

II Encontro Educação e Ciência de Roraima (II EEC)

III Seminário Institucional do PIBID

Boa Vista, 06 a 10 de maio 2013

Universidade Estadual de Roraima



# A eficiência da ciência na construção da consciência crítica

Eliezer J. Barreiro

Professor Titular

Universidade Federal do Rio de Janeiro



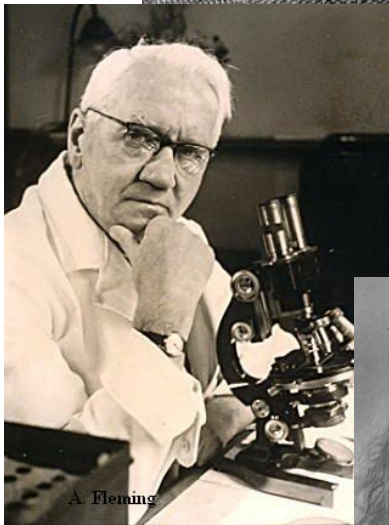
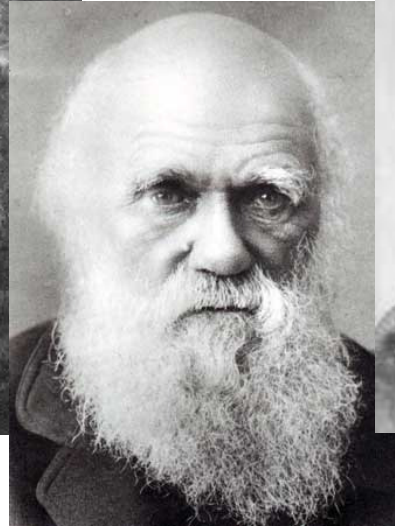
*Uma breve narrativa sobre a importância da Ciência no desenvolvimento da humanidade e sua contribuição à formação da cidadania, com o papel da universidade neste contexto.*

**"Meditai se só as nações  
fortes podem fazer Ciência  
ou se é a Ciência  
que as fazem fortes"**

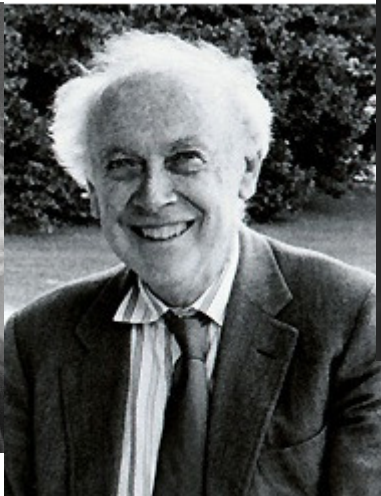
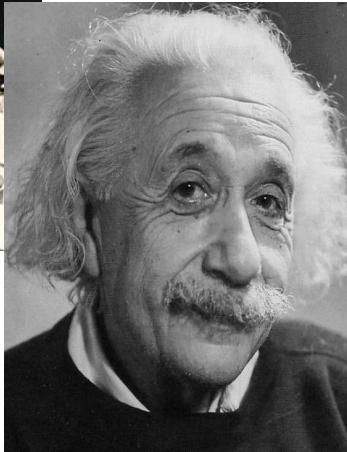


Walter Oswaldo Cruz

(1910 -1967)

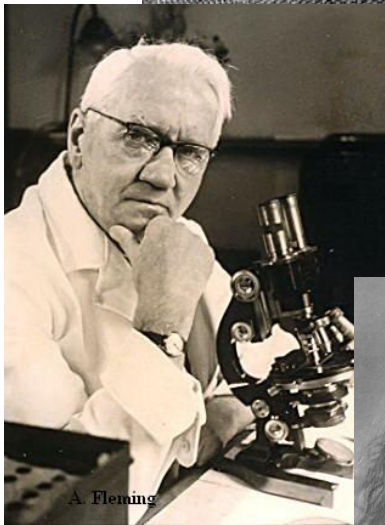
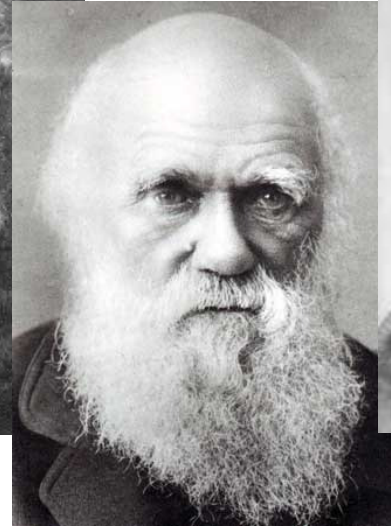


Galileo Galilei, Isaac Newton, Charles Darwin, Marie Curie,  
Alexander Fleming, Albert Einstein,  
James Watson, Francis Crick

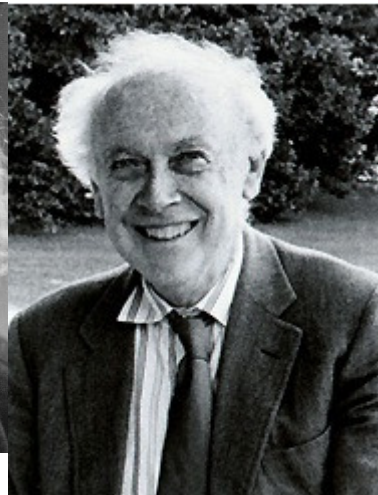
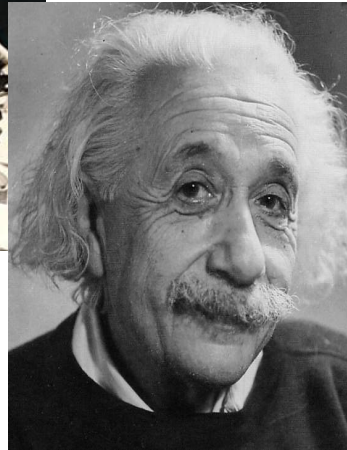




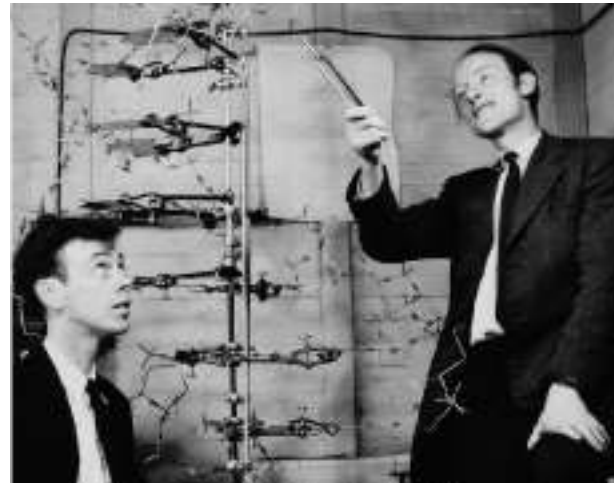
Galileo e a Inquisição



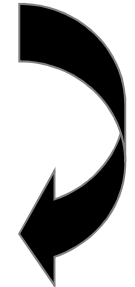
Galileo Galilei, Isaac Newton, Charles Darwin, Marie Curie,  
Alexander Fleming, Albert Einstein,  
**James Watson, Francis Crick**



# Uma das maiores conquistas da Ciência através dos tempos...



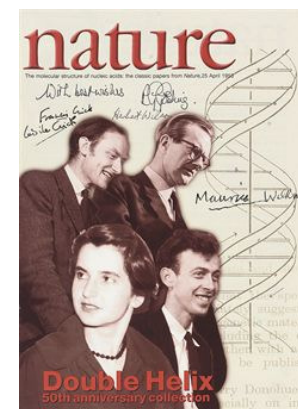
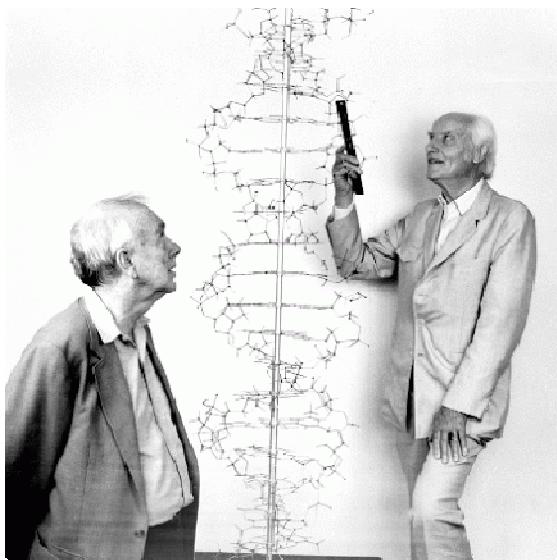
O físico Crick & e o biólogo Watson



JD Watson & FHC Crick,

A Structure for Deoxyribose Nucleic Acid,

*Nature* 1953, 171, 737–738 .



## MOLECULAR STRUCTURE OF NUCLEIC ACIDS

### A Structure for Deoxyribose Nucleic Acid

**W**E wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable biological interest.

A structure for nucleic acid has already been proposed by Pauling and Corey<sup>1</sup>. They kindly made their manuscript available to us in advance of publication. Their model consists of three intertwined chains, with the phosphates near the fibre axis, and the bases on the outside. In our opinion, this structure is unsatisfactory for two reasons:

(1) We believe that the material which gives the X-ray diagrams is the salt, not the free acid. Without the acidic hydrogen atoms it is not clear what forces would hold the structure together, especially as the negatively charged phosphates near the axis will repel each other. (2) Some of the van der Waals distances appear to be too small.

Another three-chain structure has also been suggested by Fraser (in the press). In his model the phosphates are on the outside and the bases on the inside, linked together by hydrogen bonds. This structure as described is rather ill-defined, and for this reason we shall not comment on it.

We wish to put forward a radically different structure for the salt of deoxyribose nucleic acid. This structure has two helical chains each coiled round the same axis (see diagram). We have made the usual chemical assumptions, namely, that each chain consists of phosphate diester groups joining  $\beta$ -D-deoxy-ribofuranose residues with 3',5' linkages. The two chains (but not their bases) are related by a dyad perpendicular to the fibre axis. Both chains follow righthanded helices, but owing to the dyad the sequences of the atoms in the two chains run in opposite directions.



Each chain loosely resembles Furberg's<sup>2</sup> model No. 1; that is, the bases are on the inside of the helix and the phosphates on the outside. The configuration of the sugar and the atoms near it is close to Furberg's standard configuration<sup>3</sup>, the sugar being roughly perpendicular to the attached base. There is a residue on each chain every 3-4 Å. in the z-direction. We have assumed an angle of 36° between adjacent residues in the same chain, so that the structure repeats after 10 residues on each chain, that is, after 34 Å. The distance of a phosphorus atom from the fibre axis is 10 Å. As the phosphates are on the outside, cations have easy access to them.

The structure is an open one, and its water content is rather high. At lower water contents we would expect the bases to tilt so that the structure could become more compact.

The novel feature of the structure is the manner in which the two chains are held together by the purine and pyrimidine bases. The planes of the bases are perpendicular to the fibre axis. They are joined together in pairs, a single base from one chain being hydrogen-bonded to a single base from the other chain, so

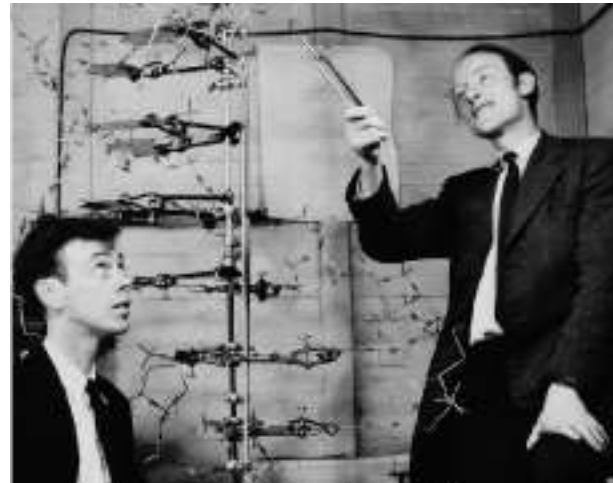
Full details of the structure, including the conditions assumed in building it, together with a set of co-ordinates for the atoms, will be published elsewhere.

We are much indebted to Dr. Jerry Donohue for constant advice and criticism, especially on interatomic distances. We have also been stimulated by a knowledge of the general nature of the unpublished experimental results and ideas of Dr. M. H. F. Wilkins, Dr. R. E. Franklin and their co-workers at King's College, London. One of us (J.D.W.) has been aided by a fellowship from the National Foundation for Infantile Paralysis.

Medical Research Council Unit for the Study of the Molecular Structure of Biological Systems, Cavendish Laboratory, Cambridge. April 2.

J.D. WATSON  
F.H. C. CRICK

# Uma das maiores conquistas da Ciência através dos tempos...



O físico Crick & e o biólogo Watson



JD Watson & FHC Crick,  
A Structure for Deoxyribose Nucleic Acid,  
*Nature* 1953, 171, 737–738 .



A equipe do genoma humano.

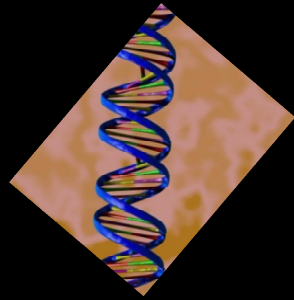


## The Sequence of the Human Genome

Craig Venter, Mark D. Adams, Eugene W. Myers, Peter W. Li, Richard J. Mural, Granger G. Sutton, Hamilton O. Smith, Mark Yandell, Cheryl A. Evans, Robert A. Holt, Jeannine D. Gocayne, Peter Amanatides, Richard M. Ballew, Daniel H. Huson, Jennifer Russo Wortman, Qing Zhang, Chinnappa D. Kodira, Xiangqun H. Zheng, Lin Chen, Marian Skupski, Gangadharan Subramanian, Paul D. Thomas, Jinghui Zhang, George L. Gabor Miklos, Catherine Nelson, Samuel Broder, Andrew G. Clark, Joe Nadeau, Victor A. McKusick, Norton Zinder, Arnold J. Levine, Richard J. Roberts, Mel Simon, Carolyn Slayman, Michael Hunkapiller, Randall

Bolanos, Arthur Delcher, Ian Dew, Daniel Fasulo, Michael Flanigan, Liliana Florea, Aaron Halpern, Sridhar Hannenhalli, Saul Kravitz, Samuel Levy, Clark Mobarry, Knut Reinert, Karin Remington, Jane Abu-Threideh, Ellen Beasley, Kendra Biddick, Vivien Bonazzi, Rhonda Brandon, Michele Cargill, Ishwar Chandramouliswaran, Rosane Charlab, Kabir Chaturvedi, Zuoming Deng, Valentina Di Francesco, Patrick Dunn, Karen Eilbeck, Carlos Evangelista, Andrei E. Gabrielian, Weiniu Gan, Wangmao Ge, Fangcheng Gong, Zhiping Gu, Ping Guan, Thomas J. Heiman, Maureen E. Higgins, Rui-Ru Ji, Zhaoxi Ke, Karen A. Ketchum, Zhongwu Lai, Yiding Lei, Zhenya Li, Jiayin Li, Yong Liang, Xiaoying Lin, Fu Lu, Gennady V. Merkulov, Natalia Milshina, Helen M. Moore, Ashwinikumar K Naik, Vaibhav A. Narayan, Beena Neelam, Deborah Nusskern, Douglas B. Rusch, Steven Salzberg, Wei Shao, Bixiong Shue, Jingtao Sun, Zhen Yuan Wang, Aihui Wang, Xin Wang, Jian Wang, Ming-Hui Wei, Ron Wides, Chunlin Xiao, Chunhua Yan, Alison Yao, Jane Ye, Ming Zhan, Weiqing Zhang, Hongyu Zhang, Qi Zhao, Liansheng Zheng, Fei Zhong, Wenyan Zhong, Shiaoping C. Zhu, Shaying Zhao, Dennis Gilbert, Suzanna Baumhueter, Gene Spier, Christine Carter, Anibal Cravchik, Trevor Woodage, Feroze Ali, Huijin An, Aderonke Awe, Danita Baldwin, Holly Baden, Mary Barnstead, Ian Barrow, Karen Beeson, Dana Busam, Amy Carver, Angela Center, Ming Lai Cheng, Liz Curry, Steve Danaher, Lionel Davenport, Raymond Desilets, Susanne Dietz, Kristina Dodson, Lisa Doup, Steven Ferreira, Neha Garg, Andres Gluecksmann, Brit Hart, Jason Haynes, Charles Haynes, Cheryl Heiner, Suzanne Hladun, Damon Hostin, Jarrett Houck, Timothy Howland, Chinyere Ibegwam, Jeffery Johnson, Francis Kalush, Lesley Kline, Shashi Koduru, Amy Love, Felecia Mann, David May, Steven McCawley, Tina McIntosh, Ivy McMullen, Mee Moy, Linda Moy, Brian Murphy, Keith Nelson, Cynthia Pfannkoch, Eric Pratts, Vinita Puri, Hina Qureshi, Matthew Reardon, Robert Rodriguez, Yu-Hui Rogers, Deanna Romblad, Bob Ruhfel, Richard Scott, Cynthia Sitter, Michelle Smallwood, Erin Stewart, Renee Strong, Ellen Suh, Reginald Thomas, Ni Ni Tint, Sukyee Tse, Claire Vech, Gary Wang, Jeremy Wetter, Sherita Williams, Monica Williams, Sandra Windsor, Emily Winn-Deen, Keriellen Wolfe, Jayshree Zaveri, Karena Zaveri, Josep F. Abril, Roderic Guigó, Michael J. Campbell, Kimmen V. Sjolander, Brian Karlak, Anish Kejariwal, Huaiyu Mi, Betty Lazareva, Thomas Hatton, Apurva Narechania, Karen Diemer, Anushya Muruganujan, Nan Guo, Shinji Sato, Vineet Bafna, Sorin Istrail, Ross Lippert, Russell Schwartz, Brian Walenz, Shibu Yooseph, David Allen, Anand Basu, James Baxendale, Louis Blick, Marcelo Caminha, John Carnes-Stine, Parris Caulk, Yen-Hui Chiang, My Coyne, Carl Dahlke, Anne Deslattes Mays, Maria Dombroski, Michael Donnelly, Dale Ely, Shiva Esparham, Carl Fosler, Harold Gire, Stephen Glanowski, Kenneth Glasser, Anna Glodek, Mark Gorokhov, Ken Graham, Barry Gropman, Michael Harris, Jeremy Heil, Scott Henderson, Jeffrey Hoover, Donald Jennings, Catherine Jordan, James Jordan, John Kasha, Leonid Kagan, Cheryl Kraft, Alexander Levitsky, Mark Lewis, Xiangjun Liu, John Lopez, Daniel Ma, William Majoros, Joe McDaniel, Sean Murphy, Matthew Newman, Trung Nguyen, Ngoc Nguyen, Marc Nodell, Sue Pan, Jim Peck, Marshall Peterson, William Rowe, Robert Sanders, John Scott, Michael Simpson, Thomas Smith, Arlan Sprague, Timothy Stockwell, Russell Turner, Eli Venter, Mei Wang, Meiyuan Wen, David Wu, Mitchell Wu, Ashley Xia, Ali Zandieh, and Xiaohong Zhu





# Genômica

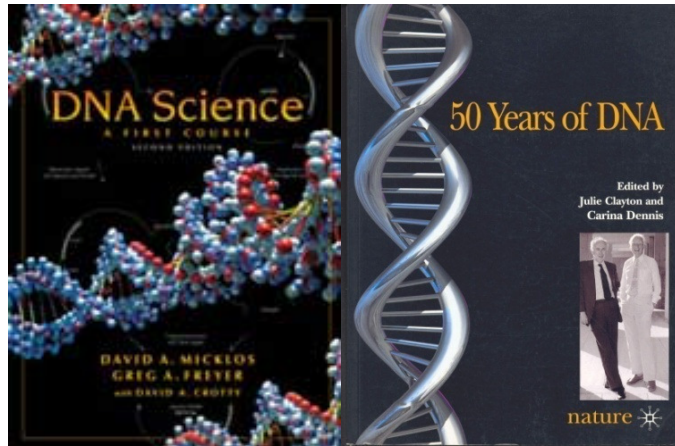
Da compreensão dos genes às atuais plataformas tecnológicas.

Proteômica



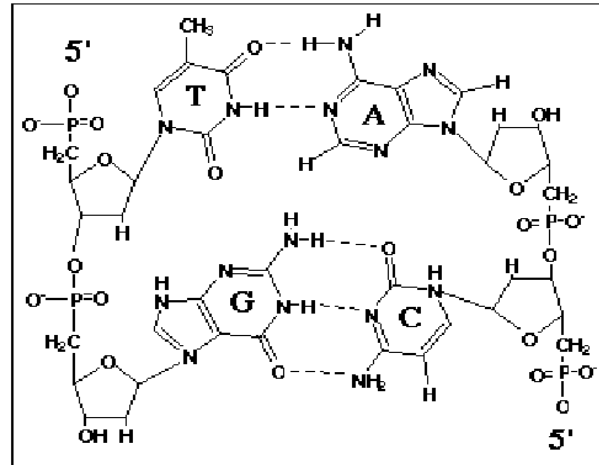


“for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material”  
Prêmio Nobel de Medicina e Fisiologia 1962



J. Clayton & C. Dennis, Eds., “50 Years of DNA”, Nature Pub. 2003.

J. D. Watson & F. H. C. Crick

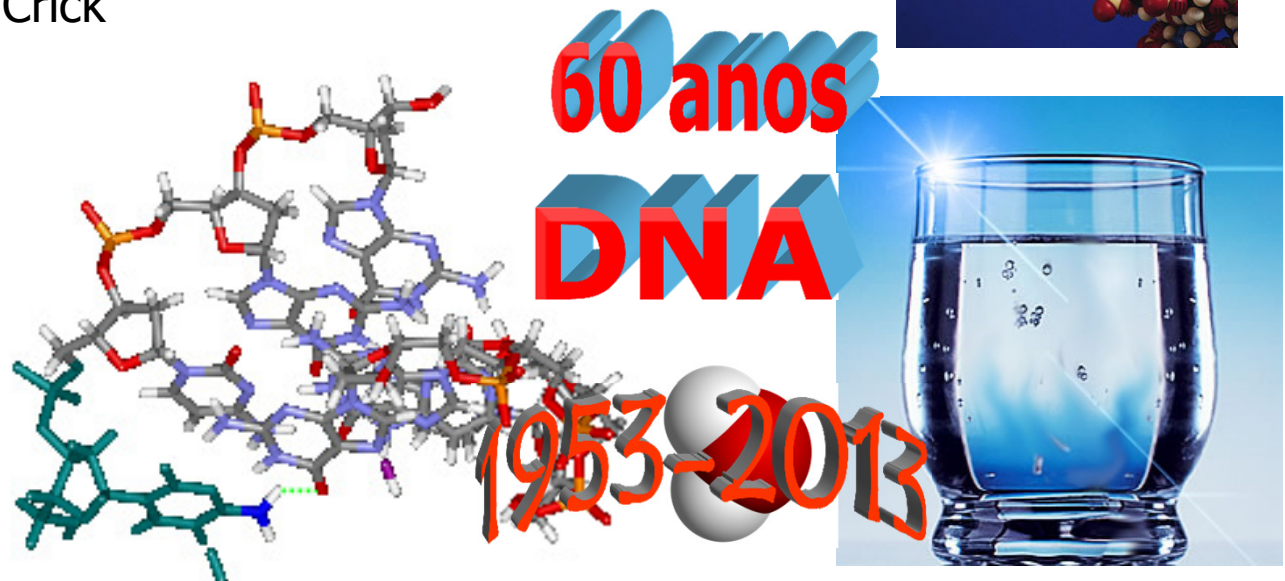


Ligações de Hidrogênio entre Guanina (G) / Citosina (C) e Adenina (A) / Timidina (T)

60 anos



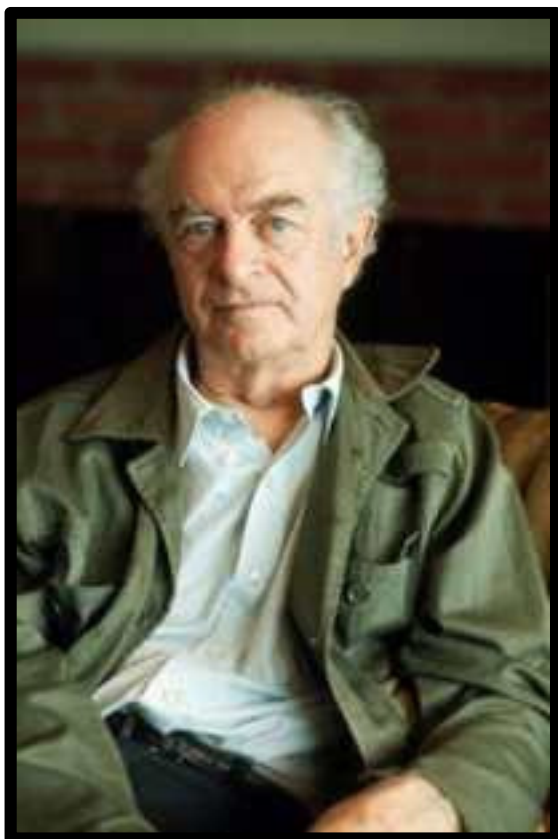
Moléculas da vida



Dia Mundial do DNA = 25 de abril

Interação de hidrogênio

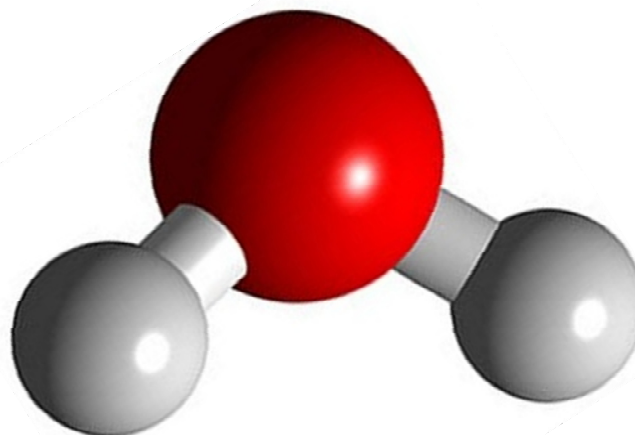
A simplicidade da Ciência...



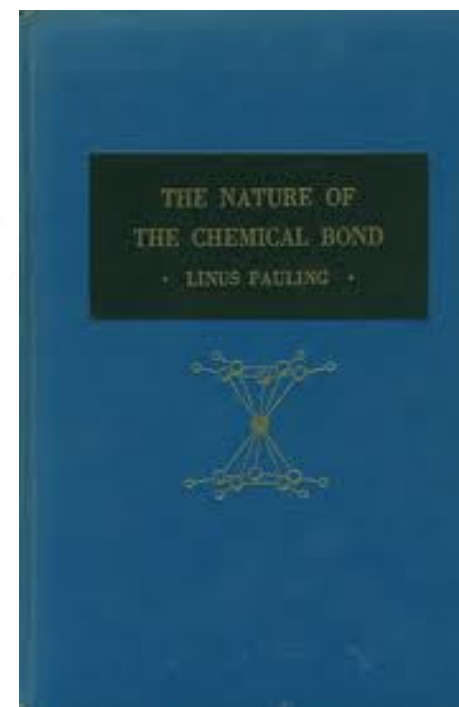
Linus Pauling

1901-1994

Nobel, 1954 & 1962



# Interação de hidrogênio

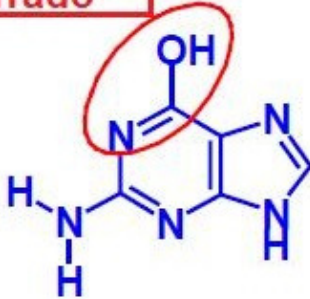


# A elucidação da estrutura do DNA

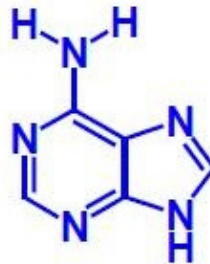
Verão de 1952 Erwin Chagaff critica Francis Crick & James Watson por ignorarem as estruturas das bases nucleicas



tautômero errado

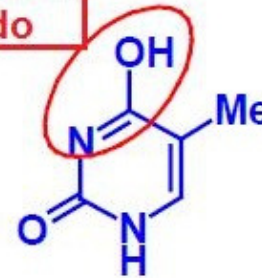


guanine

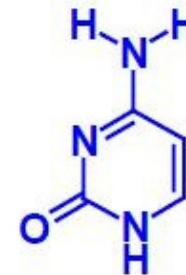


adenine

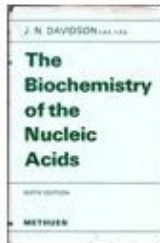
tautômero errado



thymine



cytosine



J. N. Davidson, *The Biochemistry of Nucleic Acids*, London, 1950



Início de 1953: Linus Pauling publica um modelo do DNA com fosfatos



27 de fevereiro de 1953: Jerry Donohue corrige as fórmulas das bases

28 de fevereiro de 1953: Watson & Crick deduzem o modelo correto do DNA

2 de abril de 1953: Manuscrito foi enviado à Nature; publicado em 25 de abril

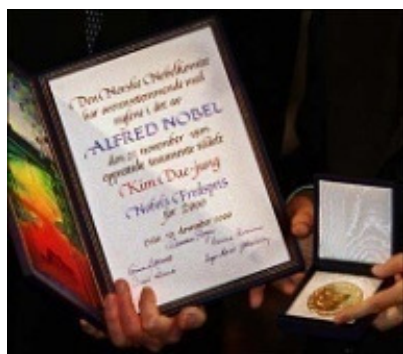
Citado por J. Watson and A. Berry, *DNA. The Secret of Life*, 2003

Vide: H. Kubinyi, *Drug research: myths, hype and reality*, *Nature Rev Drug Discov* 2003, 2, 665

**Paul Ehrlich 1908**

**Emil Fischer 1902**

**Gerhard Domagk  
1939**



**Elias J Corey  
1990**

**1947**

**Robert Robinson**

**John R Vane  
1982**

**1945**

**Alexander Fleming**

**Bengt I Samuelsson  
1982**

**1945**

**Howard W. Florey**

**Sune K Bergström  
1982**

**1945**

**Ernest B Chain**

**Gertrude B Elion 1988**

**Dorothy C Hodgkin  
1965**

**George Hitchings  
1988**  
**James W Black**

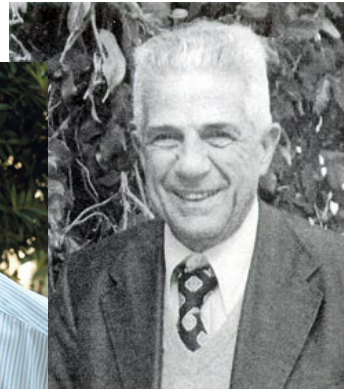
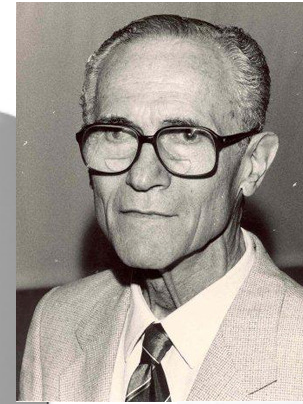
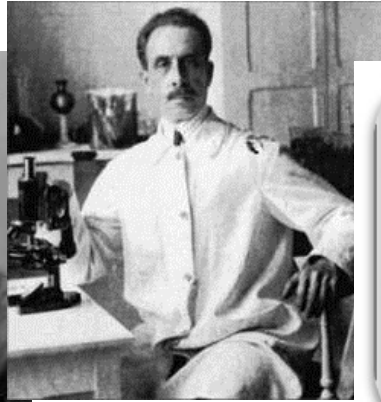
**William S Knowles**

**Brian K Kobilka**

**Robert J. Lefkowitz**

**K Barry Sharpless 2001** **Ryoji Noyori 2012**





Oscar M. Rocha e Silva, Carlos Chagas, Oswaldo Cruz, Otto Goetlieb, Walter Mors, José Leite Lopes, Johanna Döbereiner, José Ribeiro do Vale, Israel Vargas, Sérgio Henrique Ferreira, Benjamin Gilbert



- Ciências Sociais
- Exatas
- Jurídicas
- Humanas
- Biológicas
- Naturais
- Terra
- Informação
- Políticas



# Ciência

- Academia Brasileira de Ciências (1916)
- Sociedade Brasileira para o Progresso da Ciência (1948)



- ◆ O exercício da Ciência favorece o criticismo!

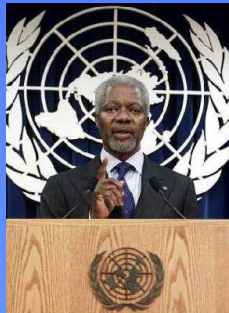


Como dar dimensão humana à Ciência?

ONU

**"Science  
has contributed immensely  
to human progress  
and to the development  
of modern society.**

**The application of scientific knowledge  
continues to furnish powerful means  
for solving many of the  
challenges facing humanity..."**



**Kofi Annan  
UN – Secretary-General  
A Challenge to the World's  
Scientists**

**Science** 2003, 299, 1485

➡ **Século XXI: O Século da Vida.**

# Ciência ↔ Universidade

**instituição pluridisciplinar de ensino terciário (*G*)**

**e quaternário (*PG*), de formação de quadros**

**profissionais de nível superior, de pesquisa,**

**com criação de conhecimento novo, de extensão**

**e de cultivo do saber humano.**



*Almoxarifado do saber...*

“Science is made of facts,  
just as houses are made of stones;  
but a mere collection of facts is  
no more science than a pile of stones a house”

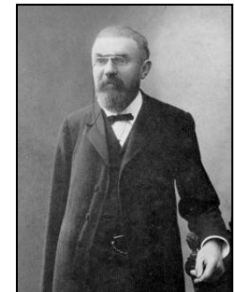
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“A ciência é feita de fatos,  
assim como as casas são feitas de pedras;  
mas uma mera coleção de fatos não é  
ciência, assim como uma pilha  
de pedras, não é uma casa.”



Jules Henri Poincaré

(1854-1912)



**Capacitação  
profissional**

**Ensino**

**"Educação para  
a cidadania"**

**Pós-Graduação**

**Conteúdos**

**Graduação**

**Metodologia  
científica**

**Experimentação**

**Pesquisa**

**Universidade  
Ciência**

**Treinamento**

**Extensão**

**Criatividade**

**Conhecimento  
novo**

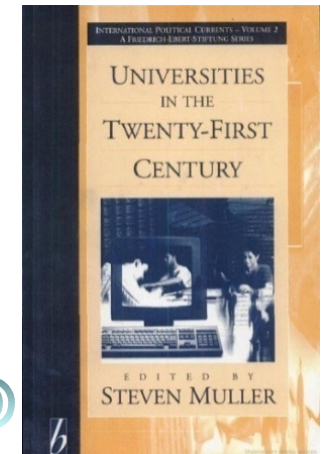
**Inovação**

**Habilidades  
profissionais**

**Prestação de  
serviços**

**Valores éticos**

Johns Hopkins University



# Século 21



# Ciência, Criatividade & Inovação

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ROBERT K. MERTON

---

ON SOCIAL STRUCTURE  
AND SCIENCE

---




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*Edited and with an Introduction by*  
PIOTR SZTOMPKA

---

THE HERITAGE OF SOCIOLOGY

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As invenções & descobertas tornam-se virtualmente inevitáveis quando:<sup>a)</sup>



- (1) o desenvolvimento cultural humano acumula pré-requisitos de conhecimento suficientes;
- (2) a atenção de um número suficiente de pesquisadores está voltada para o mesmo problema;
- (3) existam necessidades sociais emergentes, ou por desenvolvimento efetivo da ciência, ou por ambos.

Robert K. Merton

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The role of genius in scientific advance, *New Scientist* **1961**, 12, 306



Q

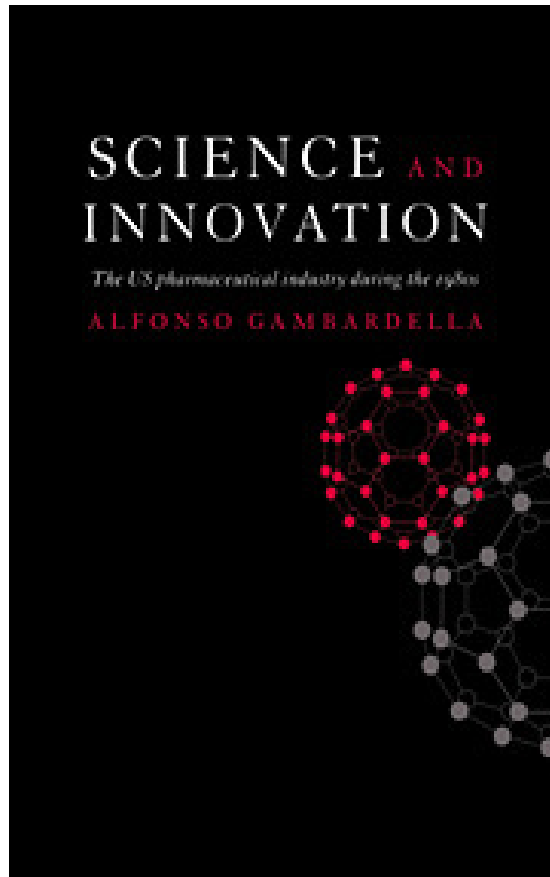
Ciência

Criatividade

Riqueza

Idéias

Inovação



A inovação tecnológica é um  
 dos processos

mais dinâmicos da atividade  
 econômica que gera riqueza.

**ESTE** dinamismo

depende da *efetiva*

interação entre

Ciência & Tecnologia.

A plena capacitação científica  
da sociedade exige  
arranjos institucionais  
capazes de promover a  
transformação do  
conhecimento científico  
em riqueza !



Ciência, tecnologia &  
inovação !

Nos currículos há tendência a se repetirem os modelos que são meras cópias do passado, que reproduzem situações de certezas que não estimulam, a capacidade criativa do estudante, senão inibem/atrofiam posturas realmente inovadoras.



*Horizonte temporal*  
*Vs fronteira tradicional*

**Não existe contratação de pesquisadores nas universidades!**

**São modestos o número de doutores trabalhando em empresas!**

**Não há alternativa científica para substituir a Universidade!**

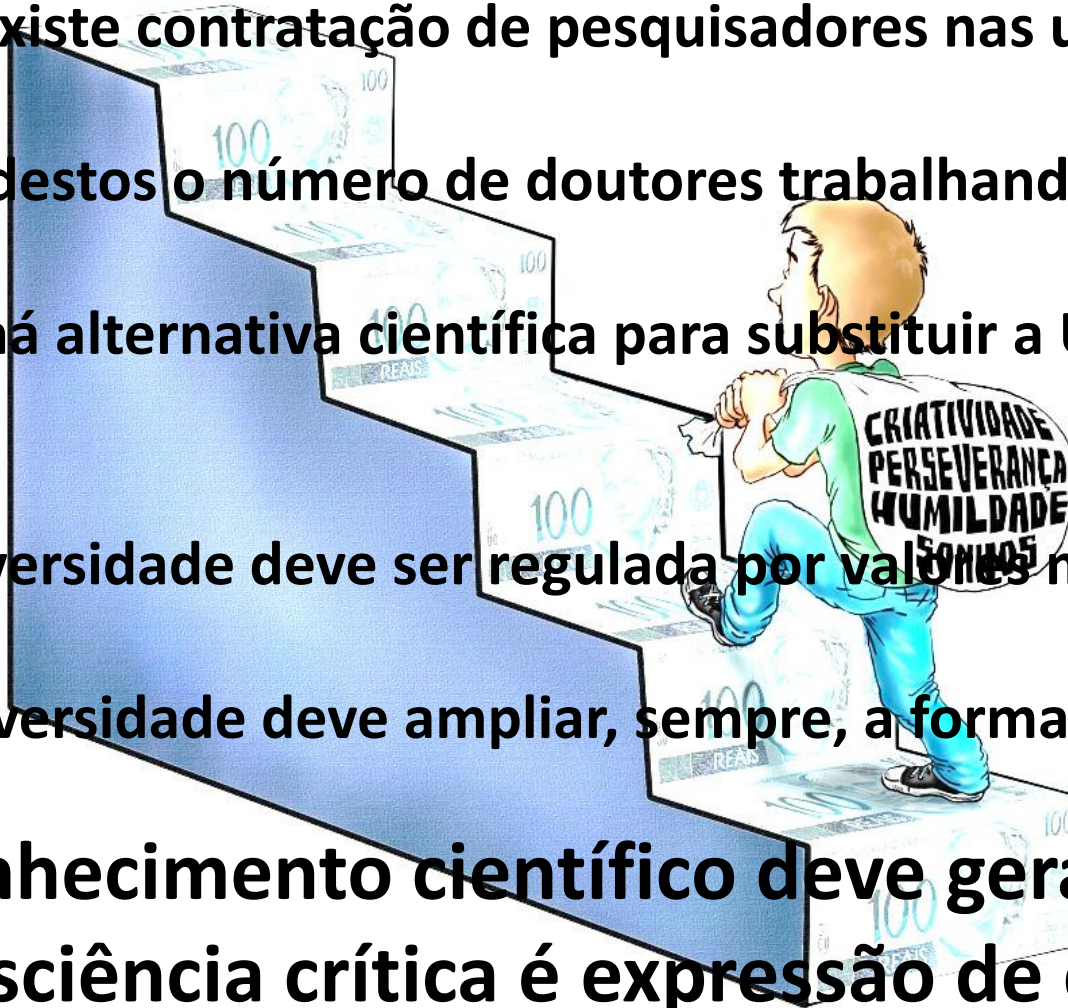
**A Universidade deve ser regulada por valores meritocráticos!**

**A Universidade deve ampliar, sempre, a formação científica!**

**O conhecimento científico deve gerar riquezas!**

**Consciência crítica é expressão de cidadania!**

**Visão política da realidade social.**



# Ciência

## Ciência



## Ciência

## Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência

Ciência  
+  
Tecnologia

+

Inovação

=

Progresso

+

Riqueza

+

Sustentabilidade



# Características desejáveis para a formação superior

(UNESCO, 1998)

1. Flexibilidade → evitar a especialização excessiva;
2. Estudar durante toda a vida (facilita o sucesso);
3. Criatividade *versus* conhecimento;
4. Habilidade social & boa capacidade de expressão;
5. Capacidade de trabalhar em grupos (heterogêneos);
6. Assumir & procurar responsabilidades;
7. Capacidade para lidar com incertezas;
8. Confiar no conhecimento adquirido (ajuda a empreender);
9. Entender sua realidade social + globalização do conhecimento;
10. Aprender e desenvolver novas tecnologias.

# Obrigado

**Uma das sete maravilhas do mundo moderno!**