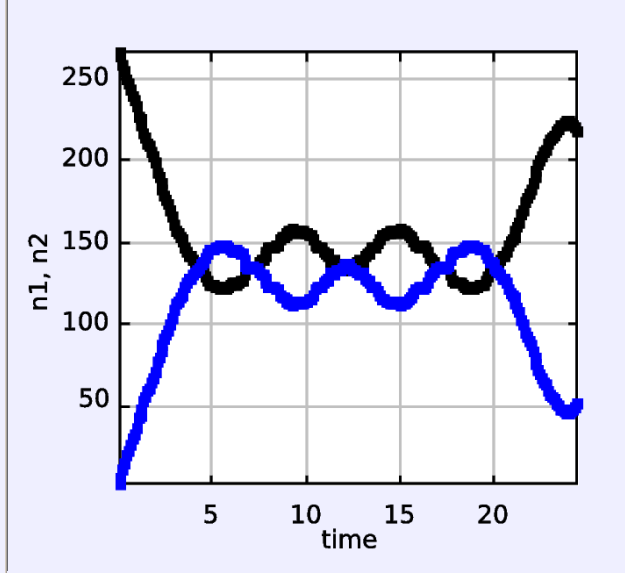
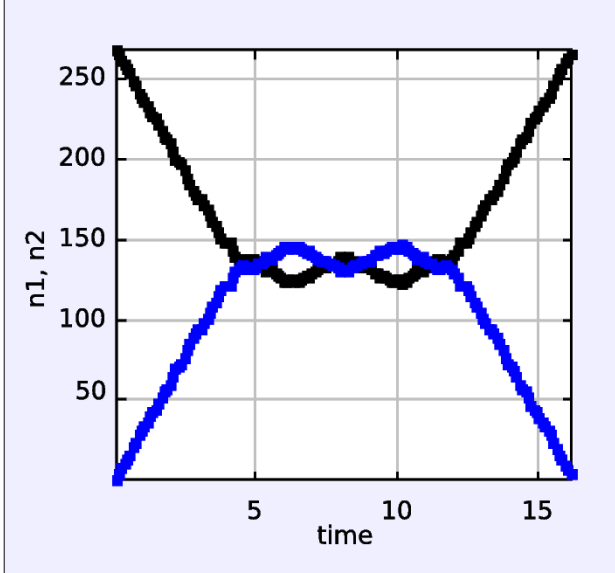


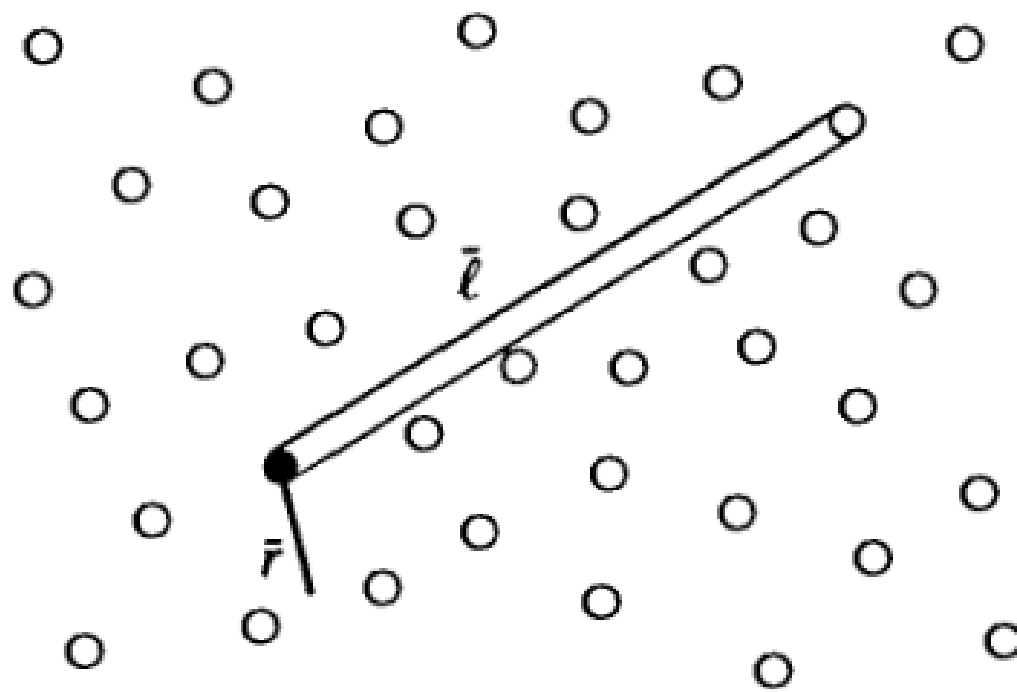


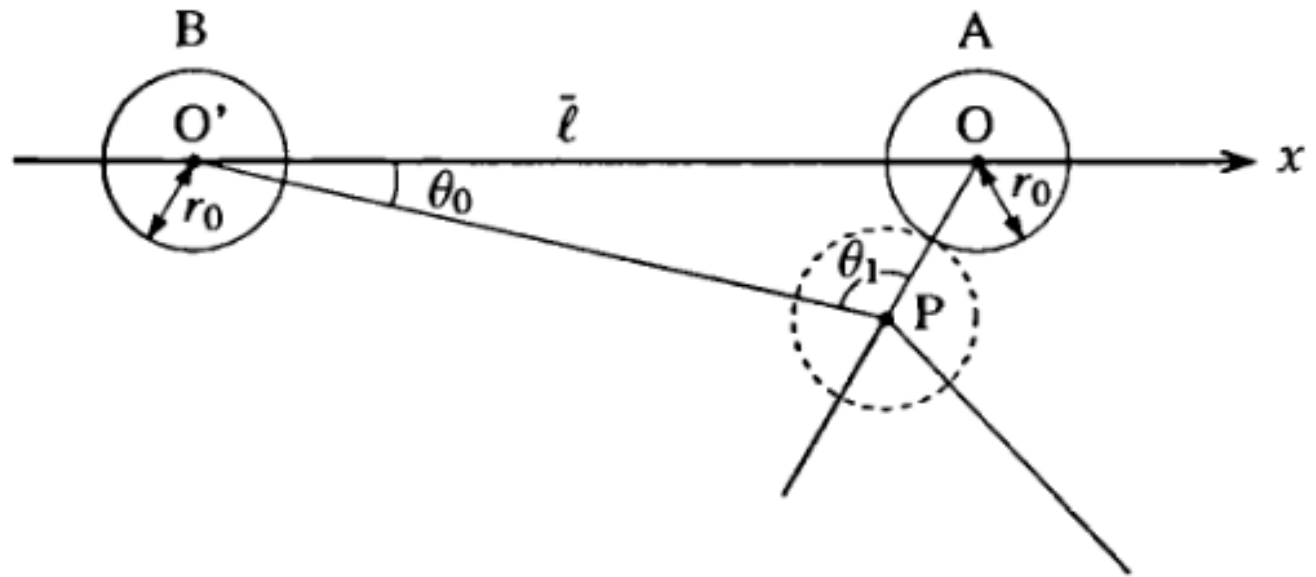


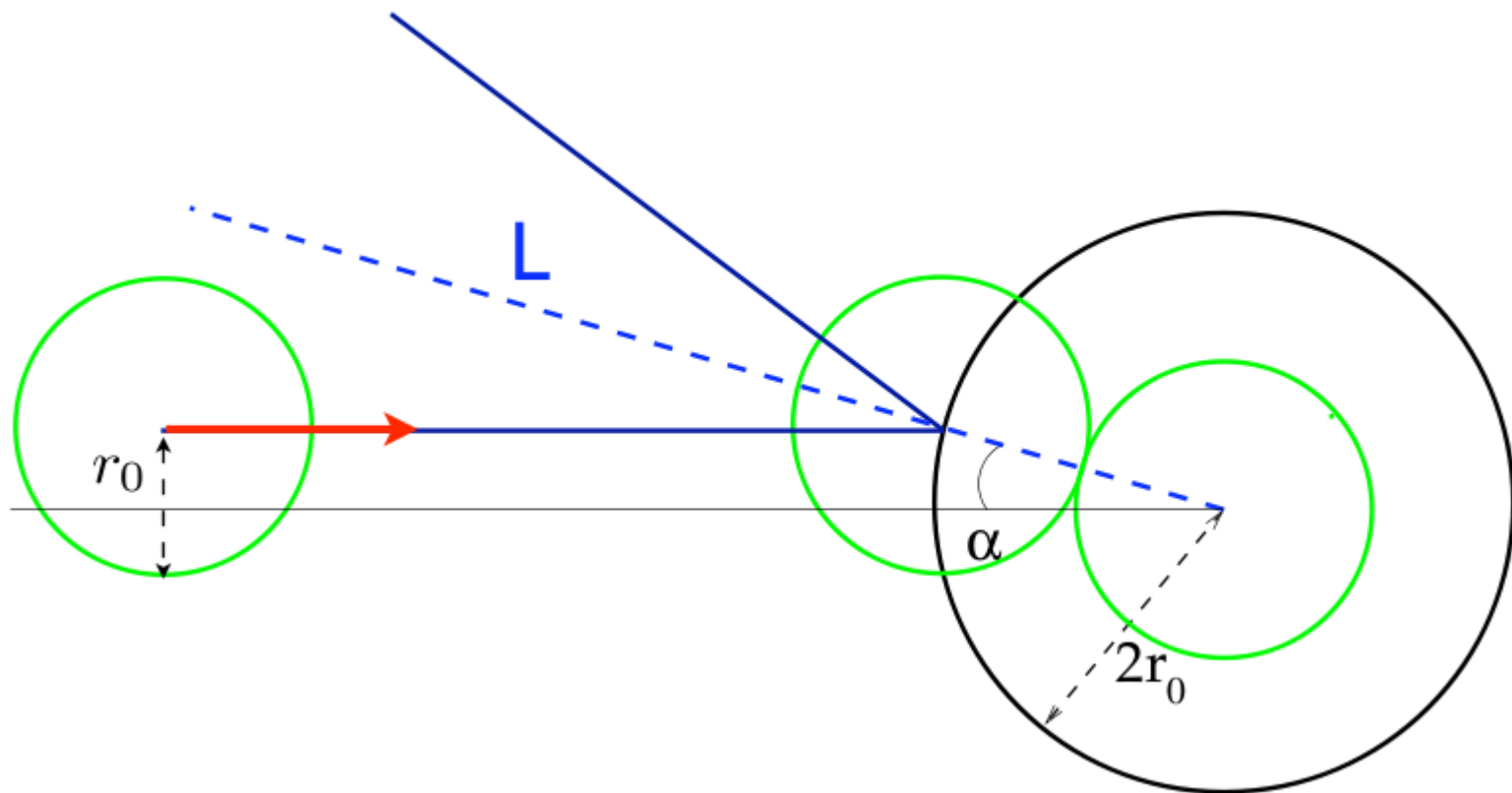


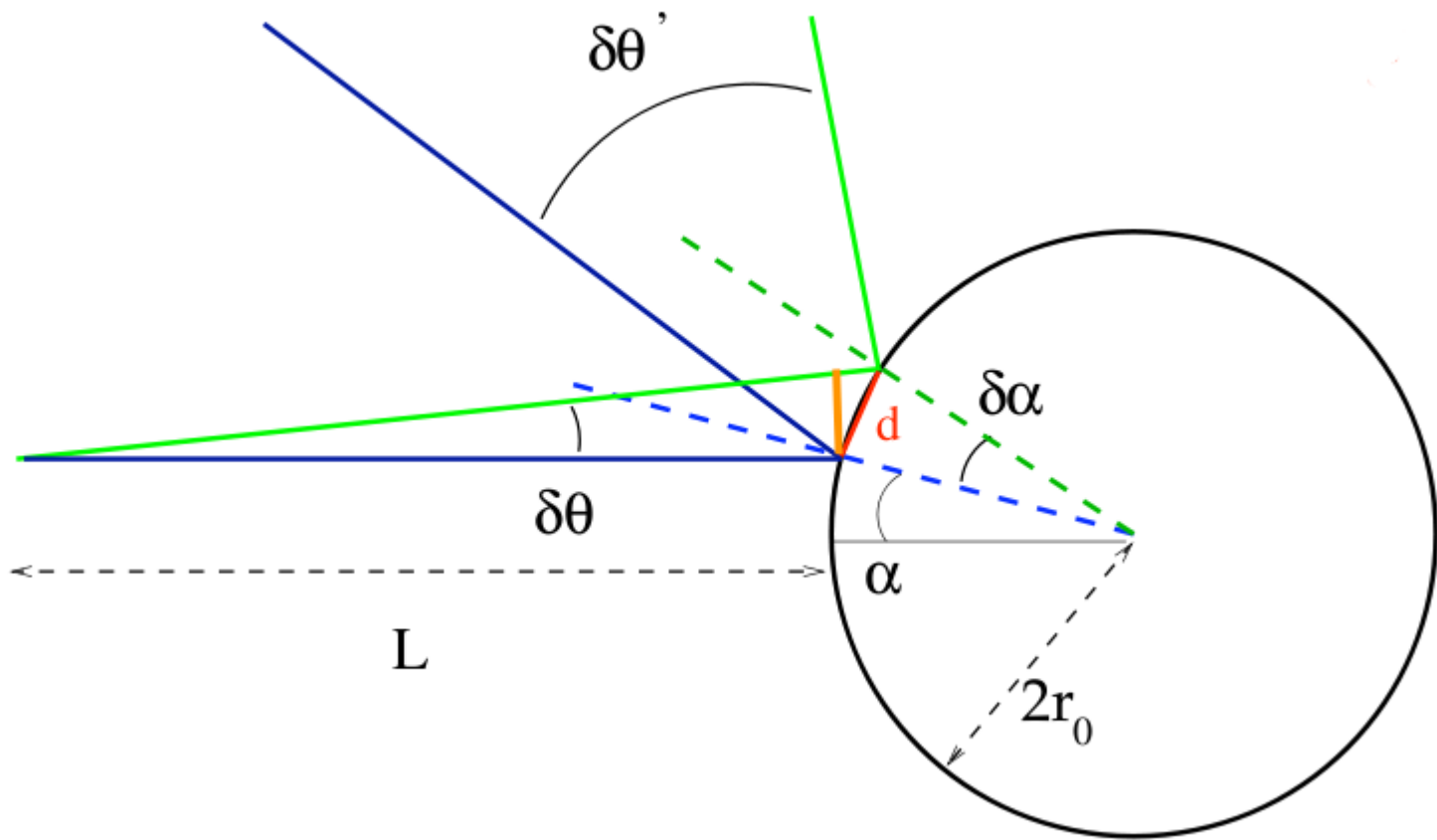


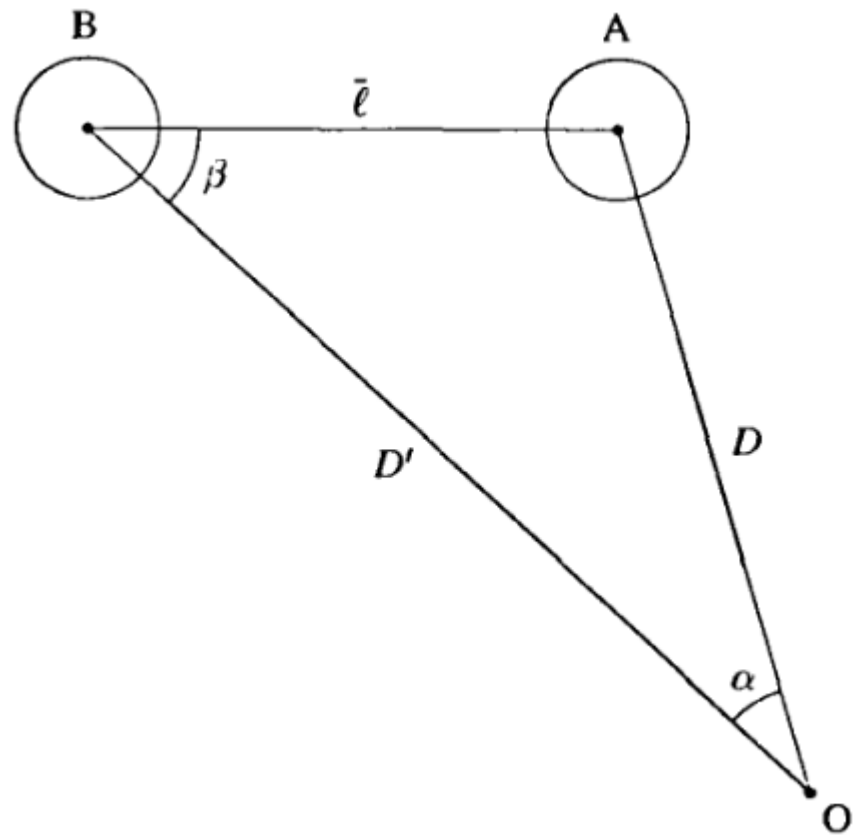


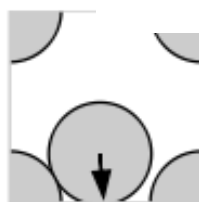
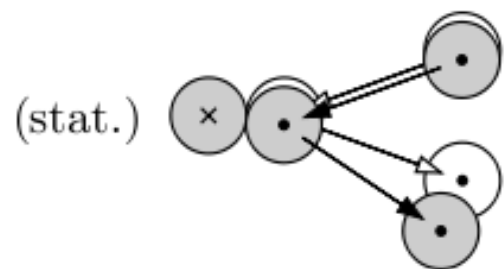




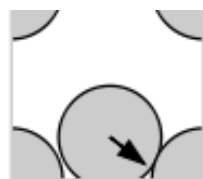




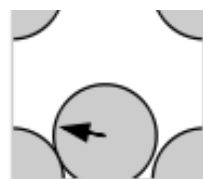




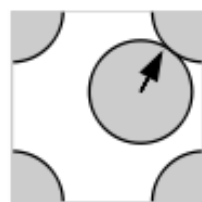
$t = 0$



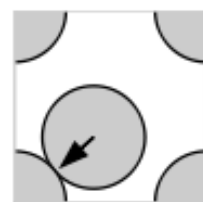
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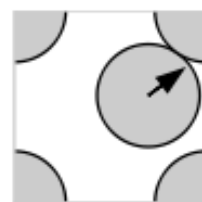
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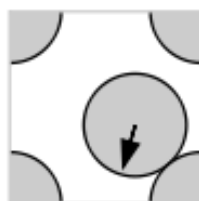
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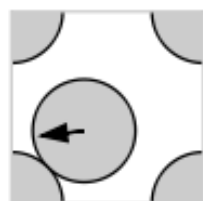
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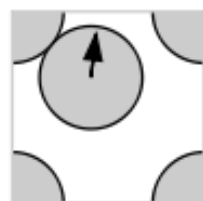
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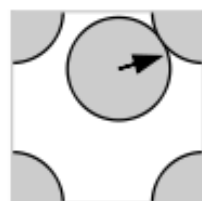
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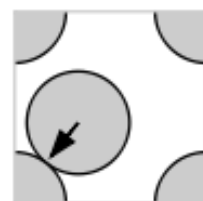
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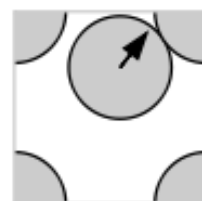
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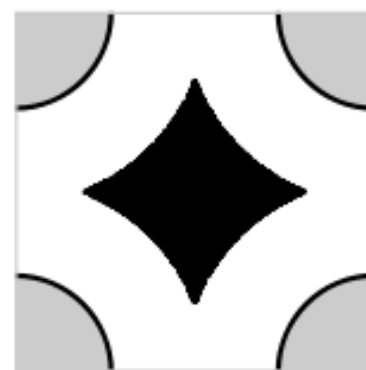
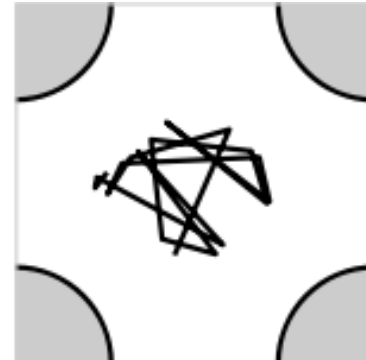
$t = 2.29$



$t = 2.69$

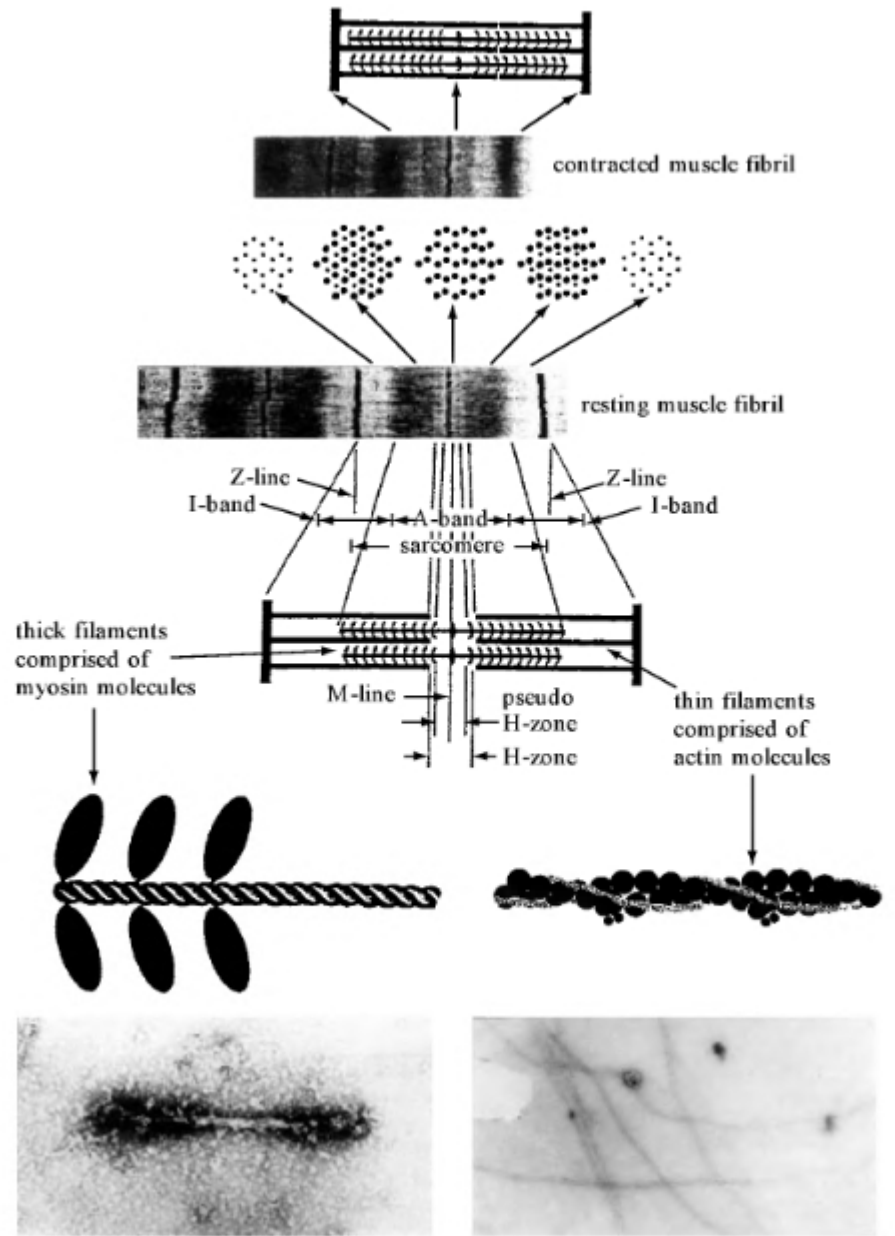
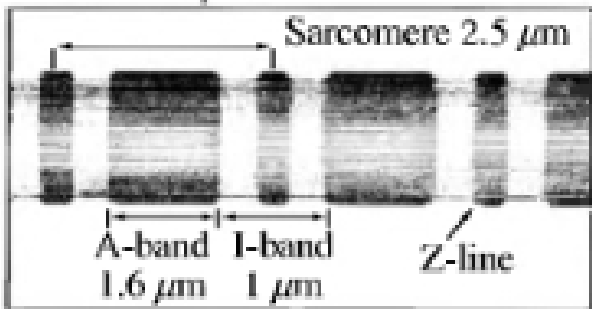
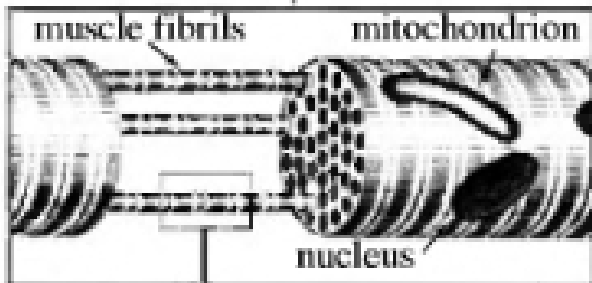
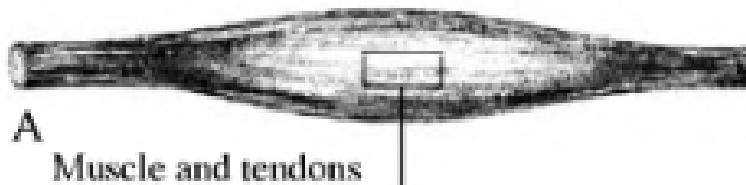


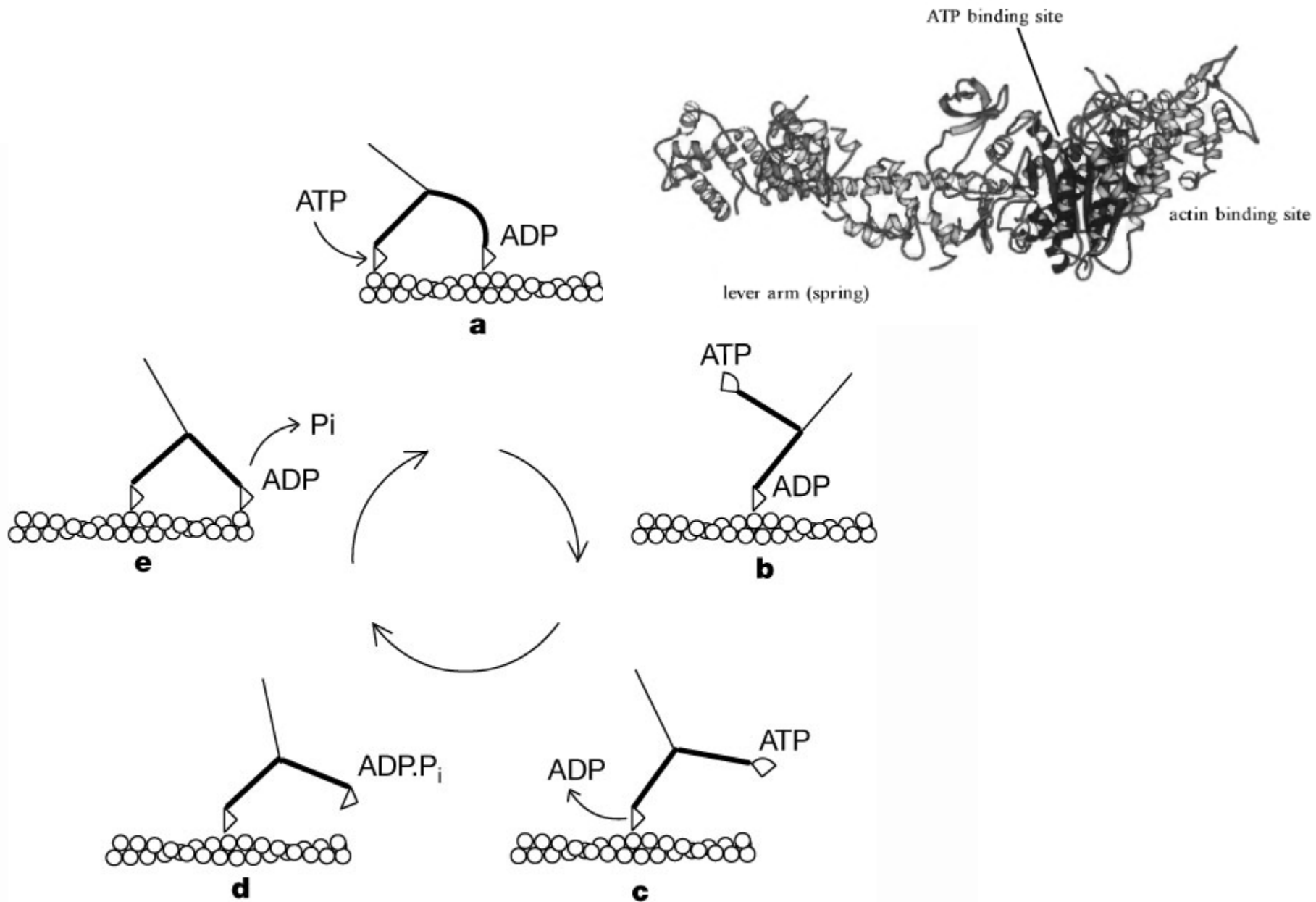
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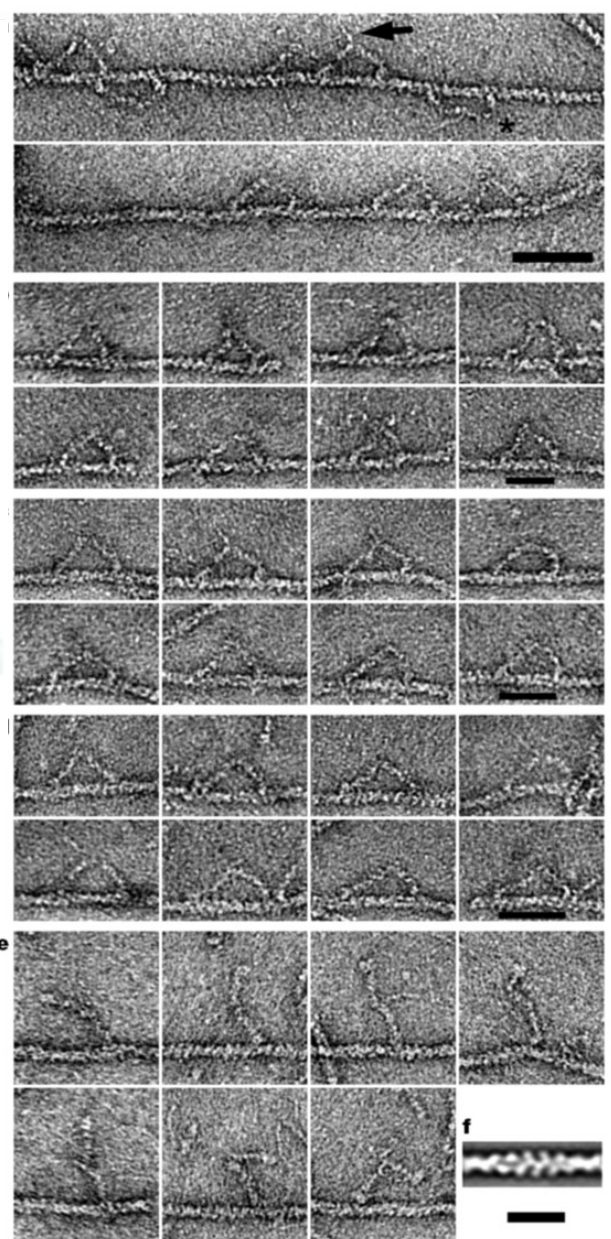
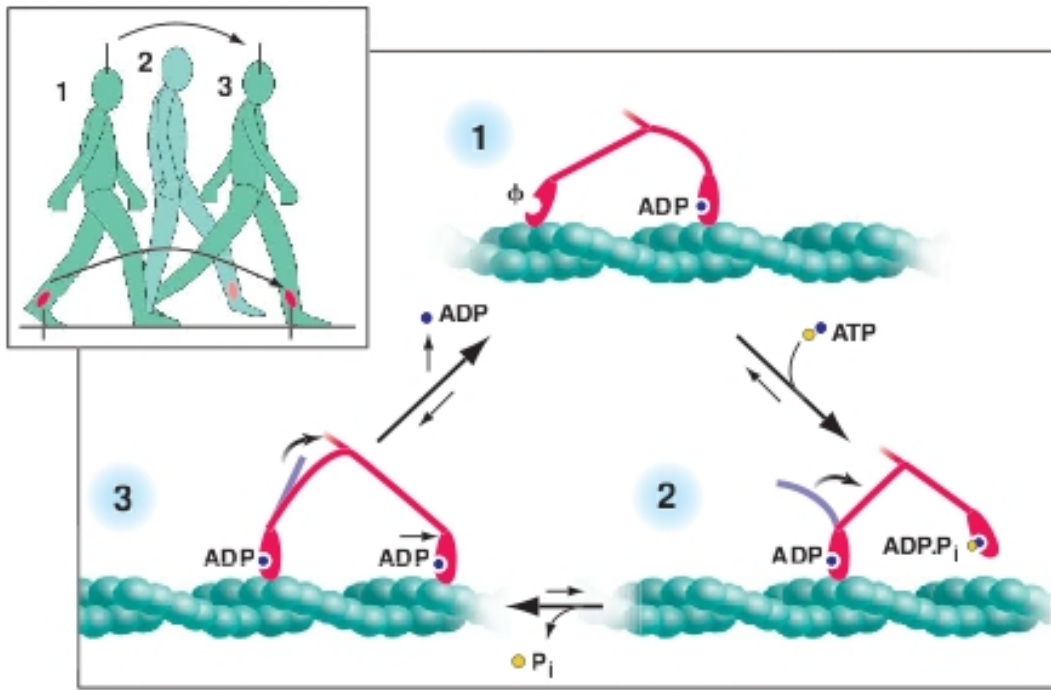










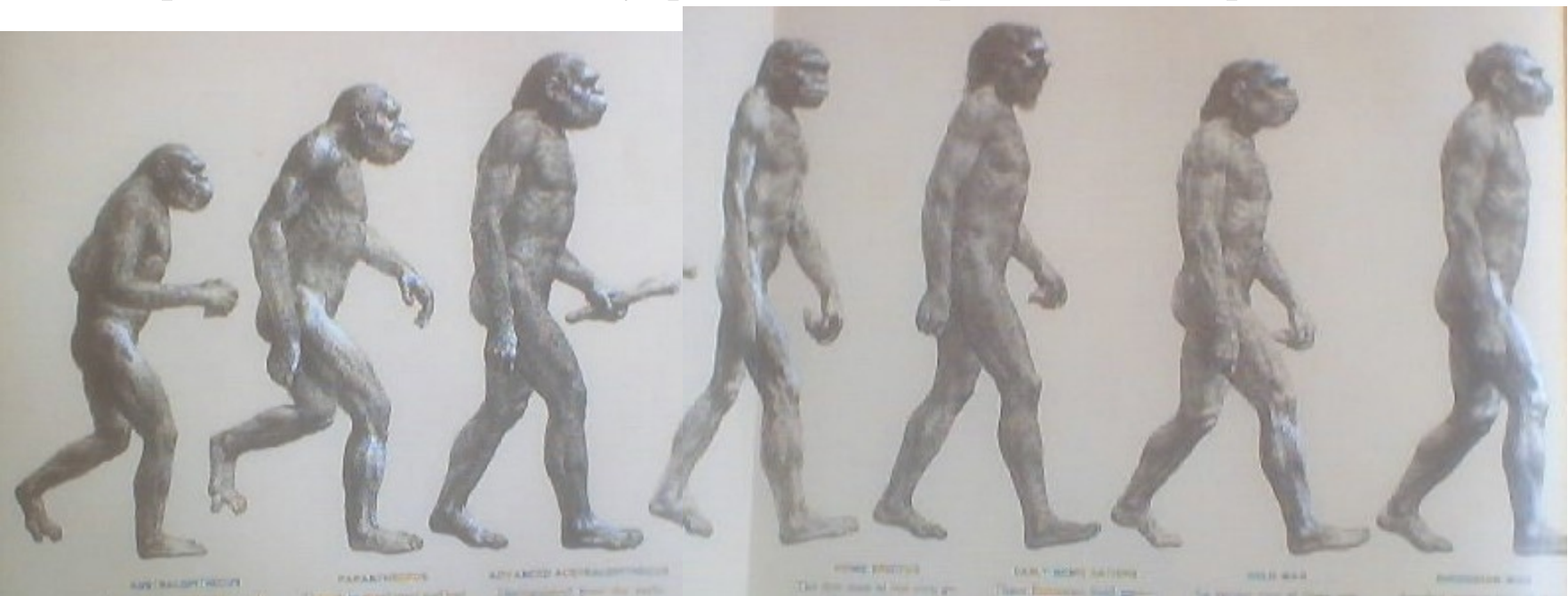




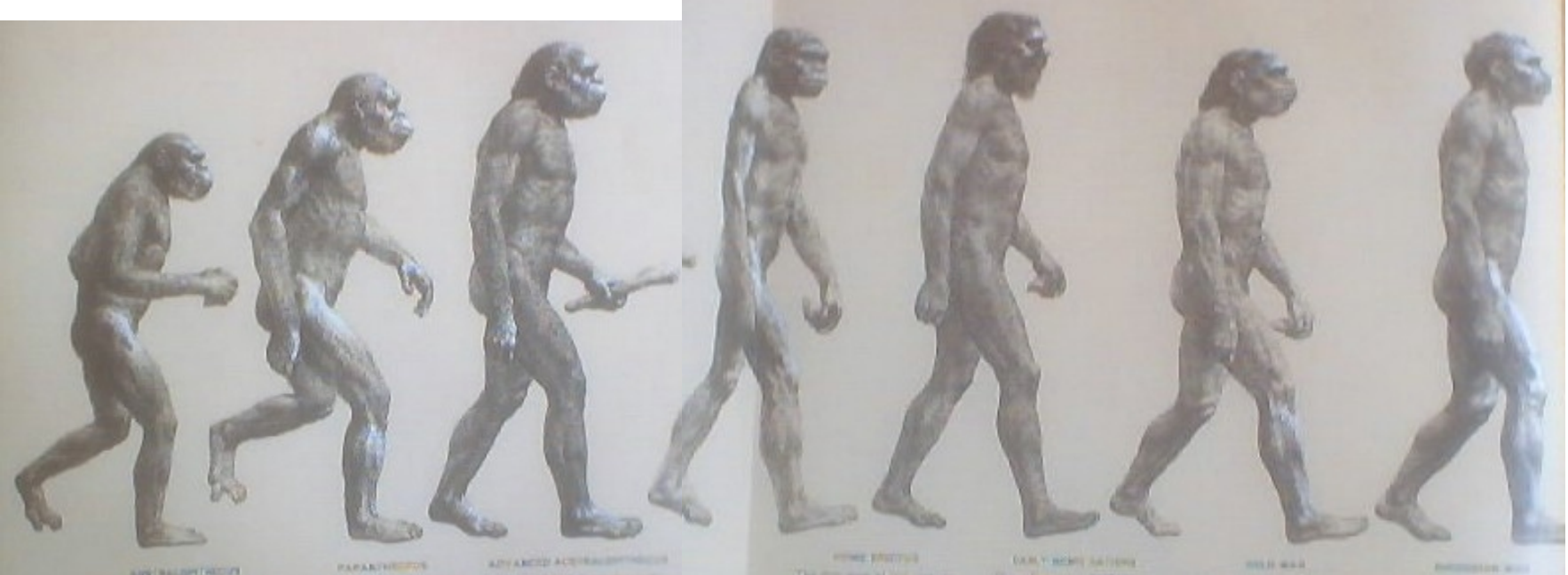
Pliopithecus, Pronconsul, Dryopithecus, Oreopithecus, Ramapithecus



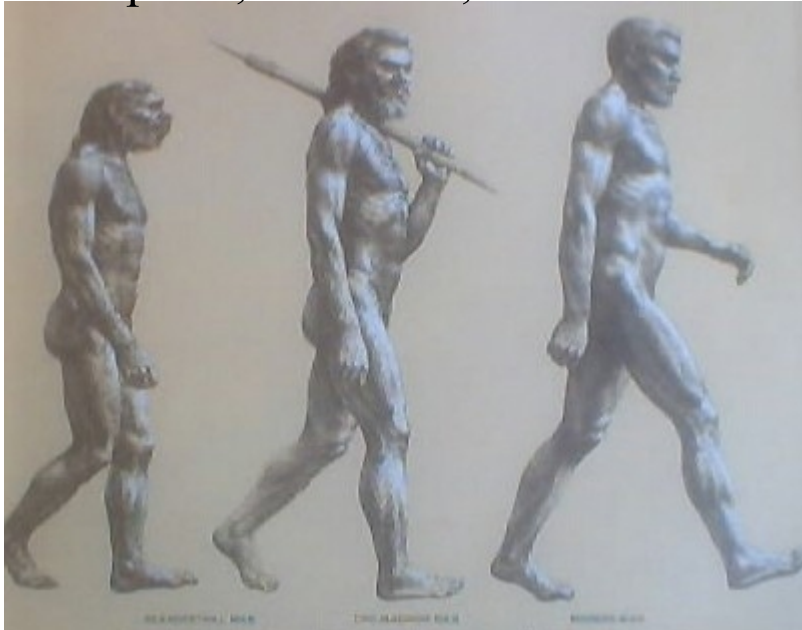
Pliopithecus, Proconsul, Dryopithecus, Oreopithecus, Ramapithecus



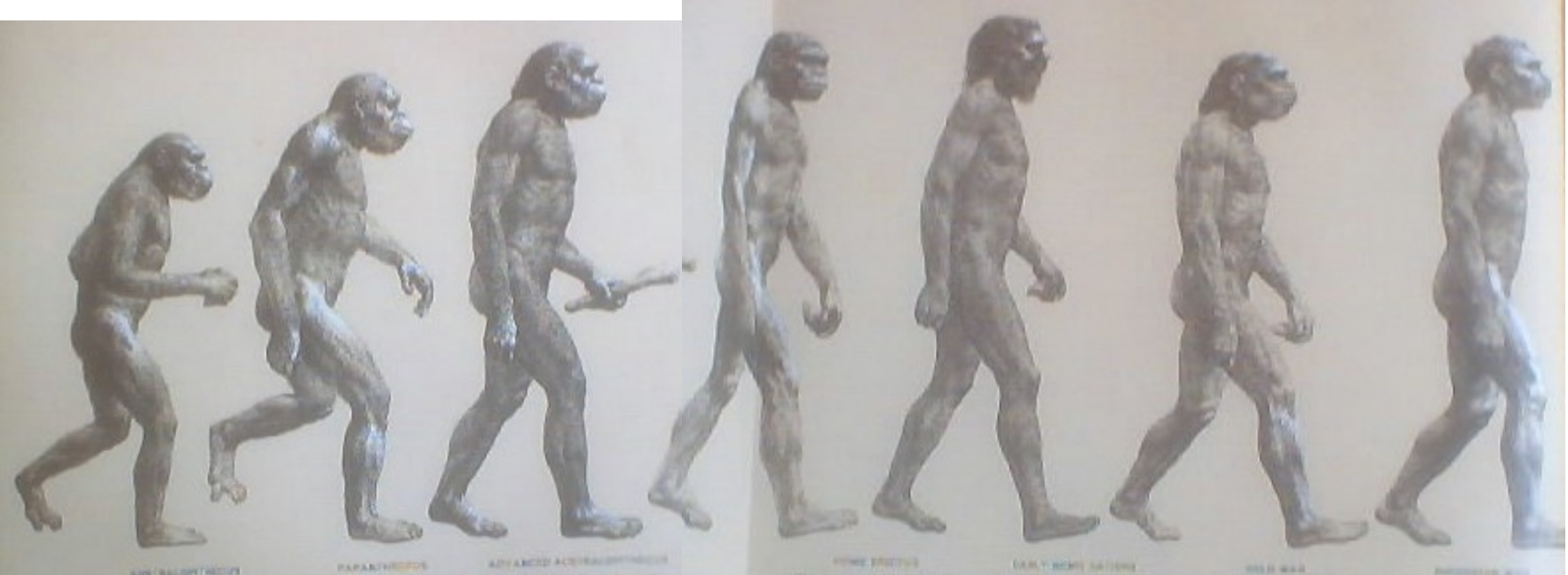
Australopithecus, Paranthropus, Advanced Australopithecus, Homo Erectus, Early Homo Sapiens, Solo Man, & Rhodesian Man



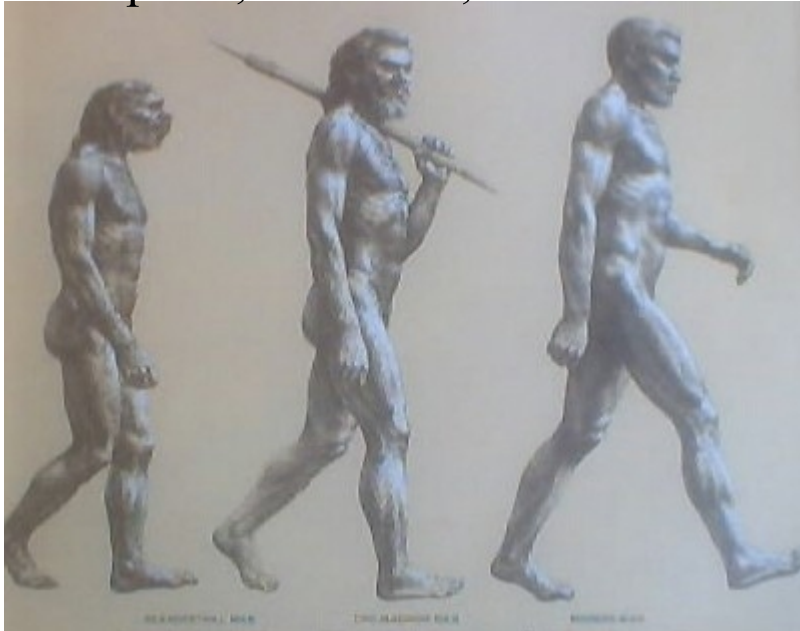
Australopithecus, Paranthropus, Advanced Australopithecus, Homo Erectus, Early Homo Sapiens, Solo Man, & Rhodesian Man



Neanderthal Man, Cro-Magnon Man, Modern Man



Australopithecus, Paranthropus, Advanced Australopithecus, Homo Erectus, Early Homo Sapiens, Solo Man, & Rhodesian Man



Neanderthal Man, Cro-Magnon Man, Modern Man

## Radiação e evolução (licença poética)

A major theme in Darwinian evolutionary theory is that novelty arises through a process in which organisms and their features are gradually transformed. Morgan provided Darwinism and the evolutionary synthesis with the idea that minor mutations produce the minuscule morphological variations on which natural selection then acts, and that, although mutation is random, once a process of gradual genetic modification begins, it becomes directional and leads to morphological, and consequently organismal, transformation.

Bruno Maresca e Jeffrey H. Schwartz, “Sudden Origins: A General Mechanism of Evolution Based on Stress Protein Concentration and Rapid Environmental Change”, THE ANATOMICAL RECORD (PART B: NEW ANAT.) 289B:38 – 46, 2006.



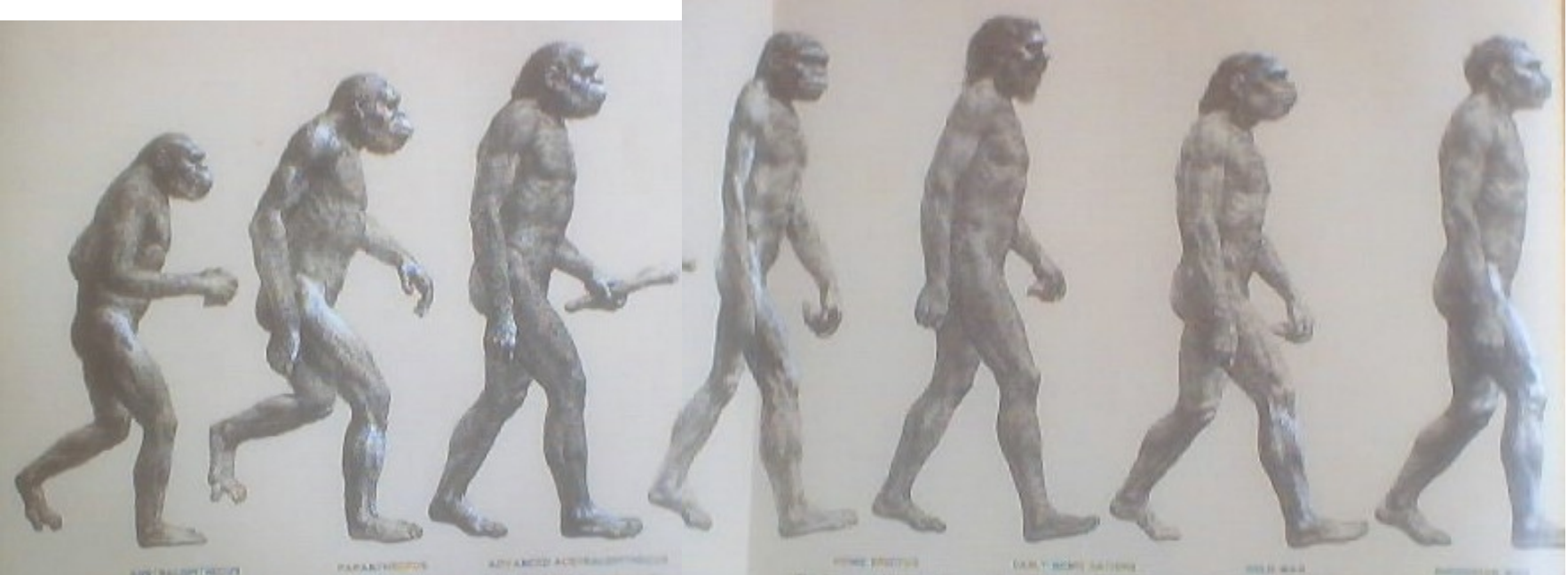
# Radiação e evolução (licença poética)

O corpo humano é quotidianamente bombardeado por radiação (a radioatividade na terra é praticamente a mesma durante o tempo de existência do ser humano (tempo de vida médio de bilhões de anos):

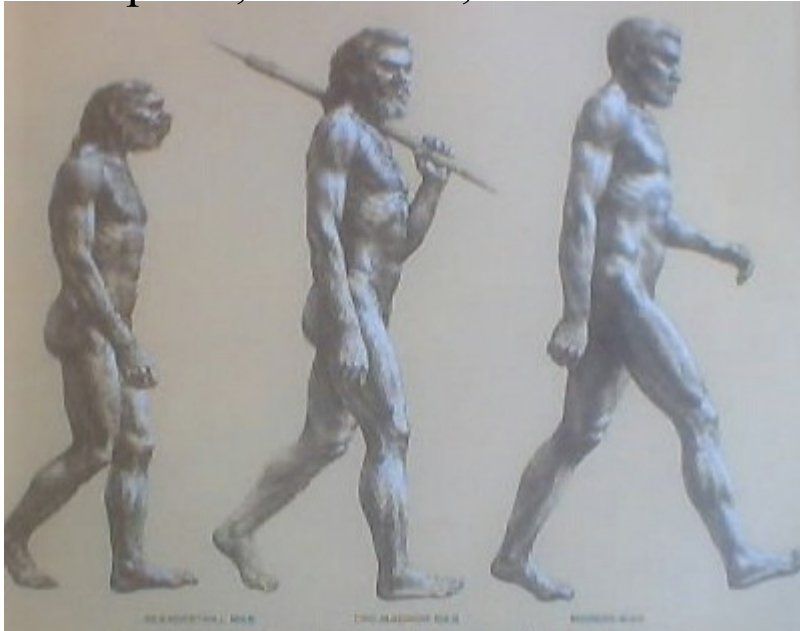
- raios cósmicos
- material radioativo na natureza (solo, rochas, água, ar e vegetação)
- radiação de dentro do corpo humano
  - K(40) (10 mg) e C(14) (10 ng)
  - K(40) – 4.000 núcleos/s decaem
  - C(14) – 1.200 partículas beta/s

C(14) do DNA: 50 decaimentos/s – C muda para N

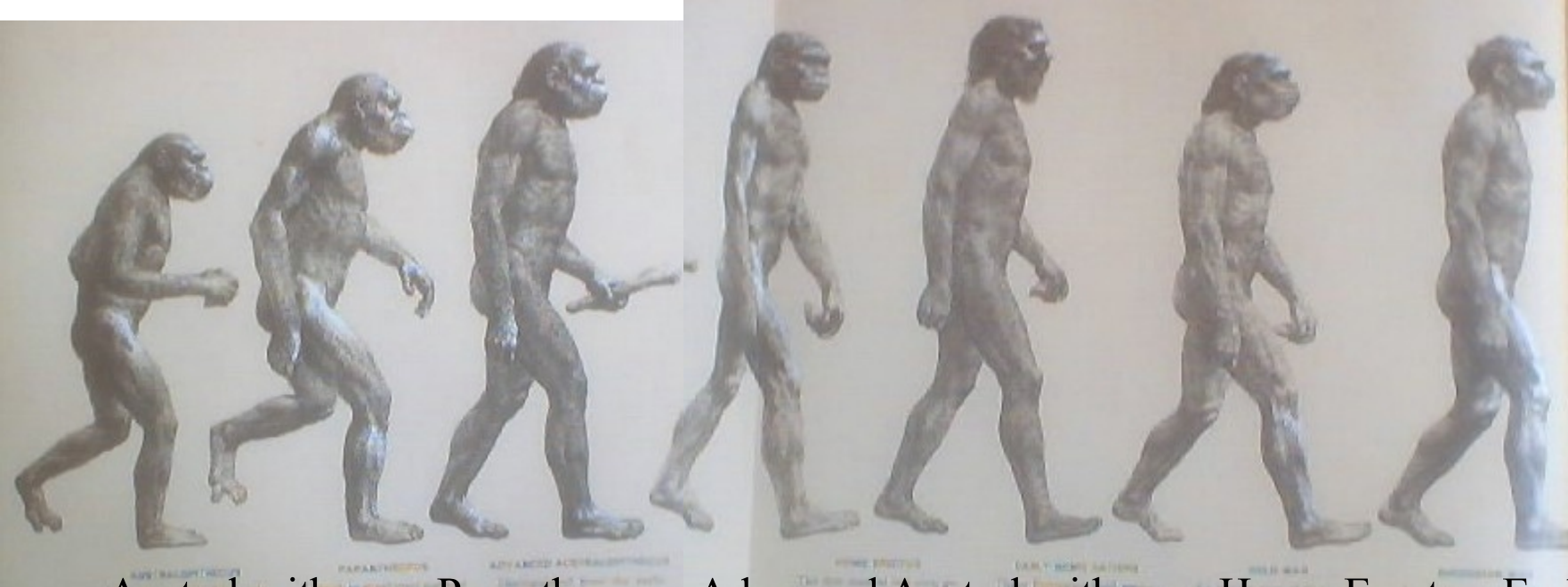
$3 \times 10^9$  pares de base no ser humano



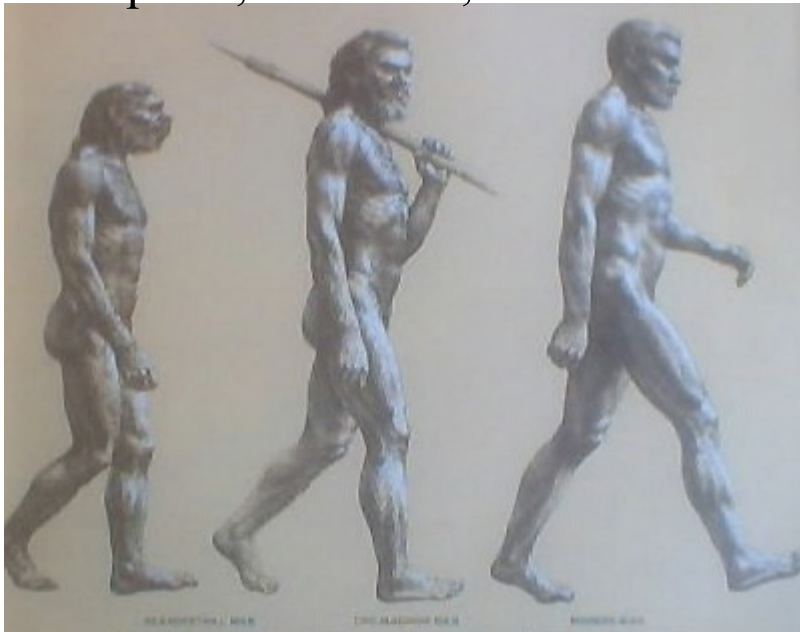
Australopithecus, Paranthropus, Advanced Australopithecus, Homo Erectus, Early Homo Sapiens, Solo Man, & Rhodesian Man



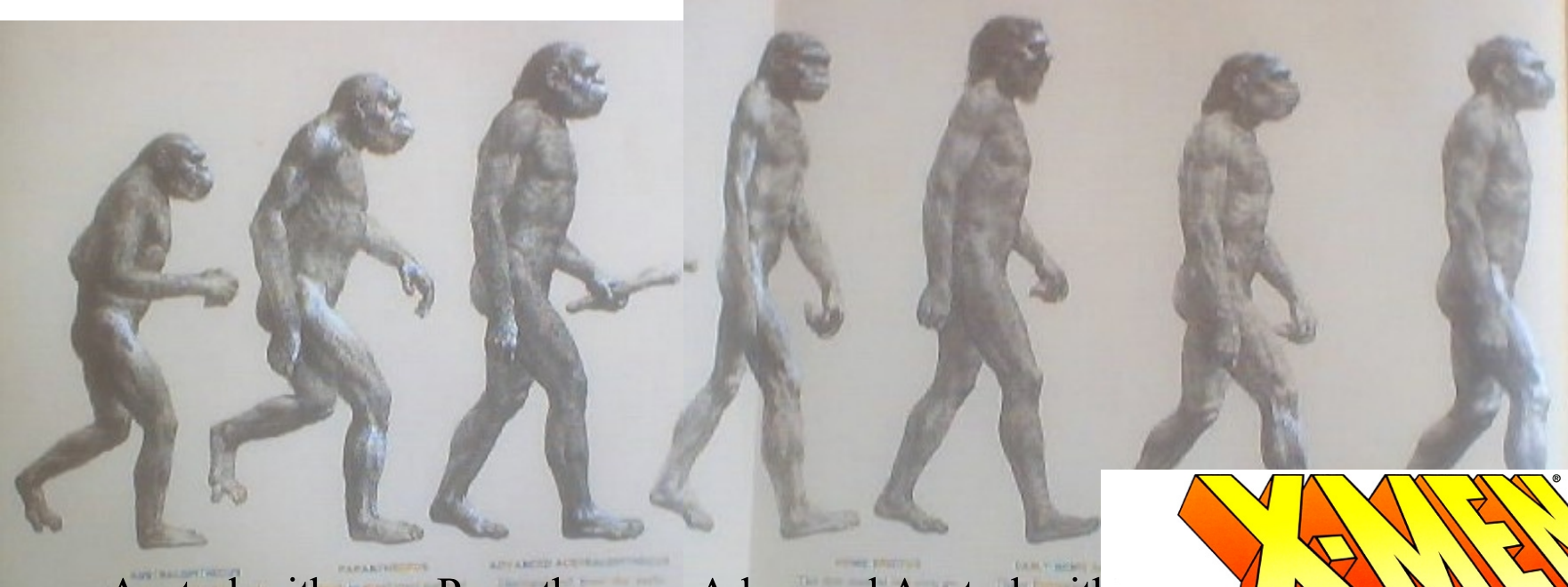
Neanderthal Man, Cro-Magnon Man, Modern Man



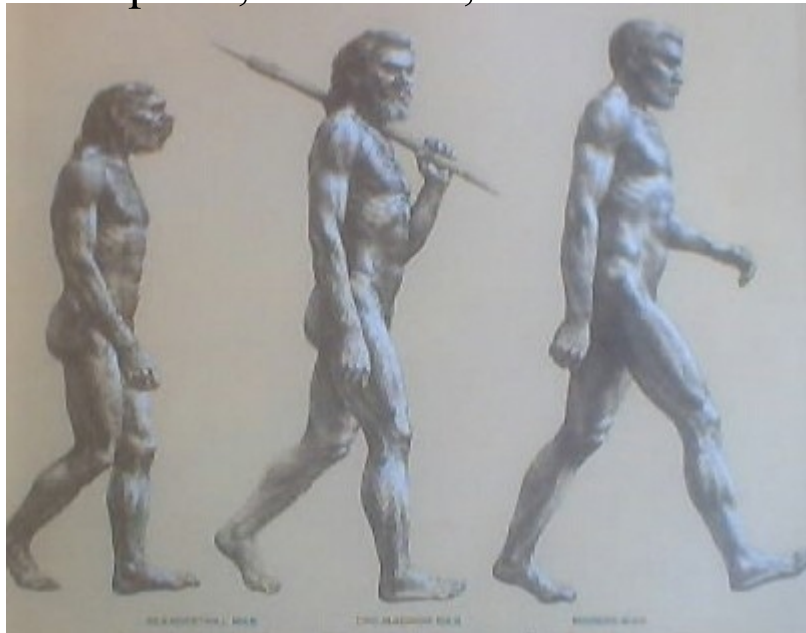
Australopithecus, Paranthropus, Advanced Australopithecus, Homo Erectus, Early Homo Sapiens, Solo Man, & Rhodesian Man



Neanderthal Man, Cro-Magnon Man, Modern Man



Australopithecus, Paranthropus, Advanced Australopithecus, Homo Sapiens, Solo Man, & Rhodesian Man



Neanderthal Man, Cro-Magnon Man, Modern Man

