

## **The Epigenome: Current Knowledge and Its Implications**

In June 2007, just prior to the European Leadership Forum that was held in Eger Hungary, the first academic paper regarding the ENCODE project was published. This research reported unexpected results. Up to this point, it was generally believed that only about 2% of the human genome was functional, functionality being understood in terms of RNA transcription from a DNA template. The 2% represented the protein-coding genes; the rest was often dismissed as "junk", simply a relic of evolutionary history. ENCODE has changed all of that. During 2012, much more detail of ENCODE has been published and it is now apparent that at least 80% of the genome is functional. In other words, the vast proportion of DNA has the potential to be transcribed and modified. The majority of DNA is involved in the highly coordinated and exquisite control of gene expression. Genes are turned on and turned off, and, although every nucleated cell in the human body has all the information encoded in its DNA, only certain genes are operational in any particular differentiated cell with its specific functions. This encrypted information and sophisticated control resides in what has been called the Epigenome. During this highly illustrated talk, the speaker will bring us up to date with current knowledge. We will also discuss the implications of these new findings for Darwinism and Design.

**Geoff Barnard** is the author of over 100 academic papers and articles. He has a PhD in Biochemistry from the University of London and a MA in Theology from the University of Southampton. He has been a professional biochemist for over 40 years, a Senior Lecturer in Biological Sciences at three UK Universities, and a regular visiting scientist at the Weizmann Institute of Science in Israel. His last academic position in the UK was as a Senior Research Scientist in the Department of Veterinary Medicine at the University of Cambridge, a position he held for over seven years. He now lives in Israel with his wife Caryl.

### **Introduction: A Revolution in Molecular Biology is Underway**

#### **I. The Situation prior to 2007**

##### **A. The Human Genome Project and its Various Surprises**

1. What only 22,000 genes (approximately)!

2. Only 2-3% of the total Genomic DNA (approximately)!

3. The Initial Disappointment of the Pharmaceutical Industry

4. The Myth of Junk DNA

B. The Shock of ENCODE in 2007

1. The Initial Publication

2. The Subsequent Scepticism

3. The Current Situation

**II. What is the Epigenome?**

A. What's in a Name?

1. An Artificial Distinction?

2. A Higher Level of Encrypted Information?

3. Is it “Beyond DNA“?

4. The Problems of speaking about it NOW

## B. The Structure of Chromatin

1. The Architecture of the Chromosome

2. The Structure of the Nucleosome

3. Histone Modification

4. DNA Modification

## C. Epigenetic RNA

1. Types of Epigenetic RNA

Short

Long

Circular

## 2. Sources of Epigenetic RNA

Sense and Anti-Sense DNA

Introns

Pseudogenes

Mobile Genomic Elements including ERVs

## 3. Actions of Epigenetic RNA

Blockers

Sponges

Mimics and Decoys

Enhancers and Inhibitors of Gene Expression

Exquisite and Co-ordinated Control

## D. Alternative Splicing

### 1. The Splicing Code

### 2. The Spliceosome

## E. Enhancers and Inhibitors

### 1. Protein Complexes

### 2. Small Molecules (e.g. steroids, feedback inhibition)

## F. Cellular Differentiation

### 1. The Concepts of Potency

### 2. Sperm and Egg

### 3. Fertilization and Implantation

4. Epigenetic Reprogramming
  
5. Epigenetic Imprinting and X-Chromosome Inactivation
  
6. Epigenetic Signals beyond DNA

### **III. Implications for Darwinism and Design**

1. Mutation in the Epigenome and Disease
  
2. The Role of Natural Selection
  
3. Maintenance of Genomic Integrity and Stability
  
4. Survival of the Fertile

5. What is Biological Information?

6. How many Levels of Encrypted Information are there?

7. I am Fearfully and Wonderfully Made

#### **IV. Questions**

## ***Helpful Resources:***

### ***1. Academic Review***

Inbar-Feigenberg M et al. *Basic Concepts of Epigenetics*  
Fertility and Sterility (March 2013) 99:607-615

#### **Abstract**

Several types of epigenetic marks facilitate the complex patterning required for normal human development. These epigenetic marks include DNA methylation at CpG dinucleotides, covalent modifications of histone proteins, and noncoding RNAs (ncRNAs). They function in a highly orchestrated manner, regulating mitotically heritable differences in gene expression potential without altering the primary DNA sequence. In germ cells and the developing embryo, genome-wide epigenetic reprogramming drives the erasure and reestablishment of correct epigenetic patterns at critical developmental time periods and in specific cell types. Two specific types of epigenetic regulation established in early development include X-chromosome inactivation and genomic imprinting; they regulate gene expression in a dosage-dependent and parent-of-origin-specific manner, respectively. Both genetic and environmental factors impact epigenetic marks, generating phenotypic variation that ranges from normal variation to human disease. Aberrant epigenetic patterning can lead to a variety of human disorders, including subfertility and imprinting disorders.

Note: Other technical publications will be available for review.

### ***2. Popular Books***

Carey, Nessa. *The Epigenetics Revolution: How Modern Biology is Rewriting Our Understanding of Genetics, Disease and Inheritance*. (London: Icon Books Ltd., 2012).

Nessa Carey writes a clear and concise review of aspects of Epigenetics that have occurred in recent years. The book is available from Amazon.

[http://www.amazon.co.uk/The-Epigenetics-Revolution-Understanding-Inheritance/dp/1848313470/ref=sr\\_1\\_1?ie=UTF8&qid=1361952167&sr=8-1](http://www.amazon.co.uk/The-Epigenetics-Revolution-Understanding-Inheritance/dp/1848313470/ref=sr_1_1?ie=UTF8&qid=1361952167&sr=8-1)

Francis, Richard C. *Epigenetics: The Ultimate Mystery of Inheritance*. (New York: W.W.Norton and Company, Inc., 2011).

Somewhat less informative regarding the mechanics of Epigenetics than the above. However, the author (an ardent Darwinist) gives many examples in a readable account which might seem to suggest that we can effect our lives and the lives of our children and grandchildren through influencing epigenetic changes. The book is available from Amazon.

[http://www.amazon.co.uk/Epigenetics-Ultimate-Inheritance-Richard-Francis/dp/0393070050/ref=sr\\_1\\_2?s=books&ie=UTF8&qid=1361952550&sr=1-2](http://www.amazon.co.uk/Epigenetics-Ultimate-Inheritance-Richard-Francis/dp/0393070050/ref=sr_1_2?s=books&ie=UTF8&qid=1361952550&sr=1-2)



Woodward, Thomas E. and Gills, James P. *The Mysterious Epigenome: What lies beyond DNA*. (Grand Rapids: Kregel Publications, 2012).

This book fits neatly between the above two popular accounts but written from an Intelligent Design perspective. It is a very clear overview of the mechanism and health implications of Epigenetics. It is beautifully illustrated and contains pages of questions so that it can be used as a study guide. It is also obtained from Amazon.

[http://www.amazon.co.uk/The-Mysterious-Epigenome-What-Beyond/dp/0825441927/ref=sr\\_1\\_sc\\_1?s=books&ie=UTF8&qid=1361953391&sr=1-1-spell](http://www.amazon.co.uk/The-Mysterious-Epigenome-What-Beyond/dp/0825441927/ref=sr_1_sc_1?s=books&ie=UTF8&qid=1361953391&sr=1-1-spell)

### **3. *Psalm 139:13-18***

For you created my inmost being; you knit me together in my mother's womb. I praise you because I am fearfully and wonderfully made; your works are wonderful, I know that full well. My frame was not hidden from you when I was made in the secret place. When I was woven together in the depths of the earth, your eyes saw my unformed body. All the days ordained for me were written in your book before one of them came to be. How precious to me are your thoughts, O God! How vast is the sum of them! Were I to count them, they would outnumber the grains of sand. When I awake, I am still with you. (from The Holy Bible: New International Version. Copyright © 1973, 1978, 1984, by International Bible Society).