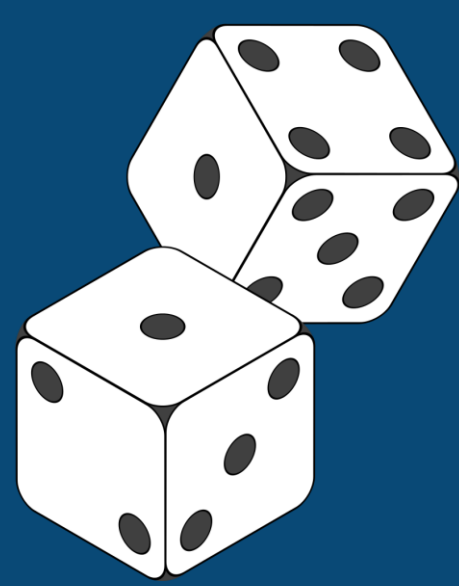


# Student-generated board game to promote understanding of the antibiotic development pipeline



David Negus<sup>1</sup> and Jody Winter<sup>1</sup>

<sup>1</sup>Nottingham Trent University **Contact:** david.negus@ntu.ac.uk

## INTRODUCTION

Antibiotic resistance (AMR) is recognised as one of the leading threats to global healthcare. It is estimated that without direct intervention, AMR related infections could cause 10 million deaths a year by 2050<sup>1</sup>. The issue of AMR is complex and multifaceted. Increases in deaths and morbidity are likely to be associated with rising levels of global transmission, the misuse / overuse of antibiotics and the development of multi-drug resistant pathogens. The problem is undoubtedly compounded by a lack of new antibiotics. An understanding of the antibiotic development pipeline is key to appreciating the difficulties of bringing a new drug market. However, drug development and licensing is complex; involving scientific, commercial and regulatory challenges. Therefore we **aimed to develop a game-based learning activity to support undergraduate (UG) Microbiology students in understanding the complexities and challenges of the antibiotic development pipeline**

## APPROACH

Game-based learning has been shown to enhance student engagement with complex topics and foster creativity, communication and team working skills<sup>2</sup>. We wished to implement this approach to help our Microbiology undergraduate students understand the challenges of bringing a new antibiotic to market.

1. Short (15 minutes) talk on the current global AMR situation and the need for novel compounds effective against AMR pathogens.
2. Brainstorming group session where students are asked to identify the key stages of bringing an antibiotic to market

## CREATING THE GAME

1. Students placed into groups
2. Each group researches a different phase of antibiotic development between preclinical testing and market
3. Students identify possible positive and negative outcomes from their pipeline phase and write these on post-it notes.
4. Each outcome is assigned a number 1-6.
5. Groups share their findings and outcomes with the class and assemble the game, using a provided template and their post-it notes.

## PLAYING THE GAME

students are informed that each roll of a 6-sided die will cost them £100 million. Their total budget to develop their drug to market is £2bn (20 die rolls). Students must navigate the phases of antibiotic development sequentially by rolling the die to achieve successful outcomes at each phase, without exceeding their budget.

Time (years)	Money (£)	INDEFINITE £2000 MILLION						SUCCESS ON MARKET / MONITORING (PHASE IV)			
		1 Resistance develops: X	2 Poor demand = bankruptcy: X	3 Production costs too high: X	4 Better antibiotic produced by rival : X	5 Longer term side effects observed: X	6 Antibiotic is effective and no resistance: ✓				
1-2	1-2	1-2 Interacts adversely with other drugs : X		3 Production facilities fail inspection: X		4 Clinical trials not performed to standard: X		5 or 6 MHRA approve drug: ✓		REGULATORY APPROVAL	
6-7	6-7	1 Toxic in certain subpopulation: X	2 Poor efficacy in larger trials: X	3 Less effective than current treatment: X	4 Resistance observed : X	5 or 6 Effective at curing infection, no side effects: ✓			III	CLINICAL TRIAL PHASES	
		1 Drug not effective in humans at all: X	2 Drug no better than placebo: X	3 Severe side effects observed: X	4 Only effective in small sub-population: X	5 or 6 Effective at curing infection, no side effects: ✓					II
		1-2 Poor PK/PD profile in humans: X	3-4 Severe side effects in humans: X		5 Unexpected off-target effects: X	6 Safe in humans, no side effects:✓					
3-6	3-6	1 IC50 value too high in vitro: X	2 Poor ADME profile in animals: X	3 Severe side effects in animals: X	4 Not effective in animal model of infection: X	5 or 6 Effective in animal model, no side effects:✓			PRE-CLINICAL TRIALS		
		1 or 2 No new antibiotic producers found: X		3 Producer found but antibiotic is made in small quantities / is unstable: X		4 Producer found but the antibiotic only kills lactobacillus: X		5 or 6 New antibiotic discovered with activity against 1 or more ESKAPE pathogens:✓		DRUG DISCOVERY + DEVELOPMENT	

Figure 1: Example of a game board created by 2<sup>nd</sup> year Microbiology UG students

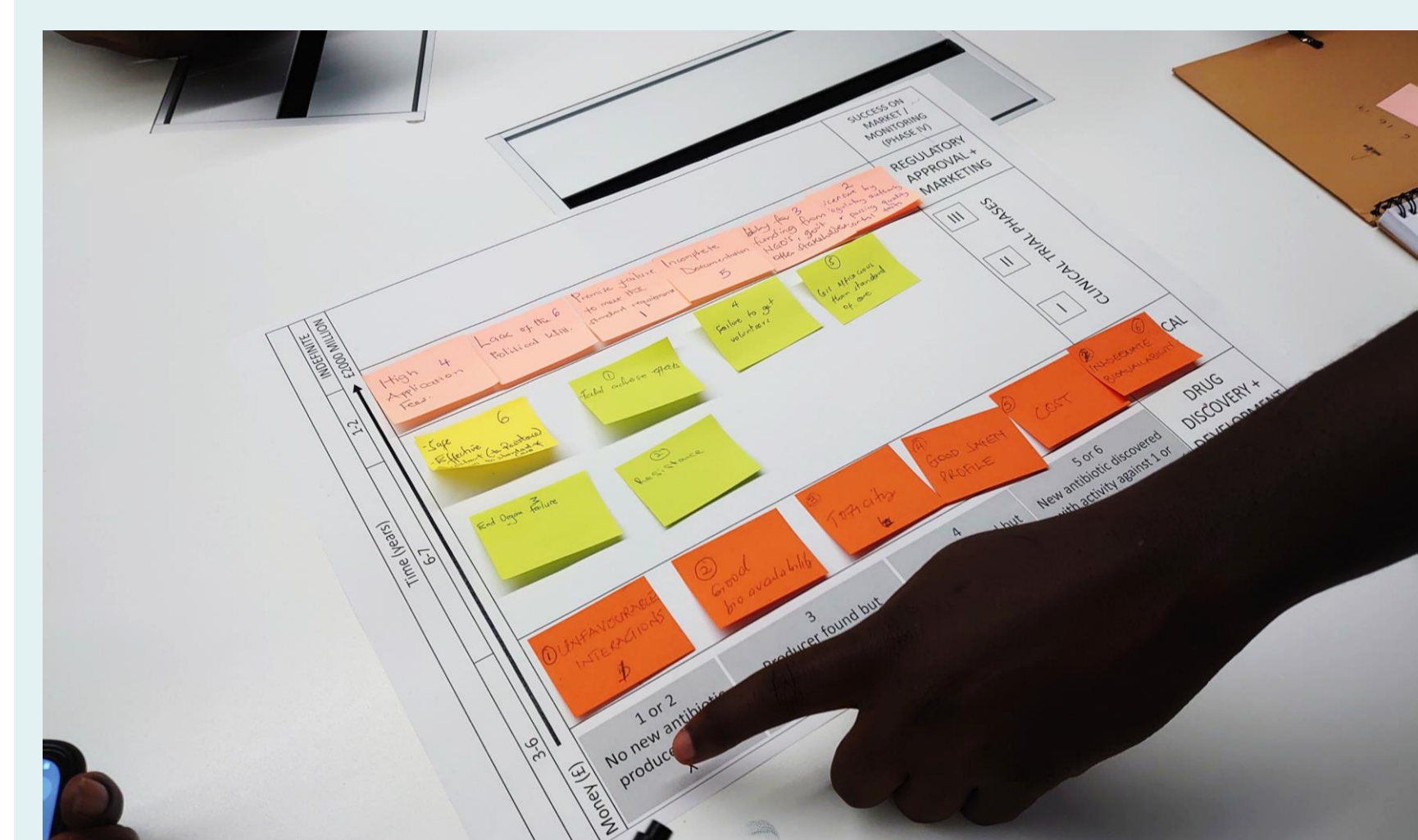


Figure 2: Students and healthcare professionals associated with Makerere University assembling and playing the game

## FEEDBACK AND CONCLUSIONS

We run this activity annually with UG Microbiology students in their Professional Skills in Microbiology module, linked to their lab-based antibiotic discovery projects and study of antimicrobial resistance. We have also used the activity successfully with visiting international students from a range of disciplines (including pharmacy, nursing, environmental and public health) to promote antimicrobial stewardship. Participants reported that the activity is enjoyable and the key learning outcomes – that antibiotic development is time-consuming, expensive, and challenging, with numerous hurdles – are surprising and memorable.

### Abbreviations

AMR: Antimicrobial Resistance  
UG: Undergraduate