

TECHNISCHE UNIVERSITÄT MÜNCHEN

Computer Graphics and Visualization Group
Computer Games Laboratory WS 17

Blood Invaders

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1. Game Proposal

1.1. Game Description

As this year's topic of the Computer Games Laboratory course is Together, we decided to make a coop game. At its core, it is a Shoot 'Em Up that is played by two players locally on the same computer. The first player assumes the role of a bacterium while the second player assumes the role of a virus. The players find themselves in a human body and it is their goal to fight against the body's immune system. The immune system as an enemy is a core element of our game. The enemies will react to player actions like a real body's immune system would react to a bacterium or virus and so create a dynamic challenge that can be different every time you play it. The bacterium and the virus will also differ from each other visually and functionally. While the bacterium is bigger and bulkier and therefore a bit slower, the virus is a swarm of multiple smaller viruses and therefore faster. The goal of the game is to infect the whole body. In order to achieve this, every level has to be beaten by defeating the boss at the end of every level. If both players die during a level, they can replay the level until they succeed. There won't be a Game Over that forces you to start completely from the beginning.

1.1.1. Artstyle

The game is situated in the human body and will be divided into separate levels. These levels correspond to different body parts or organs. At the end of each level, there is a boss, which needs to be defeated in order to complete the level. The overall art style of our game is not photo-realistic, but the players, as well as the enemies and the environments, resemble their real-world counterparts. The game will be 2.5D meaning that the assets and environments have 3 dimensions, while the gameplay will be restricted to two dimensions.

1.1.2. Gameplay

In general, the gameplay takes place in a typical Platformer or Shoot 'Em Up environment, where the players can traverse the screen either from left to right or from top to bottom. So the gameplay will be restricted to those 2 dimensions. After a short introduction video on how the bacterium and the virus enter the body, the players gain control over their characters and start to progress through the level. Some parts of the game feature an autoscroll mechanic that forces the players to progress through the level at a certain speed by automatically moving the environment forward. If the players can't keep up, they lose health. Other sections of the game allow the players to progress at their own speed.

The bacterium and the virus will not only look different but will also differ in their behavior and abilities.

The bacterium is relatively large compared to the virus. Therefore it has a bit slower movement which it compensates with a higher hp pool. Its size is also an indicator of how much

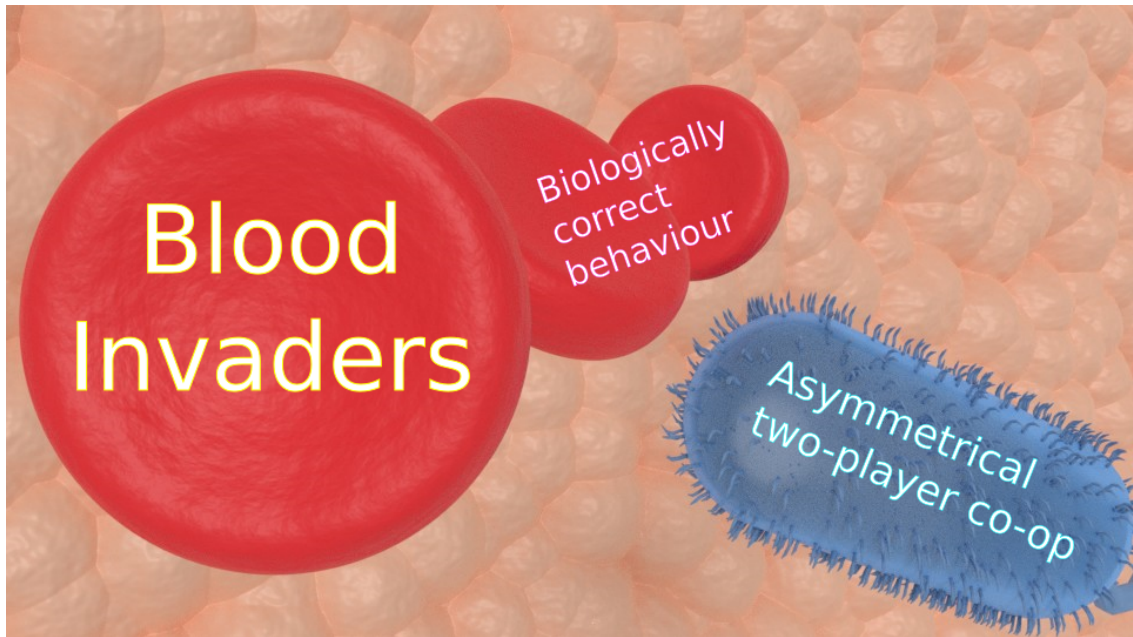


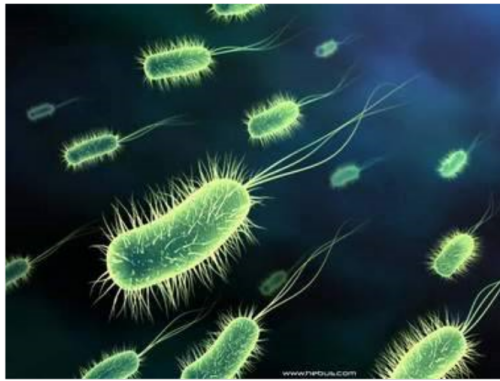
Figure 1 *Big Idea Bullseye* - Main concepts of the game

health it has remaining. So if the bacterium loses hit points, it will shrink in size. The bacterium's first ability is to eat certain cells or parts of certain cells in order to restore some health. The second ability is a dash, that allows him to quickly get out of critical situations.

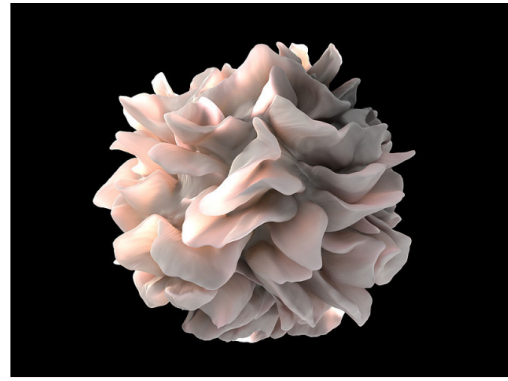
The virus, on the other hand, behaves differently. Since a single virus is relatively small compared to a bacterium, the virus actually consist of a swarm of viruses. The number of viruses in the swarm indicates the health of the virus. If there are no more viruses left, the virus is dead. The virus has the ability to infect healthy body cells in order to create new viruses and therefore restoring health. The virus' second ability allows him to temporarily mutate and so gain temporal immunity against certain enemies. The abilities of the virus and the bacterium will be on a cool down before they can be used again.

Killing enemies will also charge the duo's ultimate ability which can be activated once enough enemies have been killed. There are two ultimate abilities. The first one creates a power-link between the virus and the bacterium which kills any enemy that touches it. The second one allows the bacterium and the virus to temporarily merge and create a sort of tank where the bacterium is responsible for steering and the virus is responsible for the shooting.

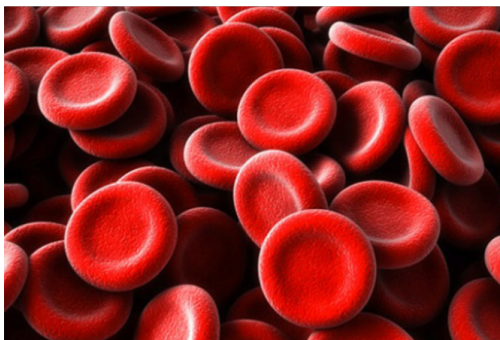
Enemies resemble cells that the body's immune system uses in order to fight bacteria or a virus. Their combat behavior is inspired by their behavior in a real human body. Cells that eat bacteria or viruses try to collide with the players. Other cells that produce antibodies, shoot those anti-bodies towards the players. Other enemies will serve as messengers that alert other parts of the immune system and therefore call forth additional enemies.



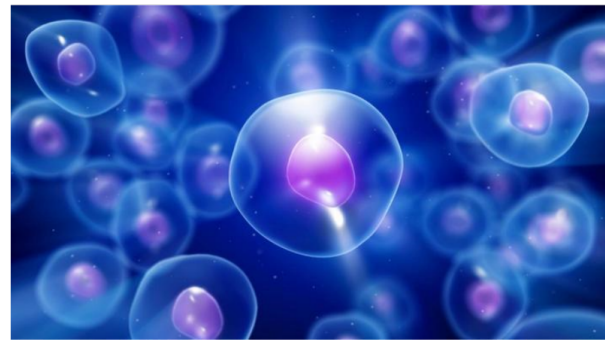
(a) Bacterium



(b) Dendritic cell



(c) Red blood cells



(d) Cells to invade

Figure 2 The art style of the game is *Scientific visualization*, similar to the CG depiction in documentaries. Simplified shapes, false colors and PBR shaders are going to be used.

1.2. Technical Achievement

The technical achievement describes the challenges arising with the implementation of the game idea.

1.2.1. Correct Representation of the Immune System

In case of *Blood Invaders*, one technical difficulty is to implement a precise and accurate representation of the immune system of the human body. It should be recognizable, how the Adaptive Immune System reacts to intruders like viruses and bacteria that are trying to harm the body. I.e. which cells defend in what kind of situation and how are they try to remove the attackers. In addition to this, what are the virus' and bacterium's way to win the fight against these defenders, which abilities help them to reach their goal.

1.2.2. Asynchronous Multiplayer

The second technical difficulty in *Blood Invaders* will be the implementation of a smoothly working and fun-to-play asymmetric multiplayer game. One player plays the virus with his individual abilities and look, the other takes control of the bacterium, which has quite a different behavior.

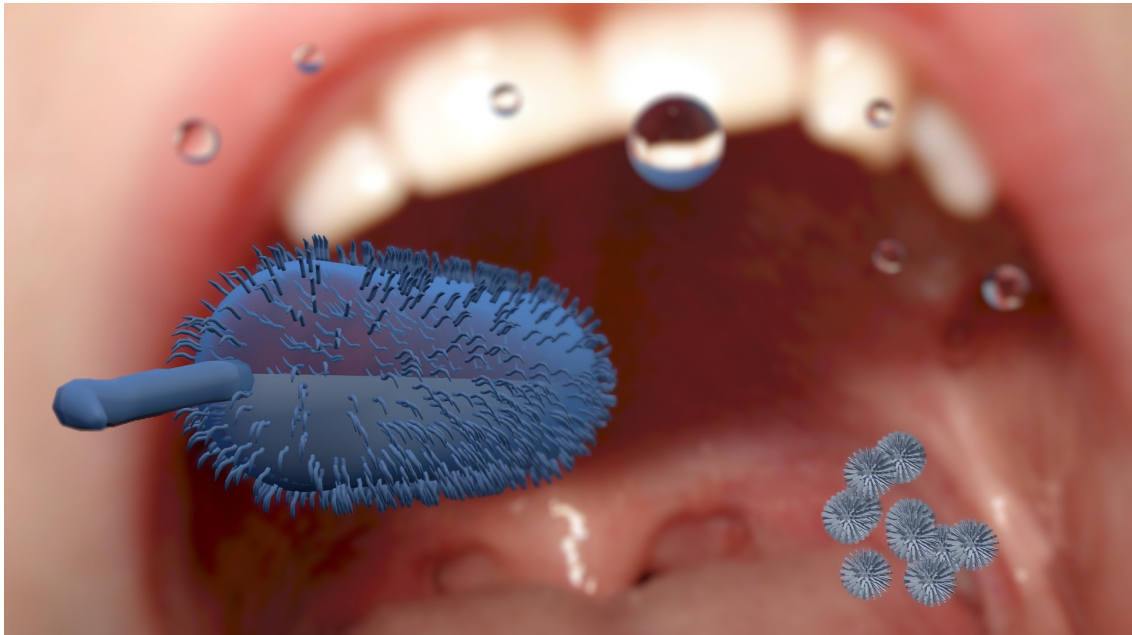


Figure 3 Mockup: Short intro sequences show how the invaders entered the body.

1.3. Schedule

1.3.1. Layered Task Breakdown

This section provides an overview of the different features the game should contain. The features are clustered associated to how crucial they are with respect to the game itself. For the separation we need to differentiate between five topics of features. Each functionality can either be associated with the player, the enemies, the UI, design and general issues.

Functional Minimum

The functional minimum describes the essential features needed to call the application a game.

- Player:
 - Basic ability: The players should be able to shoot some kind of projectile.
 - Basic health property: If hit by an enemy, a player can die.
- Enemy:
 - Basic behavior: the first enemies appearing in the game will be neutrophils with no abilities. They fly around randomly.
 - Basic damage chart: If hitting a player, the collision kills both, the player and the enemy.
- UI:
 - There will be no main menu at this point, only the gamescene with the current level.
- Design:
 - Thus far, the players and enemies both have a placeholder model, like a cube, and no

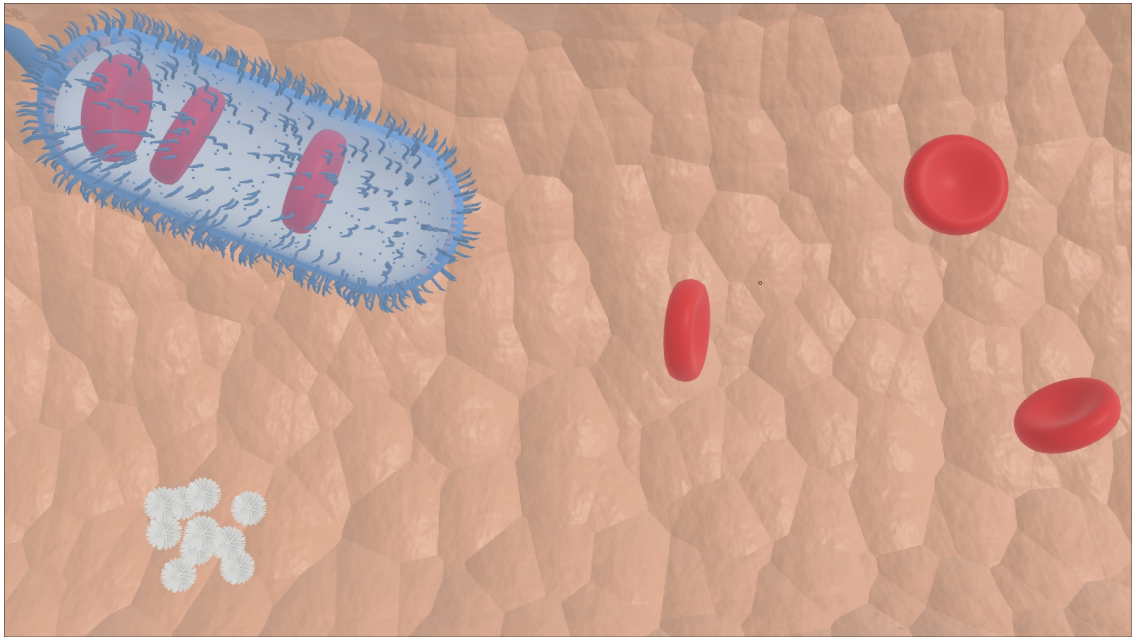


Figure 4 *Mockup*: Example scene of the game showing the bacterium and the virus swarm inside the blood stream.

animations.

- General:
 - Multiplayer: The game should be playable by two players on one machine.
 - Controls: Both players play share the same keyboard.

Low Target

The low target represents the least acceptable state of the application that can be submitted as a final result.

- Player:
 - First skill: The virus and the bacterium both have a first ability that focuses on regaining a portion of the health.
 - Different players: Both characters are distinguishable with respect to looks and abilities.
- Enemy:
 - Two kinds of enemies: Macrophages are added to the enemy spectrum. They are bigger than Neutrophils and survive longer.
 - Infectable cells: Cells, which can be infected by the virus are added to the game.
- UI:
 - Main menu: The application has a main menu which contains the options to start and end the game.
 - Level entry and exit: the existing level will have a defined start point as well as an end point, which brings you back to the main menu.
- Design:

- Low-polygon models: Some self made character models in low resolution are available for the players. The virus will be a swarm of little viruses and the bacterium a big blob.
- Background: the game scene has a simple background that scrolls from top to bottom or from right to left.
- General:
 - No new features for this layer.

Desirable Target

If the game complies with the requirements defined in the desirable target section, the developers have reached their predetermined goals for this project.

- Player:
 - Bacterium: Is bigger and slower than than the virus, also has more health.
 - Virus: Smaller and faster, more squishy.
 - Ultimate ability: A chargeable, synchronized super ability is available, forcing both players to interact.
- Enemy:
 - New types: Natural killer cells, who kill cells infected by the virus, as well as dendritic cells, who inform the adaptive immune system about intruders.
 - Adaptive immune system: B-Lymphocytes are added to the game. These shoot loads of anti-bodies that hurt the characters.
- UI:
 - Main menu: Level selection is available in the main menu.
 - Implicit indicators: there will be hints on different status attributes, e.g. an ultimate progress indicated by a glowing bacterium or health indicated by the virus' size.
- Design:
 - Self designed characters: Higher resolution and self made animations.
 - Self designed enemies: Some enemies have self designed models with basic animations.
 - Different levels: So far, there are up to two levels with different settings. The levels have a polished design.
- General:
 - Sound: Sound effects for attacks and background music is added to the game.
 - Controls: The game is playable with controller and/or keyboard.

High Target

The requirements from the high target represent the result of the application if things take course better than expected.

- Player:
 - Quick time event: A synchronized ability will be added that is started by one player and finished by the other through a quick time event.
 - Virus: Can mutate in order to gain temporal immunity against anti bodies.
 - Bacterium: Has a new dash ability to dodge enemies.
- Enemy:
 - Boss fight: At the end of each level, there will be a boss fight.
- UI:
 - Main menu: Settings section will be added.
 - Customization options: Difficulty settings, different character models to choose from.
- Design:
 - Cutscenes: Amongst others, an intro cutscene will be added.
 - Fluid animations: Character and enemy animations will be more polished and fluid.
 - Levels will contain scripted events.
- General:
 - Sound: Different sound tracks for the different levels.
 - Perspective: Multi-task sequences where both players need to contribute. These sequences will be in 3D perspective.

Extras

The extras section contains features that would be nice-to-have as addons and future work, but which do not fit in the scope of this project.

- Player:
 - No additional features.
- Enemy:
 - Biological correctness: The game will contain are more accurate and detailed representation of the immune system.
- UI:
 - No new features.
- Design:
 - Random level generator: levels are automatically created for the different environments.
 - Level editor: Blueprints and a level editor will be available.
- General:
 - Publishment: The game will be published on Steam.

1.3.2. Development Schedule

This schedule (Fig. 5 and 6) presents how we plan to implement the game. At the end of the implementation phase our target is to have all desirable target items to be finished. The

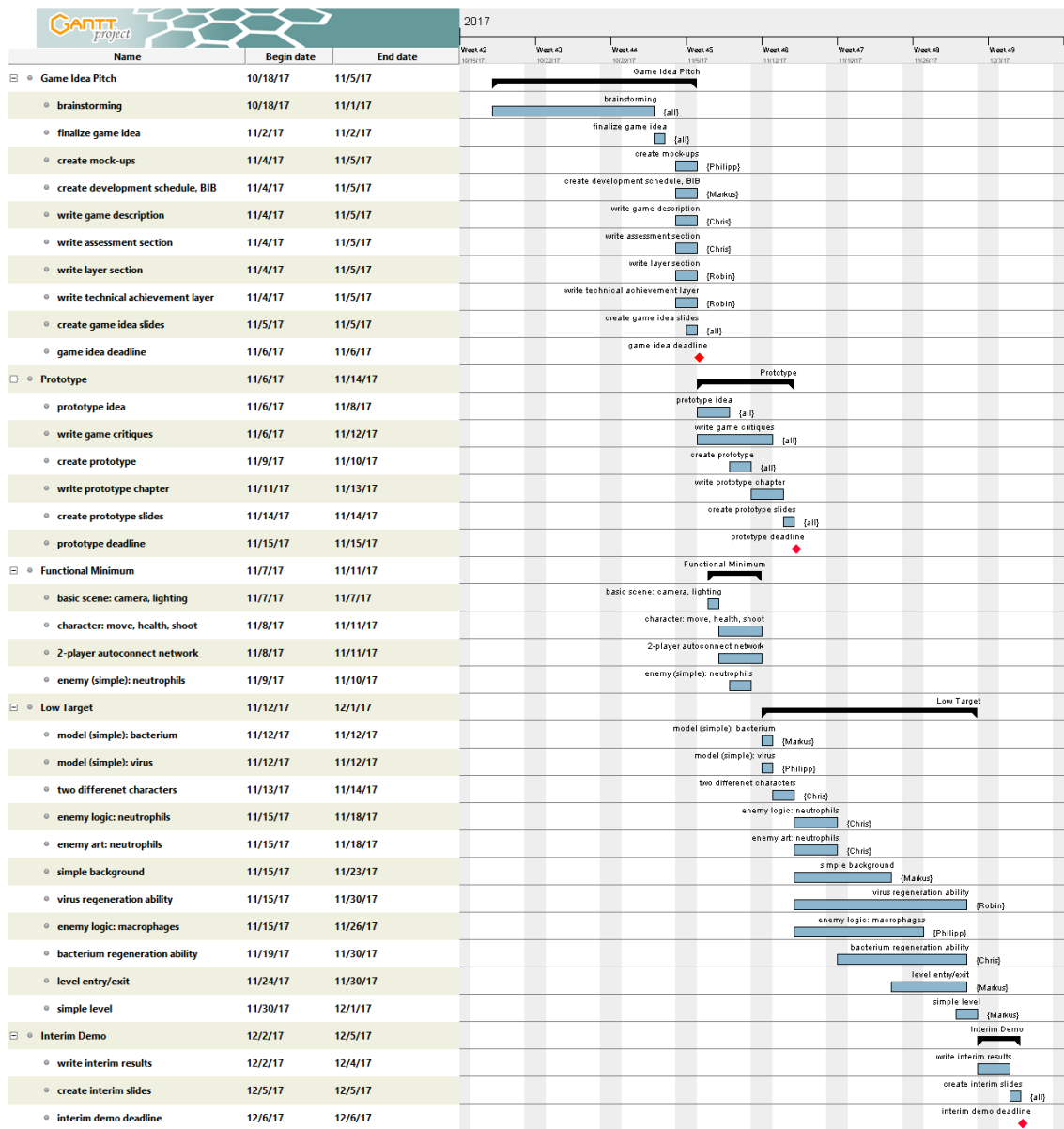


Figure 5 Part one of the development schedule

schedule includes the assignment of all four team members to different tasks. This is still work-in-progress and will certainly change during the implementation phase. Therefore, this is intended as a guideline that will help us to keep track of our work and rather not as a binding and final schedule.

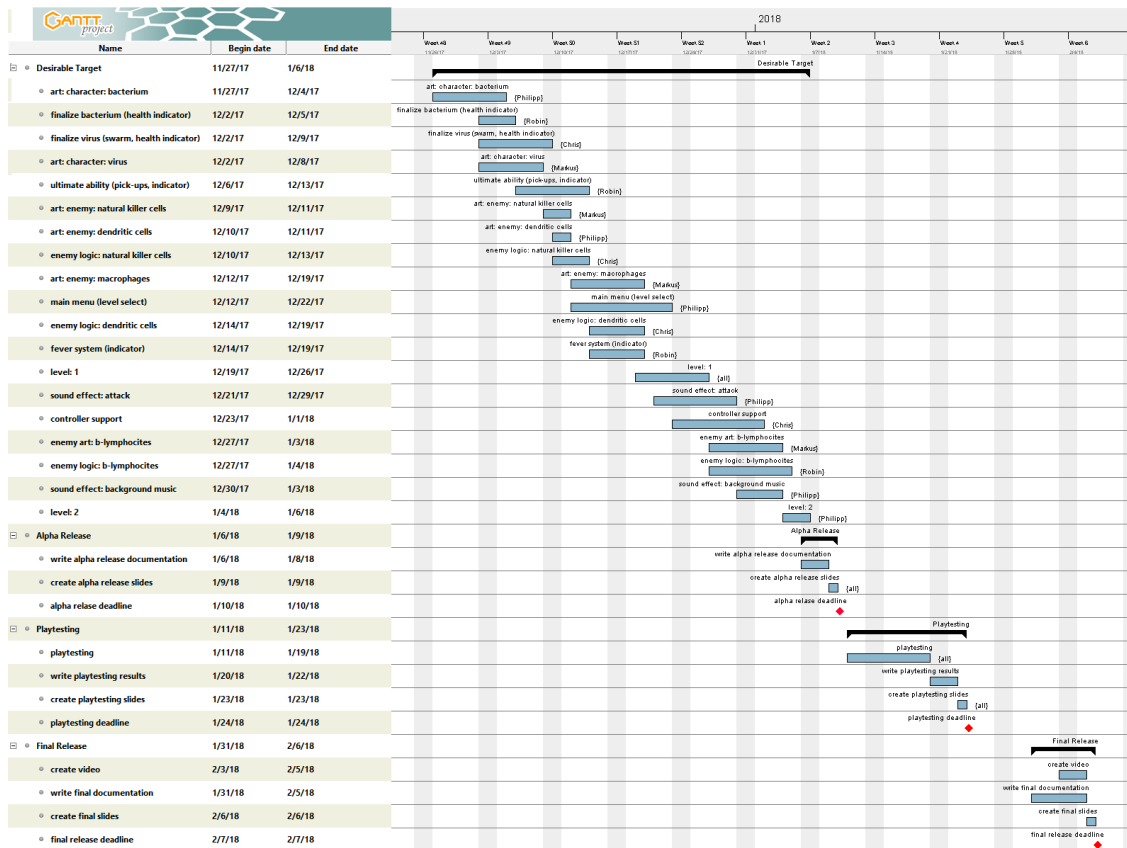


Figure 6 Part two of the development schedule

1.4. Assessment

Generally speaking, we want to create a Shoot 'Em Up game that looks and plays reasonably well, considering the time we have for the Computer Games Laboratory Course. The aspects that make our game unique and stand out from the ocean of Shoot 'Em Up games out in the wild are the following: With a bacterium and a virus as coop partners, we create a unique pairing that offers possibilities for interesting game mechanics and player-player interactions inspired by actual biology and chemistry.

Our setting inside a human body is already naturally different from the vast majority of Shoot 'Em Up games that are at least in some form space or spaceship themed. This allows for interesting and unique visuals that can make our game unique and stand out without the need to look perfectly polished.

Last but not least our enemy system that is inspired by the immune system of a real body provides a dynamic gameplay experience that can produce different scenarios depending on how the players play, without any need of additional scripting for us.

We are confident that our game will offer a fun and unique experience if we succeed to execute these three core aspects well.

2. Physical Prototype

2.1. Prototype

The main reason for creating a physical prototype for any kind of application is to test its core idea. In case of a game, the prototype should carve out the core gameplay and test its functionality. Applied to our project "Blood Invaders", it is important to try out whether our main element, the enemy system inspired by the real immune system, works with respect to our game idea. Therefore, we designed and build a board game whose mechanics and rules will be described in the following section.

2.1.1. General

The game is designed for two players. One player plays the virus, the other one plays the bacterium. Together they have to survive against the immune system until the boss of the level appears. Once they have beaten the boss, the players win. If both players die or the fever level of the body becomes too high, the players lose. The enemies behave according to a set of rules and are not controlled by a player. The game is played on a board consisting of hexagons. The players start on one side while new enemies approach them from the other side of the board. The game is turn based. It starts with the players' turn, where the virus and the bacterium get to perform their actions. After that, it's the enemies' turn. The players' and the enemies' turn keep alternating until the game is over. Players are able to shoot at enemies, however they can only shoot horizontally on the board. A player can only target enemies that are located on the same horizontal line as the enemy. We simulate the fact that enemies that are further away, are harder to hit, with dice rolls. Enemies that are further away require the players to roll higher in order to hit.

2.1.2. Players

This section describes the two player characters and their different traits and abilities.

The bacterium is the bigger one of two player characters and therefore occupies two spaces on the board and has 3 hit points. Every turn it can perform 2 actions. For the first action, the player that controls the bacterium has 3 possibilities:

- move up to two spaces forward in the direction he is facing
- move up to two spaces backward in the opposite direction
- turn by 60 degrees

For the second action he shoot once. If he is standing diagonally on the board, he has the possibility to shoot at either of the lines he is occupying. The bacterium has a range of up to 12 hexagons. If he decides to shoot he has to roll a dice. For every "eye" he rolls, the range

of the shot will increase by 2, meaning that if he rolls a "1" he will hit an enemy that is two or less hexagons away. If he rolls a "2" he will hit an enemy that is four or less hexagons away and so on. If he hits he decreases the hit points of the targeted enemy by one.

The virus is smaller and only occupies one hexagon on the board and also has 3 hit points. It can also perform actions. For the first action it can move 1 space in any direction. For the second action he can shoot at an enemy that is on the same horizontal line as the virus. The virus has a range of up to 6 hexagons. He also has to roll a dice if he tries to shoot an enemy. Every eye that he rolls increases the range of his shot by one, meaning that if he rolls a 1 he will hit an enemy that is 1 hexagon away. If he rolls a 2 he will hit an enemy that is 2 or less hexagons away and so on. If he hits, the targeted enemy loses 1 hit point. The virus also has a special ability. He can infect infectable body cells if he stands on the same hexagon as the infectable cell. If he does that, two different things happen. First of all, the virus can no longer perform his normal actions during his turn, but his actions are replaced by a dice roll. Once he reaches a cumulative "eyecount" of 10, the infection is successful. The infected cells get destroyed and the virus regains 2 health points. While the virus is infecting a cell, he can only be damaged by natural killer cells and macrophages stop targeting until the infection is completed. The second thing that happens is that 2 natural killer cells appear on the board. Their functionality will be explained in the enemy section.

2.1.3. Enemies

This section describes the different kinds of enemies, how they behave and when they spawn.

Our most basic enemies are the neutrophils, which have one hit point. Their movement is pseudo-random and is determined by a dice roll:

- if the roll is a 1 or 2: move one hexagon forward and one hexagon upward
- if the roll is a 3 or 4: move two hexagons forward
- if the roll is a 5 or 6: move one hexagon forward and one hexagon downward

A single dice roll determines the movement for all neutrophils on the board. If the neutrophils are directly next to a player at the start of the enemy turn, they always move on the space that the player is standing on, independent of the dice roll. If a neutrophil is on the same space as a player the neutrophil does 1 damage to the respective player and dies afterwards. In the first turn of the game 3 neutrophils spawn and are randomly distributed in the last third of the board. From the second turn on, a new neutrophil spawns every enemy turn. There are six different spawn positions. Where the new neutrophil spawns is determined by a dice roll.

Our next enemies are the macrophages, which have 2 hit points. They always move 2 hexagons in the direction of the nearest player. Macrophages can damage players even if

they 1 field away from the player. However they can only damage each player once a turn. In turn 4, two macrophages spawn. Where they spawn is determined by a dice roll. From there on out 1 new macrophage spawns every other turn. Once the mast cell appears on the board macrophages stop spawning. However already existing macrophages stay on the board.

Another enemy are the infectable cells, which have 1 hit point. They always move 2 spaces forward horizontally. They can not damage the player. If they collide with the bacterium they move either upwards or downwards. If they collide with virus, the virus can infect them if he wants to. In turn 6, 3 infectable cells spawn. Their spawn position is determined by a dice roll. From there on out, 2 infectable cells spawn every 3 turns until the game is over.

A special enemy are the natural killer cells, which have 1 hit point. They always move 3 spaces in the direction of an infected cell. They have to move around the bacterium. If they hit the infected cell before the infection is completed, the infection stops, the infected cell gets destroyed and the virus loses 2 health points. Also all natural killer cells are removed from the field. If the infection is completed before the natural killer cells can reach the infected cell, all natural killer cells are removed from the field. Natural killer cells can only spawn when the virus infects an infectable cell. In this occasion two natural killer cells spawn and their spawn location is determined by a dice roll.

The boss of the game is the mast cell, which has 3 hit points. Every turn, the mast cell spawns a chemical. Afterwards it moves two hexagons vertically. If it reaches the end of the board it changes direction until it hits the other end of the board. It spawns in turn 12 in the corner of the board.

Our last enemies are the chemicals, which have 1 hit point. They always move 2 hexagons forward horizontally. If they leave the board, the fever level of the body increases by 1. If they fever level of the body reaches 2, the players lose. Chemicals can only be spawned by the mast cell.

2.2. Experience

Our overall impression of testing our prototype was pretty positive. In comparison to our expectation, it was much easier to make the game fun and balanced. Both the virus' as well as the bacterium's role and influence in winning the level were approximately the same. This made it possible for us to test the crucial components for both characters.

We learned, that a big challenge will be to design the levels and the immune system in a way, that the spawning behavior together with the damage chart of the enemies is both fun and challenging. In our prototype, it took us a lot of iterations until we figured out a decent spawning sheet. Our final result (see Fig. 7) gave the players the opportunity to approach the enemies as well as the boss in different ways but still demanded a great deal from the virus and bacterium. This represents exactly what we want to achieve in the real game: A

challenging but fun experience for everyone!

Another thing we learned while playing our prototype was, that a small number of different abilities for the bacterium and the virus are sufficient, since the immune system will be complex enough to still ensure varying experiences for the player. In our setup, we used one individual ability for each player together with a sequence that required both characters to cooperate, which was enough to create a lot of variation and at the same time prevented the players from losing track. Therefore, when implementing the game, we will focus on getting few items right which fit the individual characters well and can be used in a reasonable way against the immune system.

| Round | Number of enemies | | | | |
|-------|-------------------|------------|---------------|-----------|-----------|
| | Neutrophil | Macrophage | Infect. Cells | Mast Cell | Chemicals |
| 1 | 4 | | | | |
| 2 | 1 | | | | |
| 3 | 1 | | | | |
| 4 | | 2 | | | |
| 5 | 1 | | | | |
| 6 | 1 | 1 | 3 | | |
| 7 | 1 | | | | |
| 8 | 1 | 1 | | | |
| 9 | 1 | | 2 | | |
| 10 | 1 | 1 | | | |
| 11 | 1 | | | | |
| 12 | 1 | | 2 | 1 | |
| 13 | 1 | | | | 1 |
| 14 | 1 | | | | 1 |
| 15 | 1 | | 2 | | 1 |
| 16 | 1 | | | | 1 |
| 17 | 1 | | | | 1 |
| 18 | 1 | | 2 | | 1 |
| 19 | 1 | | | | 1 |

Figure 7 Picture playing the prototype.

2.3. Design Revisions

In this section we will explain which design revisions and changes we have derived from playing our physical prototype and receiving critiques from the other groups participating in the Computer Games Laboratory.

2.3.1. Prototype

For the most part, we were rather surprised how well our ideas worked out as a physical prototype. The asymmetric gameplay with two different roles and the combat against the immune system with a predefined and rather complex ruleset, resulted in a fun experience right from the first time we tried our prototype. Therefore these two concepts still hold as central design concepts in our game.

During testing the prototype we found out that putting more work into the level details in terms

of course of events and enemy spawn behavior is important to ensure a consistent flow for the players. Because of that we want to focus on at most two levels, maybe even only a single level, that is fleshed out. With this in mind, the random level generation will move even further back in our priority list and development schedule.

2.3.2. Critiques

First of all we want to thank the other teams for their honest and constructive feedback. Overall the asymmetric gameplay seems to be the most liked feature in our game. Furthermore, the other teams seem to like our idea of simulating the humane immune system together with the setting of the game inside the body.

One aspect that was frequently requested, is to constrain the players to cooperate more often, since this is one of the core mechanics of the game. The others suggested to enforce this through environment and/or enemies.

A more detailed implementation of the cooperation component is the cell infection sequence, where the virus has to infect a cell while the bacterium protects it from the natural killer cells. We also tested this component in the prototype in order to validate that the concept we have in mind will actually work out in the game.