

## Developing Biological Board Games: Why not make a game of it?

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William Beachly is an Assistant Professor in Biology at Hastings College with previous teaching experience in a (rival) small liberal arts college, a large university, a dental school, and even a minimum security prison (where attendance was nearly perfect every day)! At Hastings College he teaches a two-semester freshman major's course, an advanced physiology course, bioethics, ecology, animal behavior, invertebrates, and some other field-oriented courses that include travel. He enjoys small classes that provide an ideal testing grounds for new teaching approaches. He also enjoys activities that surprise students and involve them as groups to solve problems.

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Students need to be challenged to think outside the familiar formats, and motivated to apply what they've learned in a non-threatening environment. This is why I make games for many of my biology courses. Most often these are played in the laboratory because the seating is more adaptable, set-up is easier, and time is more flexible. In this mini-workshop paper I hope to encourage others to design games for their curricula, as I have found students most receptive to the novelty.

The first step, as you think about the nature of the material being covered, is to decide if the material reminds you of any games you know. It is usually easier to design a game around a format that may already be familiar to students. Relatively obvious, and simple, formats are games such as *Trivial Pursuit*, or the popular TV game shows *Jeopardy* and *Who Wants to be a Millionaire*. (I'm indebted to Dr. Tom Fogle at Saint Mary's College for this suggestion.) But

with computer graphics programs and photocopiers it is possible to mimic (as the sincerest form of flattery, of course) popular board games.

Take *Monopoly* for example. Using a computer drawing program it was easy to make a one page outline of 1/4 of the game board layout (you know, the avenues and corners). Then I pasted on my own text and drawings to create *Immunopoly*. With a little photocopying and pasting you can generate a bunch of game boards and buy whatever dice and tokens you need. You can buy genuine *Monopoly* money, but *Life* has larger denominations (more suited to modern medicine). Just as the point in *Monopoly* is to get around to GO again without going broke; in *Immunopoly* you try to get around without getting sick, or killed. Rather than landing on properties and paying rent, you land on pathogens and must fight them off with white blood cells. Where in *Monopoly* you may come to own a property and needn't worry about landing there again; in *Immunopoly* you can overcome an infection and gain lasting immunity to that particular pathogen. Of course the familiar jail and "go to jail" corners are now the hospital and "go to hospital" corners. The "chance" and "community chest" cards have been replaced by "humoral immunity" and "cellular immunity" cards that ask questions about the immune system. The railroads are now biotechnology companies with which players may patent their own gamma globulins or develop their own vaccines to sell to other players. In *Monopoly* the rents get higher as you go around, until the dreaded Park Place and Boardwalk are finally passed with relief. In *Immunopoly* the pathogens are increasingly dire and it is not at all uncommon for students to die (several times are permitted, based on how you want to play the game). In short, much of the *Monopoly* rubric is adapted to your course's material. This same method of adaptation can be applied to other games and courses.

Another example that we played in the miniworkshop is *Where in the Brain is the Nucleus Accumbens* based on the popular TV geography show *Where in the World is Carmen Sandiego?* This game involves the whole class, working in teams to follow clues on a series of large posters (representing different regions of the brain) that may ultimately lead them to the Nucleus accumbens. The clues are riddles that test their understanding of CNS anatomy and function. This is a game that can be played in a lecture room or laboratory-- anywhere with an open wall or chalkboard. Designing this game involved charting a clue pathway through a series of brain structures. Students following a clue may suspect which structure it refers to and look at the clue card for that structure in one of five *–encephalon* regions. In the correct region, the clue card will advance them toward their goal more directly than the clue card in an incorrect region. Hence their group benefits by an understanding of the brain regions as well as the structures.

The point is to show that you can use your imagination to produce a challenging activity. With the tools now at our disposal your game can look quite like the "real thing". Students will appreciate the effort and creativity you put into it, and they often teach each other quite a bit in the process of playing. This is a wonderful thing to watch! It is also a refreshing surprise to students when they come to lab and find a game board set up for them. You can be quite flexible in the time you allow for this; sometimes it can fill those time gaps that occur in traditional labs, such as waiting for the gel to run. And there's no limit to your subject material. Dr. Kari Benson at Lynchburg University shared an exercise with me in which her students had to design their own "life history" game for an ecology class. She received many creative and fun game ideas and I'm sure the students thought more deeply about life history theory than they would have otherwise. Like games, biology has rules, and role-playing provides a perspective on biological processes that students are more likely to remember.

## PLAYING IMMUNOPOLY

### 1. Getting Started:

Each player selects a colored token and begins in the GO square.  
Each player begins with \$2000, 20 B units (red), and 20 T units (clear).  
Roll 2 dice for sequence of play, then roll 2 dice to move.

### 2. Landing on a pathogen square:

Roll one die, the outcomes are listed along each side above the squares:

- **Get Lucky:** If you roll an illness or death outcome, roll again and if you match your first roll nothing happens. (e.g. You rolled 1, then you roll 1 again.)
- **Death:** One strike against you, three strikes and you're out of the game.
- **Go To Hospital:** Advance to the Hospital square, on your next turn follow the instructions below (under Hospital).
- **Get over it:** Your immune system has saved you, but at a cost. Return the number of units shown in the square to the common pools. You now have lasting immunity against that particular pathogen. Get an Immunoglobulin card. If you land there again you will neither die, go to the hospital, or need to pay B-cell or T-cell units.
- If you don't have enough B-cell or T-cell units to get over it, go to Hospital.

### 1. Rolling doubles:

Advance that number of spaces. You may stay there *or* you may advance to the next Humoral Immunity or Cellular Immunity square and draw a card. If you continued on, you did not get exposed to the pathogen (if any).

### 4. Biotechnology Companies:

When you land on one of the Biotechnology companies (BTC) you have an opportunity to buy stock in that company at \$500/share. With stock you can:

- Develop and sell IMMUNOGLOBULINS (IG)s to any pathogen you have landed on **and** gotten over it naturally (you will obtain an IG card matching that pathogen). You can sell shots of IG to any other player(s) landing on that pathogen square for \$500. Since IG's only confer passive immunity, players may need to buy another shot of IG from you if they land again on that pathogen later. Note: They may choose to buy the IG from you **when** they land on that pathogen, or take their chances on the dice.
- Develop and sell VACCINES (if you own stock in any two BTC's) to any pathogen you have landed on, provided it didn't kill you the first time. It costs you \$500 to develop the vaccine, you will have lasting immunity against that pathogen even if it sent you to the Hospital. You can sell your vaccine to other players for \$1000, imparting lasting immunity, but they must purchase it **before** landing on that pathogen square. Only you can sell that vaccine.

5. In the Hospital:

To get out of the hospital, on your next turn you can either pay a fee of \$500, use a Get out of Hospital Free card (but you will not have active immunity), or roll one die. Outcomes depend on the *next lower* pathogen level than you caught (e.g. If it was a level 2 pathogen, outcomes of the roll are based on level 1, if it was a level 1 pathogen, you get out on your next turn but must pay the units shown).

- Get over it (pay units and develop active immunity). You get out free (insurance pays).
- Get **out** of the Hospital (same roll as Go to Hospital) but without immunity to the pathogen.
- Or die (one strike against you).

If you were sent to the Hospital by landing on the Go to Hospital Square you can only get out by paying \$500 or using a Get out of Hospital Free card, and you must do one of these on your next turn.

6. CELLULAR IMMUNITY cards and HUMORAL IMMUNITY cards:

When you land on one of these squares, draw the top card. It will either tell you to do something or ask a question. If so, you must read it aloud to the group and you have 3 minutes to come up with the missing word. If your guess is correct you win \$500. The rest of the group decides if you are correct or not (they may need to consult the book). Unless the card is a Get out of Hospital Free card, return it to the bottom of the deck.

7. FREE IMMUNITY BOOST and AGEING squares:

Add to or subtract from your B-cell and T-cell units as directed (you may round down on %'s). **BUYING IMMUNITY BOOSTERS:** for \$500 you can get 25 units, any combination.

8. WINNING THE GAME

The winner is either the lone survivor, or the survivor with the most money at the end of the time allowed for play. Biotech company shares are worth \$1000 each. IG patents are worth \$500 and Vaccines are worth \$1500.

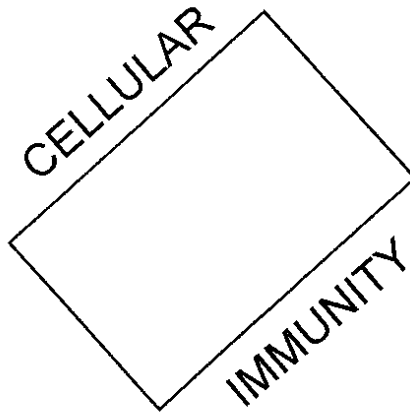
Making your IMMUNOPOLY game:

1. Photocopy the four quarters of the game board. Cut edges to match-up. Enlarge and color as desired. These can be made more durable by covering with clear Contact shelf paper.
2. Photocopy the Cellular and Humoral immunity card sheets on card stock paper. Line them up so the symbols appear on one side and the text on the other. Make sure the outlines match so that you can cut them out. Shuffle and stack each deck on the places provided on the board.

Volume 22: Mini Workshops

3. Photocopy and cut out the Vaccine and Immunoglobulin certificates. You should have extras of the IG certificates because multiple players may develop immunity to the same pathogen.
4. Obtain dice and play money from a toy store. *Monopoly* money and tokens may be obtained cheaply from your neighborhood thrift store. At a hobby store buy beads for T-cell and B-cell units. I use tri-angled beads (clear and red) because they don't roll around and resemble antibodies and T-cell receptors!
5. Feel free to modify the rules to suit your time constraints. An easy way is to adjust the number of times you're "allowed" to die.

# OPOLY

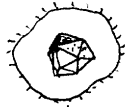



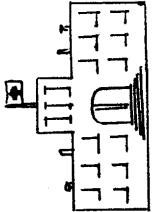


hospital, >1 Get over it - pay units shown

ACME	Streptococcus  pay 3 B-units and 2 T-units	Mumps  pay 2 B-units and 2 T-units	HUMORAL  IMMUNITY	Rhinovirus  pay 1 B-units and 2 T-units
	<p><b>GO</b> collect \$500. 10 B-units &amp; 10 T-units as you pass</p>			

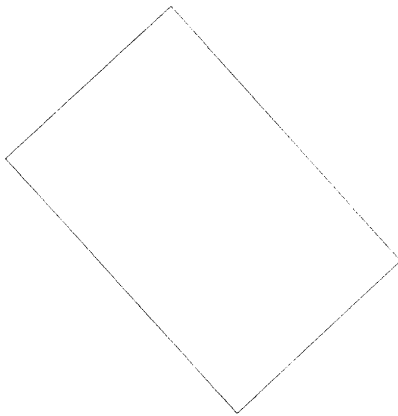
PATHOGEN LEVEL 4 roll die: 1-3 Death, 4-5 Go to Hospital, 6 Get over

I	II
Ebola  pay 7 B-units and 8 T-units	W & C BIOTECHNOLOGY  COMPANY
Hantavirus  pay 6 B-units and 9 T-units	H.I.V.  pay 5 B-units and 10 T-units
AGEING Red marrow atrophy loose 1/5th of your B-cells	ACJ prion  pay 12 B-units and 4 T-units

COMPANY	 Herpes-zoster pay 2 B-units and 3 T-units	 Adenovirus pay 2 B-units and 3 T-units	 Rubella pay 3 B-units and 2 T-units	 Reovirus pay 3 B-units and 4 T-units	HOSPITAL  JUST VISITING


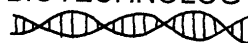

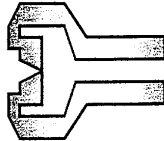


PATHOGEN LEVEL 1 roll die: 1 Gc

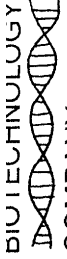


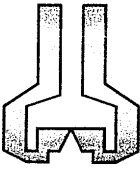

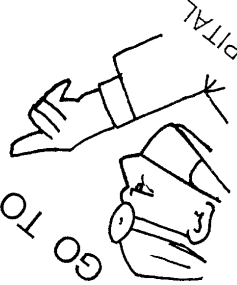
IMMUN



RAL

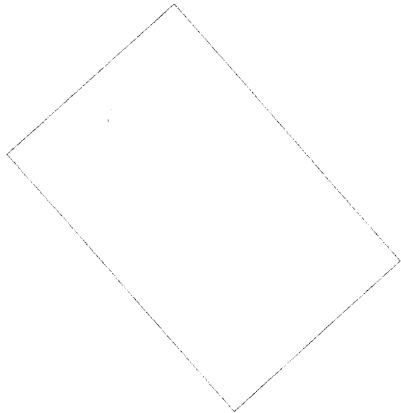
lie: 1 Death, 2-3 Go to Hospital, >3 Get over it - pay units shown

R.S.V.  pay 2 B-units and 5 T-units	EUGEN BIOTECHNOLOGY COMPANY 	Naegleria  pay 5 B-units and 4 T-units	CELLULAR  IMMUNITY	Trichinella  pay 3 B-units and 4 T-units	Epstein-Barr  pay 3 B-units and 4 T-units
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BIO TECHNOLOGY COMPANY 	Aflatoxin  pay 10 B-units and 2 T-units	Trypanosoma  pay 6 B-units and 5 T-units	CELLULAR IMMUNITY 	Varola  pay 3 B-units and 9 T-units	GO TO HOSPITAL 
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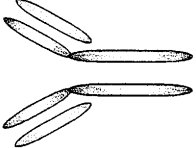


PATHOGEN LEVEL 3 roll die: 1-2 Death, 3-4 C

# OPOLY



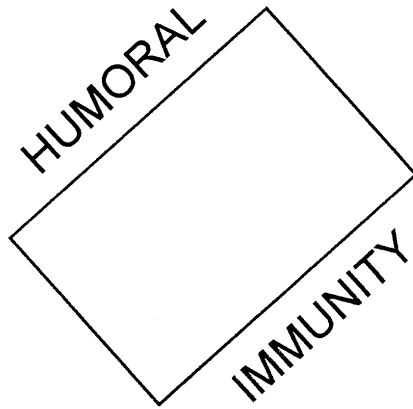
ILAR

all die: 1-3 Death, 4-5 Go to Hospital, 6 Get over it - pay units shown







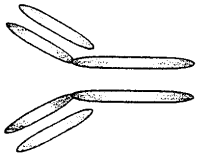



Hantavirus  pay 6 B-units and 9 T-units	W & C BIOTECHNOLOGY COMPANY 	Ebola  pay 7 B-units and 8 T-units	HUMORAL IMMUNITY 	Vibrio  pay 8 B-units and 6 T-units	Rhabdovirus  pay 6 B-units and 7 T-units
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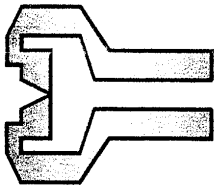
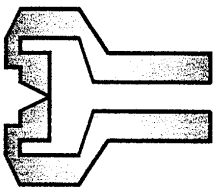
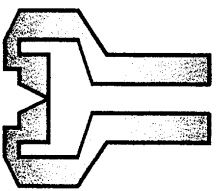
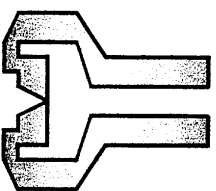
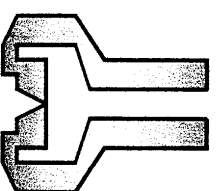
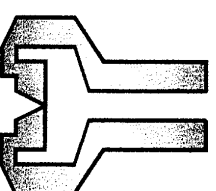
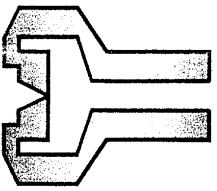
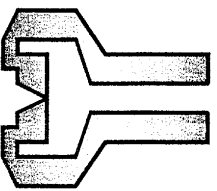
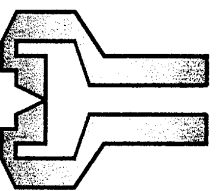
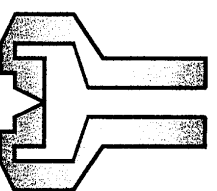
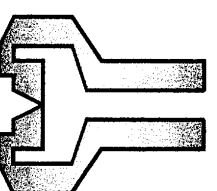
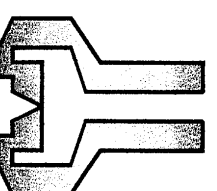
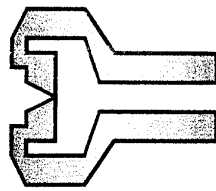
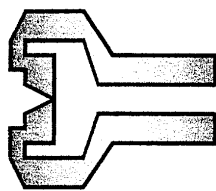
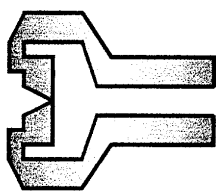
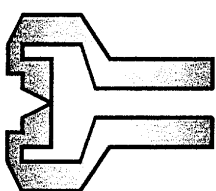
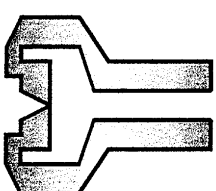
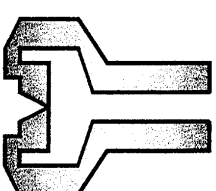
# IMMUN



to Hospital, 5-6 Get over it - pay units shown

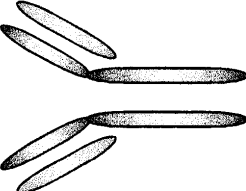
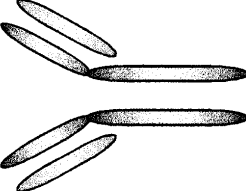
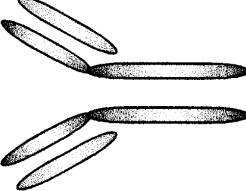
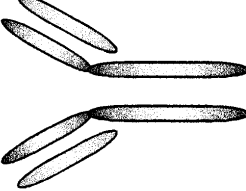
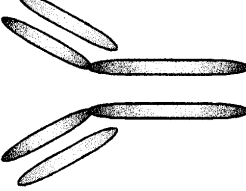
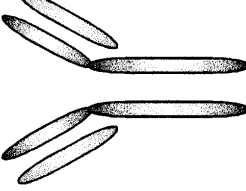
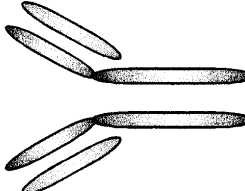
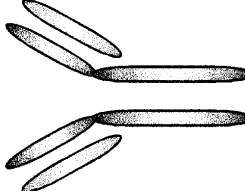
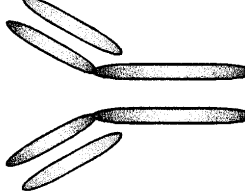
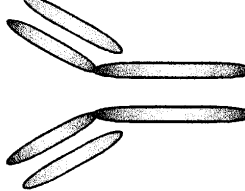
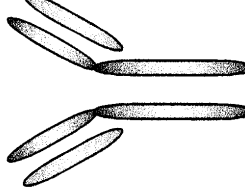
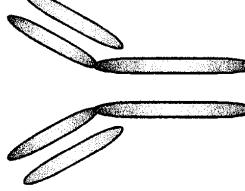
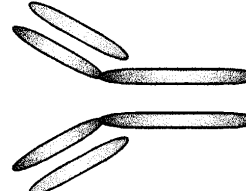
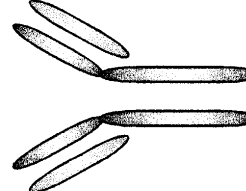
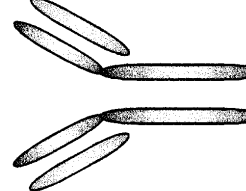
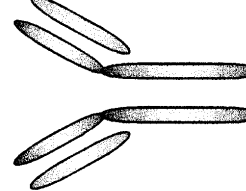
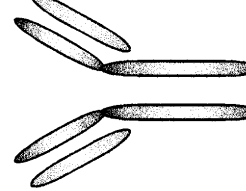
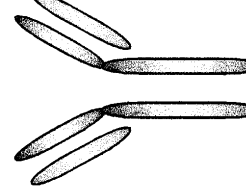
<b>GENIE</b>	<p><b>Borellia</b></p>  <p>pay 5 B-units and 5 T-units</p>	<p><b>AGEING</b></p> <p>thymus atrophy lose 1/5th of your T-cells</p>	<p><b>Tetrodotoxin</b></p>  <p>pay 9 B-units and 1 T-units</p>	<p><b>Charybotoxin</b></p>  <p>pay 9 B-units and 1 T-units</p>	<p><b>FREE IMMUNITY BOOST</b></p>  <p>add 10 units any mix of B and T</p>		
	<p><b>Histoplasma</b></p>  <p>pay 5 B-units and 4 T-units</p>	<p><b>Influenza B</b></p>  <p>pay 4 B-units and 4 T-units</p>	<p><b>HUMORAL IMMUNITY</b></p> 	<p><b>R.S.V.</b></p>  <p>pay 2 B-units and 5 T-units</p>		<p><b>EUGEN BIOTECHNOLOGY COMPANY</b></p> 	<p><b>Naegleria</b></p>  <p>pay 5 B-units and 4 T-units</p>

PATHOGEN LEVEL 2 roll die: 1 Death, 2-3 Go to Hospital, >3 Get over

CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY
CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY
CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY	CELLULAR  IMMUNITY

T-cells mature in the _____	Helper T-cells are activated by _____ cells.	T-cell receptors bind to antigen and _____ at the same time.
_____ T-cells use lymphokines to stimulate other immune cells.	_____ are a group of lymphokines known by their number (1,2,...)	T-cell receptors have _____ regions; specific for a certain antigen
_____ T-cells kill body cells that are infected by viruses or parasites.	_____ T-cells eventually bring the immune response to a halt.	_____ is a anti-viral chemical released by virus-infected cells.
Advance to the FREE IMMUNITY BOOST square. collect if you pass GO	GET OUT OF HOSPITAL FREE	GET OUT OF HOSPITAL FREE
Advance to the FREE IMMUNITY BOOST square. collect if you pass GO	BLOOD BANK error in your favor: collect 10 T-units	BLOOD BANK error in your favor: collect 10 T-units
STOCK BONUS collect \$500 if you own stock in biotechnology	STOCK BONUS collect \$500 if you own stock in biotechnology	HUMANITARIAN AWARD collect \$5,000 if you've developed a new vaccine

*BACK of CELLULAR IMMUNITY CARDS*

	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>
	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>
	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>	 <p>HUMORAL IMMUNITY</p>

Antibodies bind to specific substances called _____	The _____ region of an antibody will determine its class.	_____ bonds join the four chains of an antibody.
____-lymphocytes each have unique surface antibodies	Antigens may be proteins or poly- _____	The _____ regions on antibodies bind to specific antigens
Cloned B-cells that produce free antibodies are called _____ cells.	Activated B-cells make long-lived clones called _____ cells.	The huge variety of antibodies is possible because of _____ reshuffling.
Advance to the FREE IMMUNITY BOOST square. collect if you pass GO	GET OUT OF HOSPITAL FREE	GET OUT OF HOSPITAL FREE
Advance to the FREE IMMUNITY BOOST square. collect if you pass GO	BLOOD BANK error in your favor: collect 10 B-units	BLOOD BANK error in your favor: collect 10 B-units
STOCK BONUS collect \$500 if you own stock in biotechnology	STOCK BONUS collect \$500 if you own stock in biotechnology	HUMANITARIAN AWARD collect \$1,000 if you've developed a new gamma globulin

**Where in the Brain is the Nucleus Accumbens?**

**Your Mission:** To find the Nucleus accumbens, the “center of hedonistic reinforcement” in the brain<sup>1</sup>. Your team is assigned to begin in one of the five brain regions and you select a structure you believe can be found in that region. If you are correct, the clue you reveal by lifting the card will bring you one step closer to the nucleus accumbens<sup>2</sup>. Only one emissary from each team is allowed at the board at one time. Don’t reveal to other teams what you have learned! You are in a race to find the nucleus accumbens first.

For example, if you looked in the Mesencephalon under the Red Nucleus card, you get a clue saying “*Red Nucleus, Yes! Twixt left and right my tracts do bind, In girls I’m larger you may find*”. The riddle confirms you were on the right track and suggests which brain structure to look for next. Your group must decide in which brain region to look for that structure. You can consult your textbook<sup>3</sup> to solve the riddles. If you choose a card in an incorrect brain region, the clue beneath may say “sorry” or “not here” but lead you back towards the right path. *It is mandatory* that you follow the clue given rather than pursue the last structure chosen in some other region.

**Note:** you do not need to “take turns” with other teams. Your team may revisit the boards as often and quickly as you like; the only restraints are that only **one** member of your team is allowed at the board at a time and you must **rotate** this duty within your team. Other team members may offer guidance from their seats.

When you are ‘red hot’ on the trail, you will get a riddle that refers (but not blatantly, of course) to the nucleus accumbens and contains other clues to the brain structure of which it is a part. When you identify this brain structure and its region, write these on a slip of paper and submit them to your instructor for confirmation. If correct, you have won!

### **Instructors notes for Where in the Brain is the Nucleus Accumbens?**

#### **Setting up:**

1. Select 10 sheets of colored poster board (22” x 28” is standard sized)--2 of each color. Tape the same colored boards together on the long side to make a single poster 44” high x 28” wide. An alternative is to buy 30” x 40” white foam board. It’s sturdier but this costs more and requires more storage space. If using a white board you can color-code the five brain regions by the color of pockets (see below).
2. The five boards can be set up on the chalk tray of a standard black or white erase board. Each board has one of the brain regions: Telencephalon, Diencephalon, Mesencephalon, Metencephalon, or Myelencephalon printed boldly across the top.
2. Make 20 pockets from construction paper to paste or tape onto each board. Each pocket will fit around one of the clue cards you enlarge and photocopy from the sheets provided onto card stock paper. If you enlarge the sheets 200% each card will be 3” x 4.5” but you may want them even larger if the size of your board permits.

Volume 22: Mini Workshops

3. The top of each card, naming a brain structure, sticks out of the pocket and is visible, but the clue below must be concealed in the pocket. A group member may then take a card clue back to their group to solve the riddle before replacing the card in the pocket.

**Footnotes on instruction sheet:**

1. The nucleus accumbens was identified in rat experiments as the pleasure center of the brain. When offered a lever that delivered an electrical stimulus to this region, rats forgo feeding and even mating in order to press that lever endlessly. Other brain areas have also been proposed as being involved in addictive behaviors in humans.
2. The path taken by each group will vary. With several groups I have each assigned to begin at one of the brain regions and choose a structure they think may be found there to get onto the clue path. Another way that works for two or three groups is to assign the Red Nucleus as a starting point and they must choose the region to begin with. The most direct route will be followed by correctly identifying the structure alluded to in the clue and its region. For example the path could be:

Red Nucleus -> Corpus Callosum -> Caudate Tail -> Insula -> Three Peduncles -> Trigeminal Nucleus -> Olive -> Infundibulum -> Homunculus - which holds the final riddle to find the Nucleus accumbens:

*Your goal lies in a cluster of nuclei,  
It leans (accumbent) upon the paraventriculi*

The students need to recognize paraventricular nucleus as being one of the hypothalamic nuclei. This tells them the Nucleus accumbens is too. Then they need to correctly identify these as being in the Diencephalon.

3. We used Saladin's *Anatomy and Physiology: The unity of form and function*, pp. 469-70, 477-498. It works well because it has no direct reference to the nucleus accumbens, but can be used for the other structures along with your student's lecture notes. Most A & P textbooks will work as well.

TELENCEPHALON

<p><b>Intermediate Mass</b></p> <p>Looking for the Intermediate Mass? No trace here but explore the pyramids and have no fear.</p>	<p><b>Three Peduncles</b></p> <p>A blind alley! What once was an 'eye' in a lofty place, I still have a role in your daily pace</p>	<p><b>Optic Chiasma</b></p> <p>The optic chiasma doesn't cross here, but the vermis may worm its way near.</p>	<p><b>Cerebral Aqueduct</b></p> <p>Cerebral Aqueduct? You missed the boat. Try the pyramids of ancient note.</p>
<p><b>Vasomotor Center</b></p> <p>Vasomotor centers? Someone else has 'em, but do take a look for CN-II's chiasm.</p>	<p><b>Red Nucleus</b></p> <p>Red's not here so take a walk! But just try getting Dr. Broca to talk.</p>	<p><b>Vermis</b></p> <p>No vermis creeps here, but for better luck, take a plunge in the cerebral aqueduct.</p>	<p><b>Homunculus</b></p> <p>Your goal lies in a cluster of nuclei, It leans (accumbent) upon the paraventriculi.</p>



Volume 22: Mini Workshops

<p style="text-align: center;"><b>Insula</b></p> <p>Is the insula in? You're on the right track Sr. Detective. Make haste to peduncles three.</p>	<p style="text-align: center;"><b>Monro's foramen</b></p> <p>Monoro's not tellin' but ask the three ped- uncles of Sara Bellum</p>	<p style="text-align: center;"><b>Broca's area</b></p> <p>Broca's here! Twixt left and right my tracts do bind, In girls I'm larger you may find.</p>	<p style="text-align: center;"><b>Caudate tail</b></p> <p>My folds lie deep and out of sight my role a mystery but if you think that's bitter or sweet, it's mostly up to me.</p>
<p style="text-align: center;"><b>Olive</b></p> <p>Sorry, Olive's pit is A.W.O.L. but the massa intermedia could be fruitful.</p>	<p style="text-align: center;"><b>Infundibulum</b></p> <p>Investigating the infundibulum? Sorry. Check Pineal's body for clues.</p>	<p style="text-align: center;"><b>Trigeminal roots</b></p> <p>Trigeminal's root is not bound to this spot, but some say the hippo- campus is hot!</p>	<p style="text-align: center;"><b>Corpus callosum</b></p> <p>Callosum? You're getting closeum. 'Round about the ventricle' I go, where I stop Amygdala knows.</p>
<p style="text-align: center;"><b>Pineal body</b></p> <p>For Pineal's body you're on the wrong trail, But for thrills try pulling the caudate's tail.</p>	<p style="text-align: center;"><b>Corpora quadrigemina</b></p> <p>This four-part body isn't the right one, you must dig up the corpus callosum.</p>	<p style="text-align: center;"><b>Hippocampus</b></p> <p>The Hippocampus? Ya done well kid! Find the bulge between the vagus and hypoglossal.</p>	<p style="text-align: center;"><b>Pyramids</b></p> <p>Pursuing pyramids? Not here gumshoe, take a dive in the cerebral aqueduct.</p>

DIENCEPHALON

<p><b>Intermediate Mass</b></p> <p>Massa intermedia found! What through me flows the 3rd only knows, but to the 4th it goes.</p>	<p><b>Cerebral Aqueduct</b></p> <p>Cerebral Aqueduct? You missed the boat. Try the pyramids of ancient note.</p>	<p><b>Vermis</b></p> <p>No vermis creeps here, but for better luck, take a plunge in the cerebral aqueduct.</p>	<p><b>Caudate tail</b></p> <p>No point chasing your tail here, better luck making for the vasomotor center</p>
<p><b>Pineal body</b></p> <p>You've found the PB, now find me! I'm 'across' the underside where half decuss and half abide.</p>	<p><b>Vasomotor Center</b></p> <p>Vasomotor centers? Someone else has 'em, but do take a look for CN-II's chiasm.</p>	<p><b>Insula</b></p> <p>The insula has slipped your memory, jog it with a sea-horsey ride!</p>	<p><b>Olive</b></p> <p>Sorry, Olive's pit is A.W.O.L. but the massa intermedia could be fruitful.</p>
<p><b>Optic Chiasma</b></p> <p>Your insight shows! What through me flows the 3rd only knows, but to the 4th it goes.</p>	<p><b>Hippocampus</b></p> <p>The Hippocampus' hangout you missed, but Monro's hole is next on your list.</p>	<p><b>Broca's area</b></p> <p>Ain't seen Broca hereabouts gumshoe, but ask Corporal Quadrigemina what to do.</p>	<p><b>Trigeminal roots</b></p> <p>Trigeminal's root is not bound to this spot, but some say the hippocampus is hot!</p>

<p><b>Red Nucleus</b></p> <p>Red's not here so take a walk! But just try getting Dr. Broca to talk.</p>	<p><b>Corpora quadrigemina</b></p> <p>This four-part body isn't the right one, you must dig up the corpus callosum.</p>	<p><b>Homunculus</b></p> <p>No one home! What once was an 'eye' in a lofty place, I still have a role in your daily pace</p>	<p><b>Pyramids</b></p> <p>Pursuing pyramids? Not here gumshoe, take a dive in the cerebral aqueduct.</p>
<p><b>Monro's foramen</b></p> <p>You've found the foramen, you're warmer now too, ask Popeye's gal to get your next clue.</p>	<p><b>Infundibulum</b></p> <p>Indeed! You're gaining speed. Two 'little men' to feel and move are laid beside a central groove</p>	<p><b>Three Peduncles</b></p> <p>Nyuk, no luck! Twixt left and right my tracts do bind, In girls I'm larger you may find.</p>	<p><b>Corpus callosum</b></p> <p>Your corpse isn't here but keep looking for Pineal's body.</p>

MESENCEPHALON

<p style="text-align: center;"><b>Olive</b></p> <p>Sorry, Olive's pit is A.W.O.L. but the massa intermedia could be fruitful.</p>	<p style="text-align: center;"><b>Red Nucleus</b></p> <p>Doing fine! Twixt left and right my tracts do bind, In girls I'm larger you may find</p>	<p style="text-align: center;"><b>Homunculus</b></p> <p>No one home! What once was an 'eye' in a lofty place, I still have a role in your daily pace</p>	<p style="text-align: center;"><b>Infundibulum</b></p> <p>Investigating the infundibulum? Sorry. Check Pineal's body for clues.</p>
<p style="text-align: center;"><b>Pineal body</b></p> <p>For Pineal's body you're on the wrong trail, But for thrills try pulling the caudate's tail.</p>	<p style="text-align: center;"><b>Vermis</b></p> <p>No vermis creeps here, but for better luck, take a plunge in the cerebral aqueduct.</p>	<p style="text-align: center;"><b>Hippocampus</b></p> <p>The Hippocampus' hangout you missed, but Monro's hole is next on your list.</p>	<p style="text-align: center;"><b>Vasomotor Center</b></p> <p>Vasomotor centers? Someone else has 'em, but do take a look for CN-II's chiasm.</p>
<p style="text-align: center;"><b>Pyramids</b></p> <p>Pursuing pyramids? Not here gumshoe, take a dive in the cerebral aqueduct.</p>	<p style="text-align: center;"><b>Three Peduncles</b></p> <p>Nyuk nyuk, no luck! What through me flows the 3rd only knows, but to the 4th it goes.</p>	<p style="text-align: center;"><b>Insula</b></p> <p>The insula has slipped your memory, jog it with a sea-horse ride!</p>	<p style="text-align: center;"><b>Intermediate Mass</b></p> <p>Looking for the Intermediate Mass? No trace here but explore the pyramids and have no fear.</p>
<p style="text-align: center;"><b>Broca's area</b></p> <p>Ain't seen Broca hereabouts gumshoe, but ask Corporal Quadrigemina what to do.</p>	<p style="text-align: center;"><b>Monro's foramen</b></p> <p>Monoro's not tellin' but ask the three peduncles of Sara Bellum</p>	<p style="text-align: center;"><b>Caudate tail</b></p> <p>No point chasing your tail here, better luck making for the vasomotor center</p>	<p style="text-align: center;"><b>Corpus callosum</b></p> <p>Your corpse isn't here but keep looking for Pineal's body.</p>

METENCEPHALON

<p><b>Hippocampus</b></p> <p>The Hippocampus' hangout you missed, but Monro's hole is next on your list.</p>	<p><b>Three Peduncles</b></p> <p>The home of the three you know. Now go where a nerve with three branches grows.</p>	<p><b>Insula</b></p> <p>The insula has slipped your memory, jog it with a sea-horse ride!</p>	<p><b>Broca's area</b></p> <p>Ain't seen Broca hereabouts gumshoe, but ask Corporal Quadrigemina what to do.</p>
<p><b>Red Nucleus</b></p> <p>Red's not here so take a walk! But just try getting Dr. Broca to talk.</p>	<p><b>Corpus callosum</b></p> <p>Your corpse isn't here but keep looking for Pineal's body.</p>	<p><b>Homunculus</b></p> <p>Homunculus? No! 'round about the ventricle I go, where I stop the amygdala knows.</p>	<p><b>Vasomotor Center</b></p> <p>Vasomotor centers? Someone else has 'em, but do take a look for CN-II's chiasm.</p>
<p><b>Optic Chiasma</b></p> <p>The optic chiasma doesn't cross here, but the vermis may worm its way near.</p>	<p><b>Caudate tail</b></p> <p>No point chasing your tail here, better luck making for the vasomotor center</p>	<p><b>Trigeminal roots</b></p> <p>You've your roots, you're warmer now too, ask Popeye's gal to get your next clue.</p>	<p><b>Pyramids</b></p> <p>Pursuing pyramids? Not here gumshoe, take a dive in the cerebral aqueduct.</p>

<p style="text-align: center;"><b>Olive</b></p> <p>Sorry, Olive's pit is A.W.O.L. but the massa intermedia could be fruitful.</p>	<p style="text-align: center;"><b>Monro's foramen</b></p> <p>Monoro's not tellin' but ask the three peduncles of Sara Bellum</p>	<p style="text-align: center;"><b>Corpora quadrigemina</b></p> <p>This four-part body isn't the right one, you must dig up the corpus callosum.</p>	<p style="text-align: center;"><b>Cerebral Aqueduct</b></p> <p>Cerebral Aqueduct? You missed the boat. Try the pyramids of ancient note.</p>
<p style="text-align: center;"><b>Intermediate Mass</b></p> <p>Looking for the Intermediate Mass? No trace here but explore the pyramids and have no fear.</p>	<p style="text-align: center;"><b>Infundibulum</b></p> <p>Investigating the infundibulum? Sorry. Check Pineal's body for clues.</p>	<p style="text-align: center;"><b>Pineal body</b></p> <p>For Pineal's body you're on the wrong trail, But for thrills try pulling the caudate's tail.</p>	<p style="text-align: center;"><b>Vermis</b></p> <p>My folds lie deep and out of sight my role a mystery but if you think that's bitter or sweet, it's mostly up to me.</p>

MYELENCEPHALON

<p><b>Homunculus</b></p> <p>No one Hom! What once was an 'eye' in a lofty place, I still have a role in your daily pace</p>	<p><b>Vermis</b></p> <p>No vermis creeps here, but for better luck, take a plunge in the cerebral aqueduct.</p>	<p><b>Infundibulum</b></p> <p>Investigating the infundibulum? Sorry. Check Pineal's body for clues.</p>	<p><b>Corpus callosum</b></p> <p>Your corpse isn't here but keep looking for Pineal's body.</p>
<p><b>Caudate tail</b></p> <p>No point chasing your tail here, better luck making for the vasomotor center</p>	<p><b>Trigeminal roots</b></p> <p>Trigeminal's root is not bound to this spot, but some say the hippo-campus is hot!</p>	<p><b>Hippocampus</b></p> <p>The Hippocampus' hangout you missed, but Monro's hole is next on your list.</p>	<p><b>Broca's area</b></p> <p>Ain't seen Broca hereabouts gumshoe, but ask Corporal Quadrigemina what to do.</p>
<p><b>Vasomotor Center</b></p> <p>Right on target! What through me flows the 3rd only knows, but to the 4th it goes.</p>	<p><b>Monro's foramen</b></p> <p>Monoro's not tellin' but ask the three peduncles of Sara Bellum</p>	<p><b>Olive</b></p> <p>Holy pimento! You found Olives' center, time to interrogate the infundibulum!</p>	<p><b>Optic Chiasma</b></p> <p>The optic chiasma doesn't cross here, but the vermis may worm its way near.</p>

<p><b>Red Nucleus</b></p> <p>Red's not here so take a walk! But just try getting Dr. Broca to talk.</p>	<p><b>Pyramids</b></p> <p>My folds lie deep and out of sight my role a mystery but if you think that's bitter or sweet It's mostly up to me</p>	<p><b>Pineal body</b></p> <p>For Pineal's body you're on the wrong trail, But for thrills try pulling the caudate's tail.</p>	<p><b>Insula</b></p> <p>The insula has slipped your memory, jog it with a sea- horse ride!</p>
<p><b>Three Peduncles</b></p> <p>They're out to lunch, but look in the place where the thalami touch.</p>	<p><b>Corpora quadrigemina</b></p> <p>This four-part body isn't the right one, you must dig up the corpus callosum.</p>	<p><b>Cerebral Aqueduct</b></p> <p>Cerebral Aqueduct? You missed the boat. Try the pyramids of ancient note.</p>	<p><b>Intermediate Mass</b></p> <p>Looking for the Intermediate Mass? No trace here but explore the pyramids and have no fear.</p>