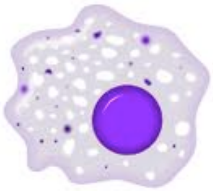
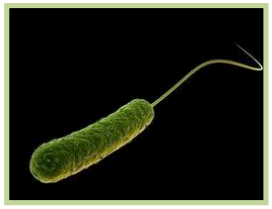
# Cystic Fibrosis Activity (Teacher Guide)
# You Be the Clinician – Part 1

**Scenario:** You are a doctor in the pediatric intensive care unit (ICU) at a hospital. You have four patients who you suspect might have Cystic Fibrosis, but you can't make a diagnosis until you run more tests.

The first step in determining whether or not your patients have Cystic Fibrosis is to collect Bronchial Alveolar Lavage Fluid (BALF) samples from their lungs and examine it for the presence of:

Inflammatory cells



*Pseudomonas aeruginosa*

Based on the **phenotypes** you observe, you will then decide which patients' DNA needs to be sequenced to determine the **genotype** of the CFTR allele.

**Instructions:** DO NOT OPEN THE TUBES!

1.) Examine the 4 Bronchial Alveolar Lavage Fluid (BALF) samples on your desk from patients A, B, C, and D.

2.) Analyze each sample for:
- mucus consistency (thick or watery/normal)
- presence of inflammatory cells (white beads)
- evidence of infection with the bacteria, *Pseudomonas aeruginosa* (green beads)

3.) Record your findings on the next page.

4.) Based on your observations, determine which two patients you think might have Cystic Fibrosis. Write your two choices in the spaces provided. You will vote as a class to determine whose DNA you want to send to the lab for genetic testing.

*Chart is filled out in order to help the instructor lead the discussion.*

| Patient | Mucus Quality | Immune Cells | Infection | Do you think this patient could have CF? |
|---|---|---|---|---|
| **A** | Watery | Yes | No | Doubtful |
| **B** | Thick | Yes | Yes | Possibly |
| **C** | Watery | No | No | No evidence |
| **D** | Thick | Yes | No | Possibly |

**Based on what you have found, which two patients are the most likely to have Cystic Fibrosis?**
Most likely Patients B and/or D due to think mucus and presence of immune cells.

### Questions to ask the class:

*"Which patients have the thickest mucus?" "Did any of the patients show signs of infection?"*

Get the class to reach a consensus about their observations.

Then ask*, "Which patients might have CF?"*

### Let's take a closer look at each patient:

**Patient A** has inflammatory cells present, but no bacterial infection. This could be a result of viral infection, but is most likely not caused by CF since the mucus quality is normal.

**Patient B** has multiple symptoms of CF so he is a definite candidate for further testing.

**Patient C** appears to be healthy. Perhaps this patient participated in a lung study as a healthy control subject.

**Patient D** has thick mucus and inflammation but no bacterial infection. Why would we think this patient could have CF in the absence of infection? Keep in mind this patient is a newborn. Bacterial infection is a secondary consequence of having thick mucus in the lungs (less able to clear bacteria, more nutrients present). Therefore, a newborn may not have had time to acquire bacterial infection yet, so we can't rule out CF based on this evidence alone.

*"What other information will help us determine whether the patients have CF?"*
***DNA sequence of the cftr gene will tell us if there is a mutation.***

*Why not just sequence the cftr gene from all patients?*
**DNA sequencing can be costly and time consuming so it's best to only do this when other evidence suggests a patient could have CF.**

# Cystic Fibrosis Activity
# Teacher's Guide – Part 2

**Scenario:** You sent DNA samples to a genetics lab for sequencing. The lab has sent you the DNA sequence for a small portion of the *cftr* gene from each patient.

Remember how proteins are made?

DNA ⟹ RNA ⟹ Protein

You now have to take the DNA sequences you obtained from the lab and convert them into a protein sequence. You will then be able to compare your patients' CFTR protein to a normal CFTR protein to make the final diagnosis of Cystic Fibrosis.

**Instructions:**

1.) First, you must <u>transcribe</u> the DNA sequences below to RNA sequences, and write them in the spaces provided.

| DNA | | RNA |
|---|---|---|
| A | → | U |
| T | → | A |
| C | → | G |
| G | → | C |

Patient _B_ *cftr* DNA sequence:

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **T** | **T** | **A** | **T** | **A** | **G** | **T** | **A** | **G** | **A** | **A** | **A** | **C** | **C** | **A** | **C** | **A** | **A** |
| RNA: | A | A | U | A | U | C | A | U | C | U | U | U | G | G | U | G | U | U |

Patient _D_ *cftr* DNA sequence:

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **T** | **T** | **A** | **T** | **A** | **G** | **T** | **A** | **A** | **A** | **G** | **A** | **C** | **C** | **A** | **C** | **A** | **A** |
| RNA: | A | A | U | A | U | C | A | U | U | U | C | U | G | G | U | G | U | U |

2.) Now that you have <u>transcribed</u> the DNA sequence into an RNA sequence, you need to <u>translate</u> the RNA sequence into a protein sequence. Copy your RNA sequences on to the next page in the space provided.

3.) Find the amino acid in the chart below that corresponds with the RNA sequence, and write the protein sequence in the space provided.

Patient **B** RNA sequence:

**RNA:** A A U A U C A U C U U U G G U G U U

**AAs:** N — I — I — F — G — V

Patient **D** RNA sequence:

**RNA:** A A U A U C A U U U C U G G U G U U

**AAs** N — I — I — S — G — V

Part of the **normal** CFTR amino acid sequence

**E — N — I — I — F — G — V — S**

Partial list of Amino Acids:

| | | | |
|---|---|---|---|
| UUU, UUC **F** | AAU, AAC **N** | GAA, GAG **E** | UAU, UAC **Y** |
| UCU, UCC, UCA, UCG **S** | GGU, GGC, GGA, GGG **G** | GUU, GUC, GUA, GUG **V** | AUU, AUC, AUA **I** |

4.) Compare the patient's amino acid sequence to the normal CFTR protein.

***Which patient has Cystic Fibrosis?***

**Patient D**