Every microbiologist knows that the best specimens for culture are fluids or tissue. However, we rarely get what we want. The majority of the specimens that microbiology laboratories receive are collected on swabs. Clinicians favor the swab as a collection and transport system because of its ease of use, low cost, and availability. What is the laboratory to do? We need to understand the various swab transport systems, encourage our clinical colleagues to give us the best specimens possible and when we are stuck with swabs, make them the best swab we can find for the specific job.

The use of the swab to collect a specimen was first recorded in 1893. Since then various holding media, shafts, and tip material have been used in attempts to find the best swab transport system. For this review we will present the components of swabs and compare some commercial brands, including the newest commercially available swab, the flocked swab.

Swab transport and collection systems are composed of two parts: the swab and the medium in the bottom of the tube. The swab is composed of the tip, which is made of some material designed to collect, hold, and release the organism onto or into a culture medium, and the shaft, which enables the tip to reach the desired sight for testing without contaminating the swab or the user. In the bottom of the tube is the medium designed to maintain viability of any collected organisms. The medium can be a gel or can be a medium-soaked polyurethane foam sponge.

**Media**

There are several basic media used in swab systems. The most common are: Cary and Blair, Stuart, Amies, and Regen-Lowe.

**I. Cary and Blair Transport Medium**

One of the basic holding media is Cary and Blair. It has sufficient nutrients to allow the organism to remain viable, but insufficient nutrients for significant growth.

**Formulation:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agar</td>
<td>5.0 g</td>
</tr>
<tr>
<td>NaCl</td>
<td>5.0g</td>
</tr>
<tr>
<td>Sodium thioglycolate</td>
<td>1.5g</td>
</tr>
<tr>
<td>Na₂HPO₄</td>
<td>1.1g</td>
</tr>
<tr>
<td>CaCl₂ solution</td>
<td>9.0ml</td>
</tr>
</tbody>
</table>

**Principle:**

The sodium thioglycolate facilitates a low oxidation/reduction potential which favors facultative anaerobic bacteria. The high pH minimizes the destruction of bacteria when acid is produced by the bacteria during metabolism.

**Clinical use:**

Cary and Blair transport medium is a holding medium for maintaining viability of enteric bacteria.

**II. Stuart Transport Medium**

The earliest transport media is Stuart Transport Medium which was described in 1948.

**Formulation:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium glycerophosphate</td>
<td>10.0g</td>
</tr>
<tr>
<td>Sodium thioglycolate</td>
<td>1.0g</td>
</tr>
<tr>
<td>CaCl₂·2H₂O</td>
<td>0.1g</td>
</tr>
<tr>
<td>Methylene Blue</td>
<td>2.0mg</td>
</tr>
</tbody>
</table>

**pH 7.4 ± 0.2 at 25°C**

**Principle:**

Stuart medium uses glycerol phosphate to maintain viability of the specimen and the pH. Sodium thioglycolate gives the medium a low oxidation/reduction potential, which favors facultative anaerobic bacteria. Methylene blue is used as an oxidation/reduction indicator.

**Clinical use:**

Stuart medium is used to transport *Neisseria gonorrhoeae* and other fastidious organisms to the laboratory.

**III. Amies transport medium without charcoal**

Amies is a modification of Stuart transport medium.

**Formulation:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agar</td>
<td>4.0g</td>
</tr>
<tr>
<td>NaCl</td>
<td>3.0g</td>
</tr>
<tr>
<td>Na₂HPO₄</td>
<td>1.15g</td>
</tr>
<tr>
<td>Sodium thioglycolate</td>
<td>1.0g</td>
</tr>
<tr>
<td>KCl</td>
<td>0.2g</td>
</tr>
<tr>
<td>CaCl₂·2H₂O</td>
<td>0.1g</td>
</tr>
<tr>
<td>MgCl₂·6H₂O</td>
<td>0.1g</td>
</tr>
<tr>
<td>KH₂PO₄</td>
<td>0.2g</td>
</tr>
</tbody>
</table>

**pH 7.2 ± 0.2 at 25°C**
Principle:
The glycerol phosphate in Stuart’s transport medium is replaced by phosphate buffer to control the overgrowth of normal flora bacteria that might overgrow the potential pathogens in the specimen. Sodium chloride provides an osmotically stable environment to prevent lysis of bacteria with unstable cell walls. Charcoal can be added to control the acids of metabolic by-products and to absorb fatty acids toxic to *N. gonorrhoeae*.

Clinical Use:
Amies is used to as part of a general transport system for specimens containing fastidious bacteria such as *N. gonorrhoeae*.

IV. Regan-Lowe Semisolid Transport Medium
Regan-Lowe is a semisolid transport medium designed specifically for the transport of specimen suspected of containing *Bordetella pertussis* and *B. parapertussis*.

**Formulation:**
- Agar 6.0g
- Beef Extract 5.0g
- Pancreatic digest of gelatin 5.0g
- Soluble starch 5.0g
- NaCl 2.5g
- Charcoal 2.0g
- Niacin 0.01g
- Horse blood, defibrinated 100ml
- Cephalexin solution 10ml

**pH 7.4 ± 0.2 at 25°C**

Principle:
The nutritional base is composed of beef extract, pancreatic digest, horse blood, and niacin. Starch and charcoal neutralize toxic substances such as fatty acids and peroxides, which are detrimental to *Bordetella* species.

Clinical use:
Transport of specimen suspected of containing *B. pertussis* and *B. parapertussis*.

Shaft
A seemingly insignificant piece of the swab transport system is the shaft. On the contrary, the shaft enables the user to reach the desired site without contaminating the specimen. Shafts usually are made of wood, plastic, or wire. Wooden shafts can have toxic compounds and be toxic to some bacteria, such as *Neisseria* species. They are not flexible when collecting the specimen. Plastic shafts are slightly more flexible; and thin wire shafts, used mostly for nasopharyngeal specimen, are the most flexible. However, Wadowsky, et al, conducted a study of PCR assays for *B. pertussis* which demonstrated that aluminum wire shafts inhibited the amplification step of the PCR assay and hampered the migration of the probe through the polyacrylamide gel. This inhibition was demonstrated when the shaft was stored for at least 48 hours.

Swab
The tip of the swab is crucial for not only collecting the specimen, but also for releasing the specimen into the culture medium. There are many types of material that may be used as the tip: cotton, polyester, rayon, calcium alginate and polyurethane. Cotton contains fatty acids that inhibit *Bordetella* species and *N. gonorrhoeae*. Calcium alginate, a crude extract from seaweed, is recommended for swabs collecting specimen containing *Bordetella* species; however, it is toxic for *Neisseria* species and inhibits polymerase chain reactions.

Rayon and Dacron are synthetic fibers developed by Dupont. Rayon was developed from plant and tree materials; Dacron was developed from refined petroleum or natural gas. Dacron is a hydrophobic polyester, so surfactants must be added to enhance the uptake of bacteria. Rayon, on the other hand, is sprayed with methylcellulose to keep the material on the shaft. Methylcellulose has been shown to interfere with rapid antigen tests, such as tests for *Streptococcus pyogenes*. Rayon and Dacron are hard, unyielding fibers from which bacteria are not readily released.

Polyurethane swabs have foam-like tips. In a study by Roelofsen, *et al*, polyurethane swabs with no media were shown to have good recovery of organisms when cultured immediately after collection. Unlike Rayon and Dacron, the polyurethane swab does not trap the bacteria in the fibers.

The newest swab transport system is the flocked swab. The flocked swab tip is covered with short strands of nylon fiber, attached at right angles. The sample is adsorbed between the fibers by capillary action and remains close to the surface of the swab. The swab is then eluted into transport medium. Radioactive tracer studies have shown that 92% of the sample collected with a flocked swab was released into the 1 ml of medium. The same studies showed that with the conventional swabs only 30% of the specimen was released into the medium. Electron microscopy demonstrated that bacteria can be seen on the fibers of the flocked swab. With the matrix swab the bacteria cannot be seen. The hypothesis is that the bacteria are trapped inside the mesh of material of the synthetic fibers of rayon and Dacron.

Another advantage of the flocked swab transport system is the 1 ml of liquid medium which comes with the swab. After the specimen is eluted into the medium, the laboratory has 1 ml of specimen to use. The medium can be used to inoculate culture plates or to perform molecular testing, gram stains, or rapid
antigen testing.

After the optimal swab is used to obtain a specimen, transport conditions become extremely important. Studies have examined the viability of both fastidious and non-fastidious organisms at various times and temperatures during transport. Some of the organisms tested were *Hemophilus influenzae*, *N. gonorrhoeae*, *N. meningitidis*, *S. pneumoniae*, *S. pyogenes*, *Escherichia coli*, and *Pseudomonas aeruginosa*. Viability of the fastidious organism decreased over time. Recovery of *S. pneumoniae* and *N. gonorrhoeae* dropped significantly after six hours, even with flocked swabs. Non-fastidious organisms, on the other hand, grew considerably more than the initial inoculums. In dilutions made with a mixture of fastidious and non-fastidious organisms, the non-fastidious organism quickly overgrew the fastidious organisms at room temperature. See graphs 1–4 for a compilation of several studies looking at several different swab transport systems.

Some studies indicated temperature was not as critical as time in transport, while others indicated holding the specimen at 4°C increased the recovery rate of the fastidious organism. As stated previously, at room temperature, the non-fastidious organism, such as *E. coli*, overgrew the fastidious organisms; however, at 4°C, the *E. coli* growth was slowed and the *N. gonorrhoeae* recovery rate was higher. This demonstrates the need to refrigerate the specimen to control the overgrowth of normal flora.

**Conclusion**

Swab transport systems are available in many combinations of media, tips, and shafts. An internet search on the BD website for CultureSwab resulted in three media (Amies, Cary and Blair, or Stuart), two tips (foam swabs or Dacron), and 2 shafts (wire or plastic). Swabs should be selected for specific needs. The large laboratory that has several outpatient sites,
performs routine cultures, antigen testing, and molecular testing will have different needs than a small, rural hospital laboratory that does mostly routine cultures. Also, more studies need to be done and published on the newer flocked swab and its various uses. These studies should compare it to other commercially available swabs. Today’s microbiologist has to be vigilant for the best swab system available, because today’s clinicians find the swab transport system the easiest and most convenient way to collect, transport, and culture specimen.

References
7. A New Concept for Transporting Clinical Material on Flocked Swabs in Liquid Amies Medium, R Human and Gillian Jones Microbiology Laboratory, Derriford Hospital, Plymouth, UK, ASM 106th General Convention, Orlando, FL.
8. Paxton, Anne, Delivering the Good to Microbiology Labs, College of American Pathologists Website, Jan 2004.

AMTIE Staffer Receives Commendation

Paula Simoncini, AMTIE Services Specialist in the AMT office, recently received a special commendation from AMTIE president Pat Cuvillo “in appreciation for her hard work and dedication to AMTIE.” Paula reviews, processes and records all member CE activities, handles inquiries regarding CE, is responsible for correction and recording of program results. She further handles AMTIE provider inquiries and maintains files on current AMTIE providers and processes CCP reinstatements. Congratulations to Paula!

CAREER OPPORTUNITY

MEDICAL TECHNOLOGIST
BS degree in Medical Technology and 1 year experience required. Please forward resume to:

NICL Laboratories
Employment Office
306 Era Drive
Northbrook, IL 60062
Questions for STEP Participants

Answer questions only on the official STEP answer sheet. If you do not have the official STEP answer sheet, a year’s supply can be obtained (at no cost), simply by writing to: STEP Program Answer Sheets, American Medical Technologists, 10700 W. Higgins Road, Rosemont, IL 60018, or by fax: 847/823-0458, or by e-mail: paula.simoncini@amt1.com.

In addition to marking your answers, be sure to include all the required information on the answer sheet and a processing fee of $3.00 per article.

In the following, choose the one best answer for each question.

1. Why is cotton not good material for collecting specimen in which Neisseria gonorrhoeae is suspected?
   A. Fatty acids in the cotton are toxic to the organism.
   B. Cotton absorbs too much moisture.
   C. The organism grows exponentially when in contact with cotton.
   D. Cotton is acceptable to use to collect specimen in which Neisseria gonorrhoeae is suspected.

2. Which material interferes with testing performed by PCR?
   A. Cotton
   B. Calcium alginate
   C. Dacron
   D. Rayon

3. What medium is best as a holding medium for Enterobacteriaceae?
   A. Amies
   B. Stuart
   C. Regen-Lowe
   D. Cary and Blair

4. The purpose of the shaft of a swab is which of the following?:
   A. to reach the site of the infection
   B. to place the tip into the medium
   C. prevent contamination of the person collecting the specimen
   D. all of the above

5. Which of the following is not a fastidious organism?
   A. N. gonorrhoeae
   B. pertussis
   C. E. coli
   D. S. pneumoniae

6. Which medium is best for transporting B. pertussis?
   A. Amies
   B. Stuart
   C. Regen-Lowe
   D. Cary and Blair

7. What is added to the medium to absorb the fatty acids from the specimen?
   A. Charcoal
   B. Sand
   C. Blood
   D. Cotton

8. Which swab has the fibers attached to the shaft at 90° angles?
   A. Cotton
   B. Flocked
   C. Rayon
   D. Dacron

9. Which of the following fits best?
   A. Refrigerate swabs to decrease the normal flora and increase ability to grow fastidious organisms.
   B. The chance to grow organisms increases when swabs are left at room temperature.
   C. Swabs may be held indefinitely; organisms can survive long periods of time.
   D. All of the swabs are the same.

10. What is the advantage of the flocked swab?
   A. It is not very absorbent.
   B. It inhibits the growth of Enterobacteriaceae.
   C. The flocked swab has no medium to dilute the specimen.
   D. Almost all of the material collected is released into the medium.