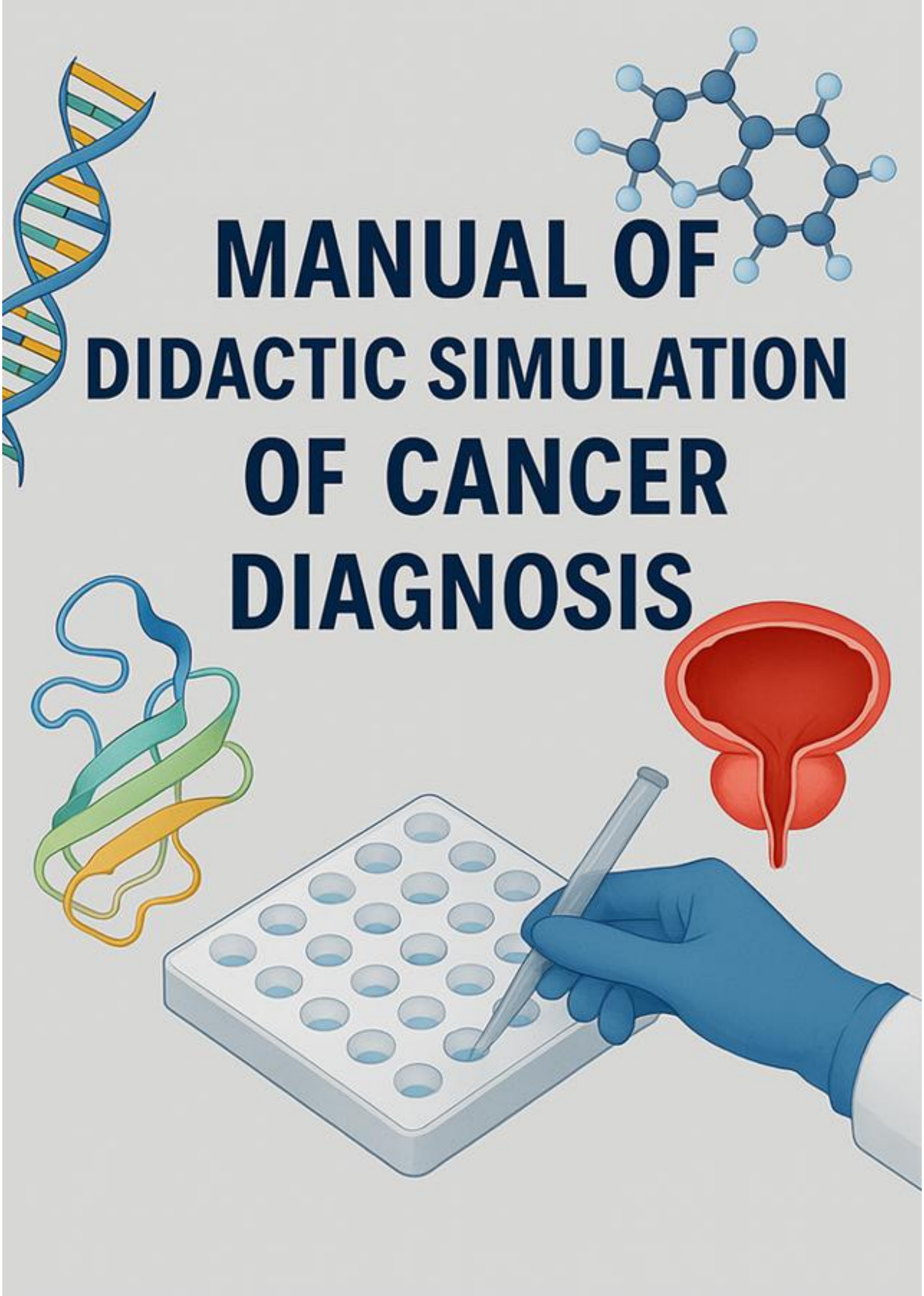

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English Edition

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MANUAL OF DIDACTIC SIMULATION OF CANCER DIAGNOSIS

LABiEMol
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1. Teaching. 2. Simulation. 3. Prostate. 4. Practice. I. Saudan, Fabíola, II. Vitorino, Maíra, III. Winagraski, Erika, IV. Castro, Helena.

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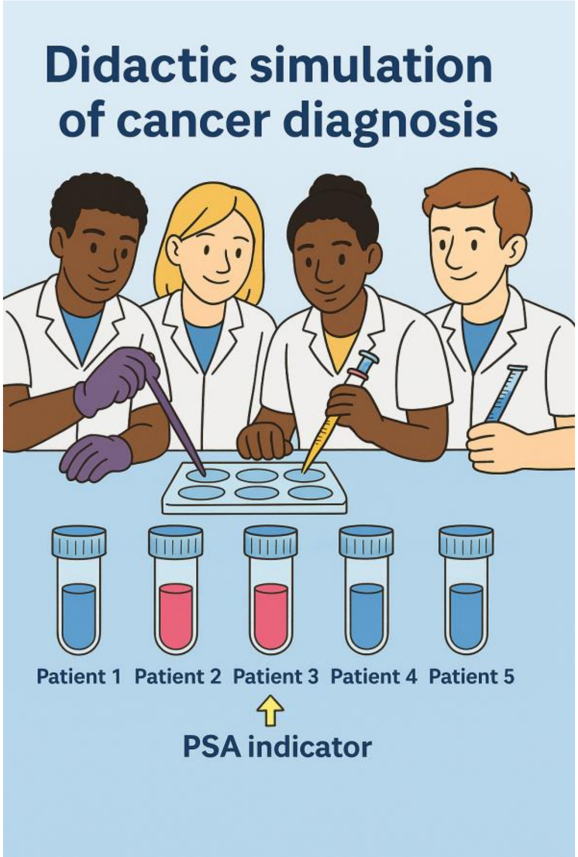
Apresentation

Prostate cancer is one of the diseases that most affect men worldwide, especially after the age of 50. Even with advances in diagnostic and therapeutic resources, there is still a great lack of knowledge about the subject, as well as prejudices and taboos that hinder prevention and early diagnosis. Therefore, talking about this type of cancer early on is essential to promote awareness, reduce fear, and encourage health care in a more natural and accessible way.



This manual was designed with a focus on high school students, aiming to include deaf students by considering the essential role of images in the learning process. The choice of a practical lesson was intentional: we believe that learning by doing is one of the most effective ways to transform knowledge into action.

Simulating a diagnosis, even with natural reagents and didactic substitutions, makes the content more tangible, awakens young people's interest, and brings them closer to scientific language in a playful and engaging way, which is a distinctive feature of this booklet along with the use of artificial intelligence (AI) in its textual development. Based on the book from our Laboratory of Antibiotics, Biochemistry, Teaching, and Molecular Modeling (LABiEMol) at the Institute of Biology of the Fluminense Federal University, published in three languages and available on the eduCAPES portal, which describes didactic simulations, AI was used to assist in organizing this edition, reviewing the scientific information, and supporting the creation of clear, inclusive, and up-to-date explanations. With this, we seek not only to innovate in the way of teaching but also to show how new technologies can be allies in producing educational materials that are accessible, interactive, and connected to the contemporary challenges of health education. More than teaching biology, pathology, and biochemistry, this manual aims to educate conscious, critical citizens who are prepared to care for themselves and others with information, empathy, and responsibility.

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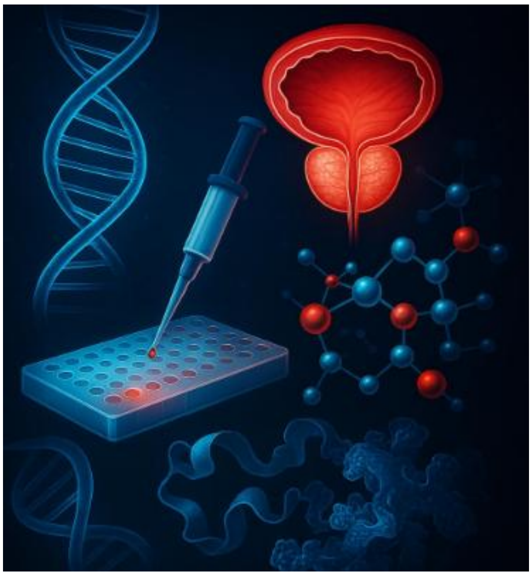
PRACTICAL LESSON - STUDENT VERSION

Introduction

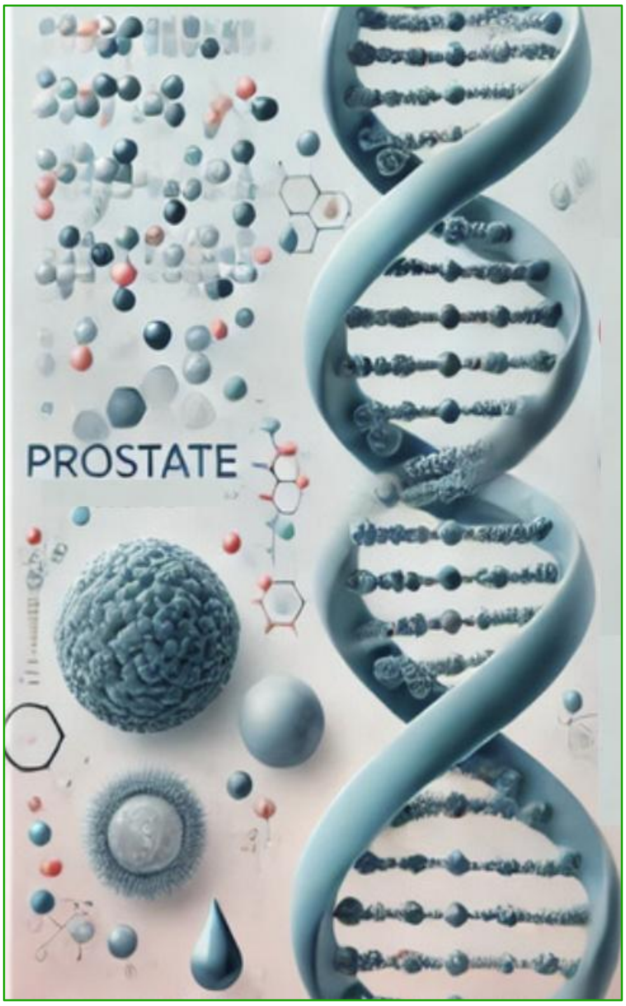


Prostate cancer is among the most frequent neoplasms in males, especially in individuals over 50 years old. Early identification of the disease is crucial for treatment effectiveness, and one of the central tools in this context is the Prostate-Specific Antigen (PSA), a protein primarily synthesized by prostate cells.

Under normal conditions, the presence of this antigen in the blood occurs at low concentrations; however, changes such as infections, benign enlargement of the gland, or even tumors can lead to elevated levels of this substance.Measuring the amount of PSA in the blood is an easy-to-perform test with great clinical importance. Generally, values below 4 ng/mL are considered acceptable, although this normal range may vary depending on age, genetic background, and other individual characteristics. Concentrations between 4 and 10 ng/mL indicate the need for further evaluation, with exams such as digital rectal examination and, in some cases, prostate biopsy. Results above 10 ng/mL raise suspicion of malignancy, although they do not constitute a definitive diagnosis.

It is important to highlight that PSA is not an exclusive marker for cancer. Inflammatory conditions such as prostatitis, or even benign prostatic hyperplasia, can also result in elevated values. Additionally, recent activities such as sexual intercourse, catheter use, or other urological procedures may temporarily interfere with the measurement, which reinforces the need for careful medical evaluation.

Despite its limitations, PSA remains a valuable tool both in screening and in the follow-up of already diagnosed cases, allowing the assessment of disease progression and response to treatment. Its effectiveness is enhanced when used in conjunction with other diagnostic methods, contributing to more precise and individualized therapeutic decisions.



Periodic monitoring of PSA is especially recommended for individuals with a higher predisposition to developing the disease, such as those with a family history of prostate cancer or Black men, who have a greater genetic risk. The main factors associated with the onset of the disease include advanced age—with higher incidence starting at 60 years old—family history in close relatives, especially those diagnosed early, and unhealthy habits such as an unbalanced diet and excess weight

According to guidelines from the World Health Organization (WHO), adopting a healthier lifestyle can mitigate risk factors. Recommendations include regular exercise, a diet rich in fruits and vegetables, maintaining an appropriate body weight, as well as reducing alcohol consumption and quitting smoking and sedentary behavior.

Objective:

To investigate the presence of PSA in serum samples to assist in the identification of possible cases of prostate cancer.

Materials Needed:

- 5 syringes of 5 mL or disposable Pasteur pipettes
- 5 microplates with 6 wells or 14 test tubes
- Reagent with anti-PSA antibodies conjugated to a chromogenic indicator
- Patient blood serum samples

Experimental Procedure:

In this practical activity, students should investigate different diagnostic hypotheses based on the detection of PSA in blood serum samples. For this, tests with specific controls will be used: a negative control (Normal Patient), whose sample should show no color change, indicating the absence of the protein; and a positive control (Altered Patient), whose coloration will change, evidencing the presence of the antigen.

Step-by-Step

1. Correctly label each tube or well with the patient's name
2. Use the following samples:
    - Patient 1: Negative Control (Normal)
    - Patient 2: Positive Control (Altered)
    - Patient 3: Unknown Diagnosis
    - Patient 4: Unknown Diagnosis
    - Patient 5: Unknown Diagnosis
3. Add 5 mL of the corresponding serum from each patient into each compartment.
4. Add 2 mL of the reagent with anti-PSA antibodies to each sample.
5. Mix carefully, wait the required time, and observe the color reaction.
6. Record the results according to the visual observation.

Results

Evaluation Form – PSA Analysis in Blood Samples			
Group name:			
Date:			
Members' Names:			
Patient	**Coloration Result**	**Interpretation**	**Diagnostic Hypothesis**
Patient 1 (Negative Control)		Expected to show no color change	Serum without detectable PSA (normal)
Patient 2 (Positive Control)		Expected: visible color change	Serum with elevated PSA (altered)
Patient 3			
Patient 4			
Patient 5			

1. What is the importance of the negative control and the positive control in this activity?

2. Which patients showed results similar to the positive control?

3. What factors can influence PSA levels besides prostate cancer?

4. What do the colors indicate about the health status of each patient?

5. How does this activity contribute to the understanding of laboratory tests and disease prevention?

PRACTICAL CLASS - VERSION FOR TEACHERS

Understanding Prostate Cancer and Its Detection with the Support of Natural Reagents

Prostate cancer is one of the most common oncological diseases in men, especially from the age of 50 onwards. To increase the chances of successful treatment, early detection is essential. One of the most commonly used markers in this process is PSA — the acronym for Prostate-Specific Antigen — a protein synthesized by prostate cells and naturally present in small amounts in the blood of healthy individuals

When PSA levels rise, this may indicate changes in the prostate, such as inflammation, benign enlargement (hyperplasia), or even cancer. The analysis of this antigen in the blood is a simple test but of great clinical importance. Values below 4 ng/mL are generally considered normal, although there are variations depending on age, family history, and other individual factors. When levels are between 4 and 10 ng/mL, further tests are recommended for confirmation. Above 10 ng/mL, the risk of cancer is higher, although the value alone is not conclusive.

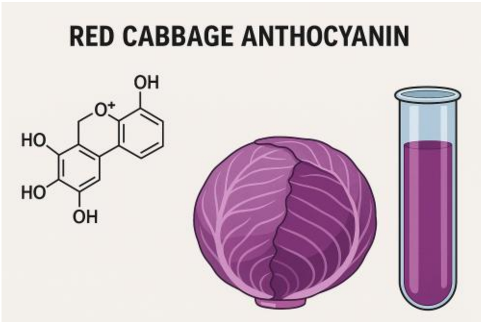
It is important to emphasize that changes in PSA levels do not necessarily mean cancer. Factors such as prostate inflammation (prostatitis), recent medical procedures, or even ejaculation can temporarily interfere with the results. Therefore, the test should always be interpreted together with the clinical evaluation.

Despite its limitations, PSA is valuable both in initial screening and in monitoring patients undergoing treatment, allowing evaluation of therapy effectiveness and detection of possible recurrences. When combined with exams such as digital rectal examination and biopsy, it contributes to a safer and more personalized diagnosis.

People at higher risk of developing prostate cancer — such as men with a family history or African ancestry — should undergo monitoring with greater attention. The most relevant risk factors are age (especially after 60 years), family history of early cancer, and unhealthy lifestyle habits such as obesity, physical inactivity, poor diet, and excessive alcohol consumption.

According to the WHO, preventive measures such as a balanced diet, regular physical activity, weight control, and quitting smoking can significantly reduce these risks.

The simulation using red cabbage as a teaching indicator illustrates the basic principles of low-cost laboratory diagnosis with great educational value, promoting practical and interdisciplinary learning in health, biology, and chemistry. In this practical activity, students will simulate a PSA analysis based on observing color changes, using natural and safe reagents instead of real samples. The proposal involves conducting tests with different simulated "patients," representing normal and altered cases. For this, materials such as water and vinegar will be used, which cause pH variations detected by a natural colorimetric indicator extracted from red cabbage.



The use of red cabbage is justified by the presence of anthocyanins, natural pigments that change color according to the acidity or alkalinity of the medium. This substance, besides being accessible and safe, is sensitive to pH variations, allowing students to visualize the simulated reactions. Once prepared, the extract should be stored refrigerated to preserve its properties.

Experimental Activity: Simulation of PSA Test with Natural Reagent

In this activity, students will simulate the PSA test using a natural reagent — red cabbage solution — as a visual indicator of changes in the patients' "serum." The experiment is designed to stimulate diagnostic reasoning based on the reagent's color change when in contact with different samples.

Objective

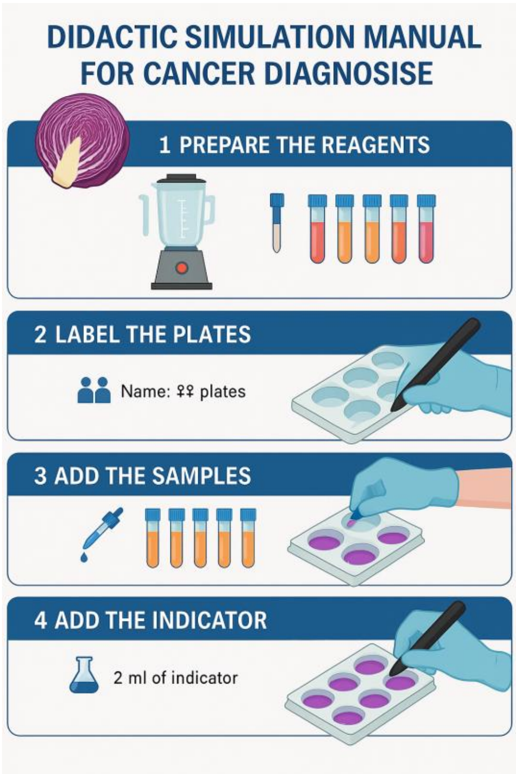
To simulate the PSA detection test in samples representing fictitious patients, using a natural substance that reacts to pH variations as an experimental model.

Materials Needed

- 5 syringes (5 mL) or plastic Pasteur pipettes
- 1 red cabbage
- Water
- 5 six-well microplates (recycled) or 14 glass tubes
- Blender and strainer
- Vinegar

Preparation of the Natural Indicator (pH Reagent)

1. Chop 500g of red cabbage.
2. Cook with 1 liter of water for about 15 minutes.
3. Blend the mixture and strain it using a sieve.
4. Store in a refrigerated place.
5. Use 2 mL of the solution in each well of the microplate or tube.



Montagem das Amostras

Patient	Control Type	Composition
1	Negative	Water (5 mL)
2	Positive	Vinegar(2,5 mL)+Water(2,5 mL)
3	Elderly	Vinegar (5 mL)
4	Adult	Water (5 mL)
5	Young	Water (5 mL)

Procedure

1. Label the tubes or microplates with the identification of the patients.
2. Add 5 mL of the "sample" from each patient.
3. Apply 2 mL of the red cabbage indicator.
4. Mix and observe the color changes.
5. Record the observations for each sample.

Theoretical Basis on Colorimetric Reactions in Clinical Diagnosis

Reactions involving color changes are widely used in laboratory tests due to their sensitivity and clear visual results. In the context of antigen detection such as PSA, these reactions can be indirect—like in ELISA, where enzymes linked to antibodies cause a color change upon reacting with a substrate—or direct, as in rapid tests where antibodies are bound to colloidal gold particles that produce a visible colored band upon antigen binding.

Example of Indirect Reaction (ELISA):

1. The antigen is fixed to the plate.
2. A primary antibody is added.
3. A secondary antibody with an enzyme is linked to the complex.
4. The enzyme substrate reacts, generating a coloration proportional to the amount of antigen present.

Example of Direct Reaction:

Antibodies linked to gold nanoparticles visibly change color upon encountering the target antigen.

- The advantage is that they do not require additional steps, making them ideal for rapid tests

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Discussion

- Compare the results and describe possible interpretations.
- Reflect on the care in sample preparation and conservation.
- Explain the chemical basis of the reaction used as a model.
- Analyze the importance of positive and negative controls in the experiment.

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