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UNIVERSITY STUDENTS' KNOWLEDGE ABOUT EPIGENETICS PERSISTENCE OF GENETIC DETERMINISM

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ABSTRACT: In recent decades, Genetic issues play a large role in health and public policy and new knowledge in this field continues to have significant implications for individuals and society. In spite of this increased exposure to genetics, recent studies of the general public's genetics knowledge show a relatively low understanding of genetics concepts. Epigenetics is a new paradigm in biology. Nevertheless, the notion of genetic determinism is still present in syllabuses and textbooks. The present research explores the future Biology teachers' conceptions related to the genetic determinism of human performances. The research method is a questionnaire elaborated by the Biohead-Citizen consortium. The findings revealed that future Biology teachers still reducing the biological identity to a genetic program. The set can also enhance the danger of hereditarian ideology and justifies the fatalism and racism. We concluded that the teaching of epigenetics becomes a scientific and citizen challenge.

Key words: Genetic determinism, Students, conceptions, epigenetics.

INTRODUCTION

In the twentieth century, the nature-versus-nurture debate was one of the most important themes of genetics (Castera et Clement 2008). Now, most scientists accept that both factors have a crucial role and that phenotypes result from the actions and interactions of both, which often change over time (Petronis 2010).

Most phenotypes show some degree of heritability, a finding that formed the basis for a series of molecular studies of genes and their DNA sequences (Nicol-Benoit et al 2013). In parallel to such genetic strategies, thousands of studies have been carried out to identify environmental factors that contribute to phenotypes (Georgel 2015). The new paradigm is not one of nature versus nurture, but of a complex and dynamic interaction between DNA sequence, epigenetic DNA modifications, environment, gene expression, and environmental factors that all combine to influence phenotype (Gibson 2008 ; Kilpinen & Dermitzakis 2012).

Over the last years, several university programs introduced bit by bit epigenetics as part of the genetics (regulation of the expression of multiple genes, cell differentiation,...). However, in most countries, university programs of Biology do not include the wealth of information gathered over the last 30 years of investigation of epigenetics.

This article aims to explore the students' understanding of Epigenetics and to identify their conceptions related to the genetic determinism of human performances.

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METHODS

This study is mainly qualitative, our methodology was mixed. We used a questionnaire and interview. This qualitative analytical methods were supplemented with statistical analysis to identify students' misunderstanding in Epigenetics.

Students sample. All students surveyed in the study were enrolled in a graduate science program at the University of Cadi Ayyad, The sample is composed of 86 Graduate Students (baccalaureate plus 3 years of study) and 20 Master' students (baccalaureate plus 4 or 5 years). Females comprised 46 percent of the sample.

The questionnaire. We composed an questionnaire to acquire information on several key issues: (a) the students' understanding of Epigenetics and interaction between Genotype and Environment in expression of the phenotype (b) the students' conceptions of the genetic determinism of human performances.

Some of the questions were inspired by previous studies especially those relating to the genetic determinism of behaviour and intellectual performance (Clement & col 2006). However, we developed many new questions appropriate for students at the graduate level.

The responses to all the questions about genetics are based on a Likert scale on which each teacher was asked to tick one of four boxes, ranging between 'I agree' and 'I don't agree'. The majority of the questions concern genetic/biological determinism of human behaviour. These questions can be grouped into four different categories: 12 (1) Genetic determinism of personal or individual features: questions about clones and twins (A3, A6, A19, A24, A43 and A53). (2) Genetic/biological differences related to gender (A9, A14, A21, A25, A36, A38 and A46). (3) Genetic determinism of human behaviour (B8, B10, B14 & B20).

The interview. Interview was conducted on six students. The interviews lasted approximately 30 minutes. Thematic interview questions are used to explore in greater detail the most commonly held misconceptions identified by the questionnaire analysis.

RESULTS AND DISCUSSIONS

More than six students out of ten states that the phenotype is determined solely by the genotype (62%) and that the action of the environment on the phenotype requires a change in the DNA sequence (60%). This reflects that a majority of students don't know epigenetic mechanisms. This is confirmed by the fact that more than the half of them state that chromatin is a DNA carrier and is not involved in the expression of the phenotype (58%) (Table 1).

Table 1. Students' Responses Related To Genotype-Phenotype Relationship (in %)

Responses in %	I strongly agree	I rather agree	I rather disagree	I strongly disagree	I don't know
The phenotype is determined solely by the genotype	35	27	13	11	14
The action of the environment on the phenotype requires a change in the DNA sequence	42	18	14	17	9
Chromatin is a DNA carrier and is not involved in the expression of the phenotype	35	23	9	12	21
DNA methylation / demethylation is a signal for activation or deactivation of a gene	27	25	16	9	23

One student out of two states that DNA methylation / demethylation is a signal for activation or deactivation of a gene (52%).

In the interview, we identified a common perception held by the students which stipulates that genes, as units of information controlling various traits, are distinct and totally separate from the environment (Fig 1).

This perception is certainly true of the physical-structural- chromosomal entity called gene, but it does not apply to genes as units of information or function. The notion that information resides in the genes and that the environment simply provides the medium through which information is displayed is incorrect. The only sure evidence of epigenetic inheritance involves methylation of genes through which identical genes coming through the two parents can behave differently in their expression (Singh 2015 ; Agorram 2010).

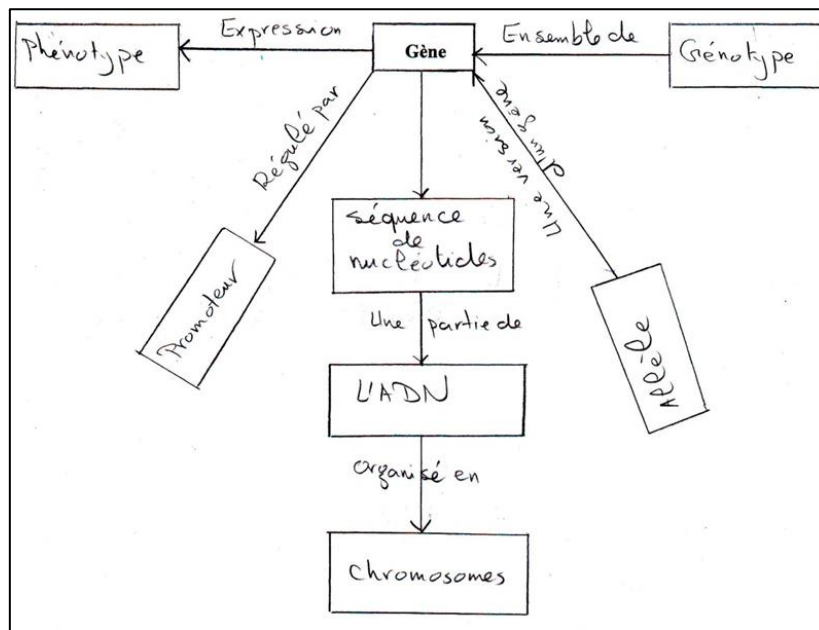


Fig 1: An example of Students' responses about gene-phenotype

About half of the students surveyed say that similarity of the reactions to different factors (immune response to micro-organisms and to transplantation) or similarity of behaviors of identical twins is due to the identity of their genes (Fig 2).

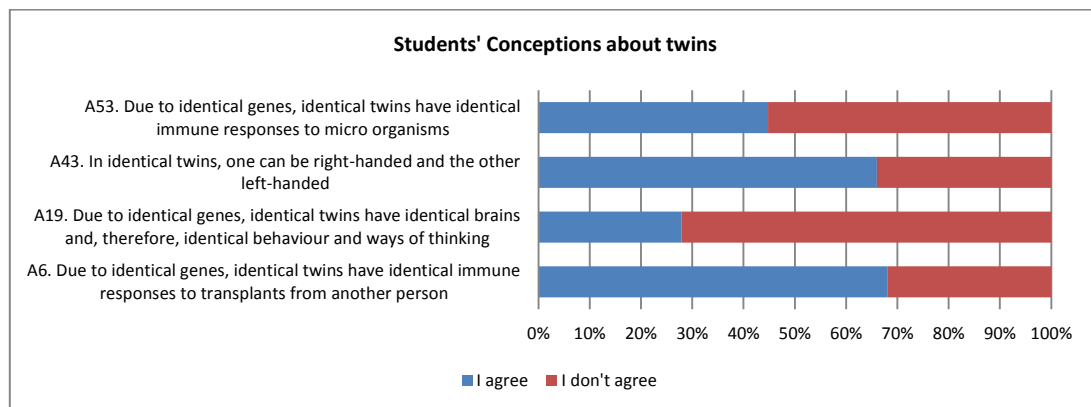


Fig 2 : Students' responses about genetic determinism among twins

It is generally agreed that epigenetics provides sufficient flexibility and latitude to the developmental program of a given genotype such that even identical twins become “unidentical” as they proceed through life (Haque & col. 2009).

Numerous studies show that it is clear that identical twins have substantial differences in obvious phenotypes like disease, and in epigenetic DNA modification patterns. Earlier twin studies were based on the premise that monozygotic twins are genetically identical, and that phenotypic differences must arise from nonshared environment. However, knowledge of epigenetic mechanisms such as differential DNA methylation, skewed X-inactivation, and imprinting provides a new model to understand monozygotic twins discordance (Gibson 2008 ; Bhalla and Iyengar 1999).

We notice that some of the students think that the differences between men and women (intelligence, sensitivity) are due to biological and genetic factors. Women are biologically different from men, these differences make them suitable for some household activities but that make them less able to do other activities. According to these students, the difference in behavior of men and women is due to the identity of their genes (Fig 3).

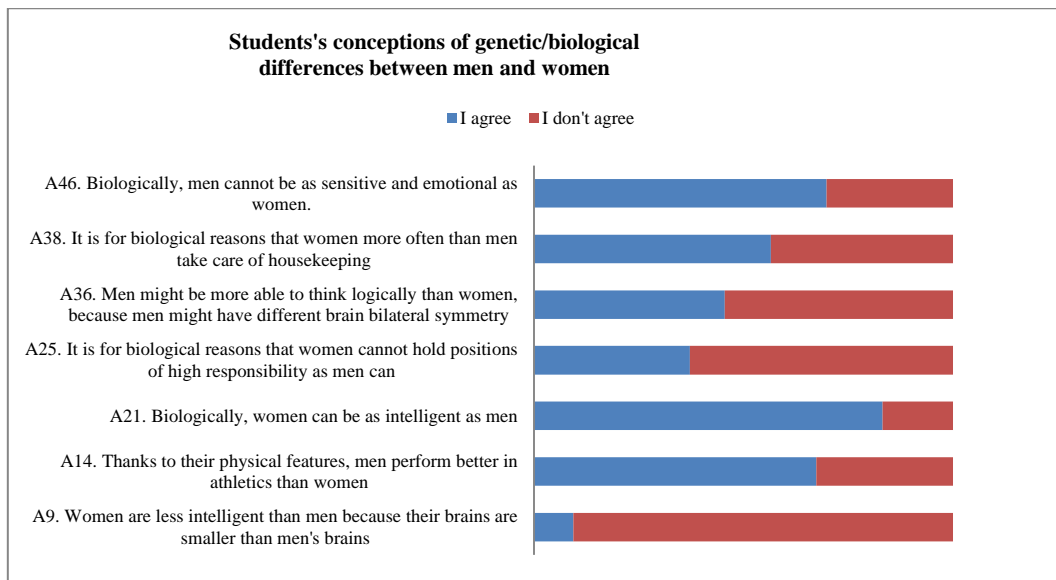


Fig 3: Students' responses about genetic/biological causes of differences related to gender

Genes determine all of characteristics, and cloned organisms are exact copies of the original. This misconception was found among more two students out of ten (Fig 4).

It's sure that genes play a huge role in how an organism develops, but environmental factors also play a role and some heritable changes occur without changes in the genome. Many studies showed that gene expression in identical twin changes from environmental factors and suggested that these changes can accumulate over the life of the organism. It is possible that these behaviors have a genetic component, but they are not governed by genes alone, there is an interaction between genes, environment, and epigenetic factors.

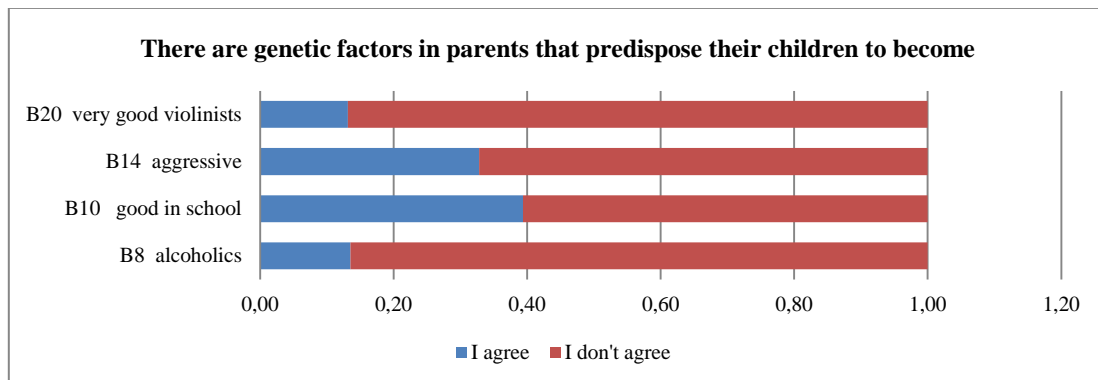


Fig 4 : Students' responses about heredity of some performances

CONCLUSION

Whether cellular or macroscopic phenotype is ultimately based on the properties of synthesized proteins. Now these are the genes which code proteins responsible for the phenotypic characters. so we would think that there is a linear relationship between a gene and a character, the first determining the second. In fact the relationship between genotype and phenotype are often more complex.

This complexity of life can not be reduced to a single genetic determinism. Its study needs to compete with other epigenetic, mechanisms to analyze the construction of phenotypic traits. New models (based on the concepts of self-organization, collective intelligence) contribute significantly to this change in perspective (Petronis 2010).

The analysis of students' responses related to the genetic determinism of human features, behaviour or performances shows a clear innatism in a majority of students' answers. Moreover, this innatism is partly correlated to some sexist and even racist answers. This conclusion is illustrating interactions between the taught science (the scientific knowledge K) and implicit values (V) (Clement 2006).

Epigenetics is still absent from university education programs reflecting an important didactic transposition delay. In the next few years, our understanding of the multiple layers of genomic information is likely to

improve significantly. The school must incorporate these scientific innovations quickly enough and especially when they have an important educational dimension and which are related to socially controversial problematics.

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