THE PRODUCTION AND EVALUATION OF A VIDEOTAPE INSTRUCTIONAL PACKAGE ON "AUTOCLAVE STERILIZATION"

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ABSTRACT

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Students' difficulties in understanding principles and operating procedures of the autoclave as currently taught during lecture session appear to be due to the absence of visual representation of this laboratory equipment.

The aim of this thesis-equivalent, therefore, was concerned with the design and development of a videotape instructional package to improve learning of "Autoclave Sterilization" - techniques and theory, and eventually to replace the traditional face-to-face lecture on the topic. This unit is an integral part of the second year of the Medical Laboratory Technology programme.

For the purpose of designing the instructional material, this project incorporates findings of previous researches in the field of audio-visual instruction as well as principles and theory of learning.

A pretest-posttest control group design was employed to compare the videotape package approach with the more typical traditional face-to-face lecture. Subjects consisted of 51 students in the second year of the Medical Laboratory Technology programme in two institutions, Dawson College (Montreal) and the Toronto Institute of Medical Technology. Students were assigned to experimental, lecture control and no-treatment control groups. The experimental method included a videotape to be used as programmed instruction and a viewing guide.

The findings indicate a statistically significant superiority ($p < .05$) in learning for students taught by the videotape package over that of the lecture group.

Note: This document is accompanied by the actual thesis-equivalent in videocassette form.

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CHAPTER I

INTRODUCTION

> Most students can master what we have to teach them, and it is the task of instruction to find the means which will enable them to master the subject under consideration (Bloom, B.S., 1971, p. 43)

If the goal of education is to have most students "master" what we have to teach them, it is necessary to assess the needs of the learner as they relate to an educational programme or to a particular unit of instruction, and to develop educational programmes or instructional materials more responsive to their needs so that they do not waste time mastering irrelevancies.

1.1 The Educational Problem

Nine Quebec CEGEPs (College d'Enseignement Général et Professionnel) offer a Medical Laboratory Technology programme. In this programme, difficulties are experienced in the teaching and learning of the principles and operating procedures of "the autoclave"; which is the standard sterilization device used in medical laboratory situations. The need for a visual representation to cover the subject area has been generally observed. In 1975, the provision of financial support to develop audio-visual instructional material to cover "autoclave sterilization" as well as other areas of the curriculum was seriously considered by the Provincial Department of Education. (Therrien, C.).

The size and structure of this equipment not only makes it impossible to transport it into the classroom, but rules out large group demonstration. Also, during the second academic year at the College, laboratory time is not scheduled in the "Cahier" to allow students to operate this equipment. Repeated explanations were therefore provided after the lecture to small groups of students in front of an autoclave, in order to help them understand its principles and clarify any question they might have.

The purpose of this thesis-equivalent is therefore to develop and evaluate a videotape package for the unit of instruction on the autoclave. Because it is desirable that transfer from learning situation to "criterion" situation be facilitated, emphasis is placed on achieving maximal similarity between the learning situation and practice in the laboratory environment. As visuals are integral to the criterion situation, they should be used in the learning context so that the knowledge acquired there will transfer to the criterion situation. This assertion is supported by Gagné (1970) who, recognizing that no single medium is always best, maintains that the use of reality-oriented visualization is important if the learner must later respond to real objects.

1.2 The Evaluation Questions

As the purpose of this study is to develop instructional material to optimize the learning of the autoclave sterilization procedures, the evaluation questions can be stated as follows:

1. Is the use of a videotape package covering the subject area an effective method of teaching "autoclave sterilization" to medical laboratory technology students?

2. Is the videotape approach more effective and/or more time-efficient than the traditional face-to-face lecture?

3. Is this approach a cost-effective way to achieve the instructional objectives?

The basic features underlying the problem dealt with in the study are concerned with two factors: the selection of the appropriate media or media-mix to convey the information, and the selection of relevant design factors incorporating learning principles so that maximal cognitive gain will occur.

1.3 Programme Content and Media Selection

The programme "Autoclave Sterilization" deals with the following areas:

- The principle of moist heat sterilization
- The autoclave principle, description and operation
- The efficiency of autoclave sterilization
- Load arrangement and preparation
- Sterilization cycles and autoclave controls.

This programme calls for the two types of visuals as described by Gropper (1966):

1. "Criterion visuals", those "that appear in the criterion situation and are the stimulus contexts to which the student is

expected to respond". For example, in order to be able to identify laboratory apparatus, the actual equipment might be used in the learning situation and students given practice in identifying it; and

2. the "Intermediary visuals" concerned with the learning of concepts and principles on the basis of visual representation.

Although in media-choice decisions, pragmatic determinants such as equipment availability for production and presentation, skills of the producer, and economic constraints often play an important role, task analysis and learner analysis should precede decisions about media selection (Levie and Dickie, 1973).

The nature of the learning task and the nature of the objectives associated with the unit of instruction could be provided by any type of motion picture, but as pointed out by Tolsti and Ball (1969) in learning experiments, the presentational variables are primary. The presentational variables are those concerned with the structure by which the information is carried by a medium. They should be selected on the basis of the conditions or factors that should be present within any instructional set for the effectiveness of an educational system such as: "response-demand characteristics" (the type of learner response required) and "response-demand frequency".

Therefore, the selection of the videotape medium was based not only on the capabilities of this medium to provide simultaneous visual and auditory stimuli, to show objects in motion, but also for its capability to be stopped and started, to allow for overt learner response. This topic would also be appropriate for programmed instruction or CAI where learning sequences can be easily started, stopped, backed up and moved forward according to individual learner's need, "time-locked forms such as film, being generally not appropriate when memorization of details is demanded" (Hugh, 1975, p. 86).

Another consideration that played an important role was the availability at Dawson College of equipment for VTR production and presentation within the classroom. Other factors such as low production cost and immediate replay capability allowing shorter production time were additional determining factors.

1.4 Potential Significance of the Study

The significance of this study lies in its exemplification of sound pedagogical methodology in instructional television. It is an example of how to improve the learning process by simulating otherwise unavailable laboratory equipment in the classroom. This special material could also be used for remedial learning or for student's review purposes before their internship within hospital laboratories. Reviewing this material will increase confidence when, following demonstration in their hospital laboratories, they will be expected to operate this apparatus correctly.

By "sound pedagogical methodology" is meant that I have applied learning theory and instructional design principles (Gagné and Briggs (1974) in the production of the videotape package covering this subject area. The goals and objectives of instruction concerned with learning the use of this apparatus are quite varied: knowledge of specific facts, scientific principles and laws, concept identification. Therefore, while visual representation is the most suitable mode of representation, it does not lessen the importance of verbal specification of the behaviors to be shaped and of the techniques used to meet design objectives.

Motivation devices are introduced at the outset of the programme to "gain attention" and appeal to the learner. This strategy is recognized by Gagné and Briggs (1974) as the first step in the sequence of instructional events, and hopefully will avoid a negative attitude to be developed by the learner.

Research on instructional television (Gropper, 1967, Gryde, 1966) has demonstrated that the level of instructional effectiveness can exceed that usually attained with "conventional" television lessons, by incorporating the techniques of programmed instruction. Therefore, the videotape presentation will be divided into well-delineated segments, sequenced in a systematic way and learners will be required to construct responses to questions.

Research on learning from various media has shown that, in certain cases, the use of introductory material, "advance organizer" (Ausubel, 1960, Ausubel and Fitzgerald, 1962.) directs the attention of the student during the learning process and facilitates learning and retention. Introductory material in the form of objectives are used in the introductory segments of the videotape presentation and at the beginning of each sequence within the viewing guide.

Since listening and watching are normally (externally) passive processes, the designer must create programmes that force the learner to interact with the presentation (Bertou, 1972; Ausubel, 1968; Rothkopf, 1970).

Therefore, provisions are made for active student response, by having the students fill out a viewing guide at the end of each sequence.

The importance of active student response in audio-visual instruction raises the question of feedback or knowledge of the correct answer. Behavioristic theories of learning (Hull, 1952; Skinner, 1954) have established that learning is improved when some reinforcer or feedback immediately follows one's behavior. The advent of teaching machines and auto-instructional devices has fostered the belief in this principle. Gagné and Briggs (1974) emphasize the role of feedback as an essential event in the instructional process.

For the purpose of this study, feedback is provided, as in instructional programmes, that is, correct answers will be printed on the page of the adjunct material following the questionnaire. This can be used later on as review material by the student.

Production variables research, such as that on monochrome versus coloured presentation and modeling, was also systematically examined. Even though cognitive learning in general does not seem to be helped by the use of colour (Kanner, 1968) and the scarcity of information on the effect of colour on affective learning cannot lead the designer to any particular decision, it was felt that a colour presentation would appeal more to the student than a monochrome one.

Within section requiring the use of a technologist to load and operate the autoclave, the "modeling theory" (Bandura, 1971) was taken into consideration. Modeling is concerned with the shaping of behavior through influential or emotional responsiveness by the use of social models. By selecting a very competent and personable graduate student to operate the autoclave, it was expected that through such cues as general appearance, age, sex, uniform, the learner would identify with her and that the acquisition of the specific behavior would be facilitated.

Finally, it is to be noted that, this study falls within the main concerns of "Educational Technology", as defined by the British National Council (1973), that is: "The development, application and evaluation of systems, techniques and aids to improve the process of human learning."

1.5 Overview

This chapter has presented the context of the problem along with the specific areas dealt with in this thesis equivalent. Chapter 2 provides a review of relevant related research. Chapter 3 deals with the design of the videotape, which encompasses: objectives and constraints, the design process, the production procedures, and an analysis of the finished programme in light of the objectives to be met. Chapter 4 is concerned with the method and conduct of the evaluative experiments. Chapter 5 gives the summative and formative evaluation results. Chapter 6 discusses these results, draws conclusions and makes recommendations.

CHAPTER II

REVIEW OF RELATED RESEARCH

Recent summaries of and comments on instructional media research unanimously agree that this research has, in fact, yielded very little in terms of understanding media, guiding their utilization or improving education (Snow and Salomon, 1968; Allen, 1971; Campeau, 1974; Salomon and Clark, 1977). The major defects observed by these authors were concerned with inappropriate media choice, poor design and failure to apply learning theory considerations.

This project related to the production of material to improve the learning process, therefore pays due consideration to their observation by examining findings relevant to media attributes and design factors in light of learning theory considerations.

As Postman (1961) pointed out: "The process of audio-visual education does not call for the formulation of special principles; it calls for the application of the general laws of human learning."

2.1 Research on Media Attributes

As defined by Booth and Miller (1974) "media attributes are properties of stimulus materials which are manifest in the physical parameters of media", that is, the capabilities of a medium to show objects in motion, objects in colour, objects in three dimensions, to provide visual or auditory stimulus.

What are the contribution of media attributes to effective learning?

Thus far, media comparative effectiveness studies have adequately demonstrated that television is as effective as other media and conventional classroom instruction in imparting information in a variety of subject areas. (Chu and Schramm, 1967; Briggs, Campeau, Gagné and May, 1967). In various studies also, television, videotape, motion pictures and film-strips, all quite similar visual media, were examined in the light of certain variations such as size of screen (Greenhill, Rich and Carpenter, 1962; Reede and Reede, 1963), camera angle (Grant and Merrill, 1963) use of colour, motion versus still picture, dramatic versus expository presentation etc... There seemed to be no conclusive evidence to suggest that these variations improved the effectiveness of audio-visual instruction over face-to-face verbal instruction.

In a review of research about the effectiveness of motion pictures, Allen (1975) observes that motion pictorial form may be more effective than the still pictorial form at all intellectual levels for presenting <u>factual information</u>, <u>models for imitation</u> and mental processing operations.

As previously mentioned, the content for this programme is related to the learning of the principles as well as the operation and loading of an apparatus. This programme is therefore designed to work primarily in a visual mode giving meaning to scientific concepts and principles by using the inherent characteristics of the subject matter, that is, picture and motion. As stated by Pryluck and Snow (1967, p.65)

"The structural characteristics of motion pictures are significant to the extent that they can uniquely constrain or facilitate cognitive processes relative to the information presented."

In his review of research on colour films versus monochrome productions, Schramm (1972) concludes: "The research findings are consistent colour per-se has no learning advantage over monochrome" ... but" by concentrating on learning rather than liking, we run the risk of paying too little attention to motivational elements in learning." Considering the work of VanderMeer in science teaching (1952, 1954) and Rosenstein and Kanner in teaching for military personnel (1961), where no significant difference was indicated for the use of colour versus monochrome film, it was observed nonetheless that subjects preferred colour and that colour sometimes attracts more attention and contributes more to motivation. Colour was therefore used in this particular project as colour equipment was available for production.

2.2 Design Research

> Instructional media design refers specifically to the ways the instructional message is manipulated in the design and production process to influence consciously and deliberately the learning from that material. (Allen, 1975, p. 141)

Therefore, the discussion will be concerned with the selection of those design factors that are directed toward improving performance of this specific instructional unit. Accordingly, relevant research will be reviewed under the following headings: introductory material, programmed television lesson, application of modeling theory.

A. Research on introductory material

Prior preparation of the learner for the instruction to follow and its general facilitative effect has been well documented in the literature. The use of "prompting stimulus" introduced at the beginning of training (Anderson, 1967), the gaining or arousal of attention (Gagné and Rohwer, 1969), the "advance organizers" of Ausubel (1969) to the behavioral objectives (Gagné, 1970), overviews and pretests (Hartley and Davies, 1976), all these appear to be important factors influencing learning or enhancing motivation for the later appearing instructional material.

Although all these strategies serve a pre-instructional role, there exist essential differences among them in form and often in function as well.

"Prompts" refers to visual indications that appear at the beginning of training material and then fade. Hersberger and Terry (1965), Lumsdaine, Sulzer and Kopstein (1961) using films found that "prompts" make more salient the important aspects of the presented material and consequently enhance learning.

"Overviews" refer to summaries of what is to be accomplished. Introduced before instruction, they are usually cast in the form of written or spoken prose. Pictorial and graphic forms such as headings and subheadings are sometimes used at the outset or within the body of the material as an organizing structural framework. Little research attention has been given to the role played by "overviews" as pre-instructional material other than the work on special "advance organizers". (See below). What research exists has been mainly carried out in the context of research on the utilization of films. Northrop (1952) mentions the effectiveness of such techniques only with films that were not previously well organized. May and Lumsdaine (1958) providing oral and written overviews, Norford (1948) in two of his studies using summaries with film, observed that this aid seems to enhance learning by orienting the student's attention to certain aspects of the film presented. Conflicting observations were made by Norford (1949) where one treatment without introduction yielded higher scores than treatment with this type of introductory material.

Section headings and subheadings also proved to give variable results. Christensen and Stordahl (1955) recorded no significant effect whereas Kalt and Barrett (1973) noticed a marked improvement in student's comprehension when typographic cues were used to aid learning of a technical manual. Brown (1970) and Niedermeyer, Brown and Sulzen (1969) found evidence that lower ability learners were more adversely affected by unstructured programmed sequences in mathematics than those of higher ability.

More complex than overviews, "advance organizers" (Ausubel, 1969) do not concentrate on providing the learner with a specific outline of the content, but rather provide a conceptual framework of the context of the learning sequence. These introductory passages are written with "a high level of abstraction, generality and inclusiveness" (Ausubel, 1969) and include also relevant information already present in the student's cognitive structure. By providing "ideational anchorage" they facilitate the learning and retention of totally unfamiliar material (Ausubel, 1969).

In the majority of the studies, "advance organizers" appear to provide some facilitative effect (Ausubel, 1960; Ausubel and Fitzgerald, 1961; Ausubel and Youssef, 1963; Merrill and Stolurow, 1966; Earle, 1971). In other studies summarized by Barnes and Clawson (1975) the conclusion that the "efficacy of advance organizers has not been established" was reached. Lawton and Wanska (1977) emphasize the weaknesses in research design and statistical procedures used in the researches reviewed by them and also point out that the construction of the organizers was often too abstract to be comprehended and therefore failed to produce effective learning and retention.

"Behavioral objectives" as advocated by Mager (1962) and Popham (1969) identify the kind of behavior that will be accepted as evidence that the objective of the instruction has been achieved, outline the conditions under which this behavior is expected to occur, and specify the standard that will be used to determine whether the performance is acceptable.

The statement of a clear goal enables the students to organize their learning activity and assess their own progress (Gagné, 1965). Hartley and Davies (1976), reviewing the literature on the topic, delineate three variables to summarize the findings:

1. the type of teaching strategies: Dalis (1970), Huck and Long (1973), Lawson (1973) have demonstrated a greater recall of prose material when objectives are used by the subject as directions to learn specific subsets of material.

2. the task characteristics: conflicting results were obtained. Duchastel and Merrill (1973) in their review of seven studies observe that objectives have no effect when a learning task is associated with knowledge and comprehension; their effectiveness lies in higher learning tasks calling for analysis, synthesis and evaluation. Using behavioral objectives to teach the use of scientific apparatus for measurement and critical measuring skills required in using the metric system to 146 vocational students divided into experimental and control groups, Martin and Bell (1977) observed significant differences in achievement between the two groups.

3. the learner characteristics: Cook (1969) observes that learners of middle ability seem to profit more from being provided with behavioral objectives than students of higher ability. Olson (1971) however, proves that retention is increased in high, middle, and low ability groups of students by using behavioral objectives. Furthermore, a reduction in anxiety has been observed when students are provided with instructional objectives. (Merrill and Towle, 1972).

Turning now to pretest, it is obvious that the usual purpose of a pretest is to obtain a measure of the student's actual knowledge of the material to be taught. However, pretests have been found

(Pressey, 1926; Warr, Bird and Rackman, 1970; Lumsdaine, 1963) to possess an instructional character by increasing student's sensitivity to a learning situation and enhancing subsequent posttest performance. Conflicting results were obtained in some studies where no pretest effect was observed (Welch and Walberg, 1970; Peeck, 1970; Lucas, 1972); in one case even an adverse effect was recorded. (Bloomer and Heitzman, 1965; Welch and Walberg, 1970).

In spite of conflicting observations recorded in these studies, it would appear that the expectations from theory would support the use of introductory orientation material. Also, there are important points to underline in these studies: first, introductory material appears to be more beneficial to students of lower ability (Brown, 1970; Niedermeyer, Brown and Sulzer, 1969; Cook 1969). Furthermore, introductory materials are not meant necessarily to be used by themselves, but rather to be used along with other stimuli and activities (Sulzen, 1973). O'Meara (1974) observed that students in science and paramedical area who were given objectives and guides to interact with the material performed significantly better ($p < 0.01$) than students not provided with this aid.

Taking into consideration the complexity of the learning task as well as the variability in ability within the student population, typographic, graphic overviews and objectives were therefore used.

The pretest has been used to assess pre-existing knowledge in order to evaluate the effectiveness of the package. It is expected that no teaching effect occurred from it, as there was a deliberately large time gap arranged between pretest and teaching in the present project.

B. Research on "Programmed Television Lesson"

Research on instructional television has demonstrated that the innovations which have led to greater effectiveness derive from instructional technology represented in programmed instruction. In defining "programmed instruction", Lumsdaine and Schramm imply the presentation of instructional material to the student in a preplanned, presequenced order, provisions being made for active student response with confirmation provided immediately after each response.

Gagné (1969) has proposed one of the best organized models for the presentation of instructional material. He suggests a hierarchical organization based on a step-by-step approach through the prerequisites in a special kind of hierarchy culminating in the desired behavior. Bloom (1971, pg. 561) has suggested a cognitive theory of science learning within which knowledge is organized into categories of subsets to meet the full range of student behaviors which may be sought as outcomes of science instruction.

This project makes some use of both of these techniques for planning and sequencing the instructional material.

Referring to active student response Schramm (1972, p. 58) writes:

> The striking thing about this research is the consistency of results. In many forms, with many kinds of subject matter, active student participation has almost invariably been found to contribute a substantial amount to learning.

Anderson's (1967), Gagné and Rohwer's (1969), Tobias' (1973) review of the topic seem in agreement with this statement.

Gropper (1967) applying programming techniques only (their design, sequencing) to the "stimulus" features of a conventional television lesson of science concepts and principles observed no significant difference with conventional television lesson. Further modification of the programme in which active response was added to the design features however did produce a significant result.

In a comparative study on a television lesson on chemistry that required students to construct responses on a worksheet, completing sentences presented on a television screen, or having the instructor read twice while the student reads silently the identical sentences in which the blanks had been filled, Gropper and Lumsdaine (1961) observed that although overt responding requires more time than either listening or reading, it was worthwhile to require the written response.

Lumsdaine, May and Hadsell (1958) added approximately four minutes of student participation questions to a film on the human circulatory system. Students learned more through responding than students seeing the original film twice which had required more time.

A number of studies summarized in an article by Frase (1968) have established that the frequency and position of questions interspersed in text influence what is learned. Post-questions are found to be more effective than pre-questions, and greater control of learning is achieved when questions are frequent.

Rothkopf (1970) has proposed the "mathemagenic" hypotheses to explain the process by which post-questions favor the performance of students. Post-questions are conjectured to reinforce or elicit a class of response which gives birth to learning. ("mathemagenic behaviors").

To the contrary, Lang (1977), using three different types of adjunct questions (viewing guide) with commercially produced video training tapes, and he observed no significant differences between the viewing guide and the tape-only approach at the 0.05 level.

The importance of active student response in audio-visual instruction raises the question of "feedback" or knowledge of the correct answer.

The use of correct answer feedback or "knowledge-of-results" relative to a learner's elicited response has been extensively reported, (Lumsdaine, 1963; Anderson, 1967; Gagné and Rohwer, 1969; Tobias, 1973.) and its general effectiveness demonstrated. Behavioristic theories of learning (Hull, 1952; Skinner, 1957) have established that learning is improved when some reinforcer or feedback immediately follows one's behavior. The advent of teaching machines and auto-instructional devices has fostered the belief of this principle. Gagné and Briggs (1974) emphasize the role of feedback as an essential event in the instructional process.

Given the overall consensus existing among these research findings, it was decided to use some adjunct material asking for active student participation. Feedback is provided, as in an instructional programme, that is, correct answers are printed on the page of the adjunct material following the questionnaire.

C. <u>Application of Modeling Theory</u>

A major problem when examining modeling is one of definition; its meaning seems to vary from "copying", "contagion" to "imitation", "identification" and "social learning".

The modeling phenomena, as suggested in Bandura's theory (1971) extends far beyond simple physical imitation. It is a multiprocess phenomena encompassing attentional, retention and "motoric" reproduction processes (Bahdura, 1969, 1971). To exert selective control over the observer's attention, the model should present the physical and distinctive characteristics with which he regularly associates. The retention process occurs by rehearsal operation and symbolic coding of modeled events. These patterns, registered by the observer, guide further reproduction. The perceived similarity of the model motivates the subject, activating overt performance and avoiding the development of inhibitory effects.

Social learning theory has been demonstrated in a series of studies by Bandura, Grusec and Menlove (1966), Coates and Hartup (1969) on children, and by Gerst (1971) on College students.

In this study, even if the role of a model is limited to a few sequences, it was felt important to select a subject exhibiting physical characteristics that would encourage students to personally identify with him or her. This could result in facilitating the acquisition and retention of the capability of skillful execution of modeled behavior, or at least provide the development of a positive incentive toward the learning task.

CHAPTER III

DESIGN

This chapter provides all the information used for the systematic design of the videotape package, namely a description of the target audience, the strategy formulation of the programme and instructional design objectives, the analysis of the constraints. It also describes the production procedures and examines if the package design meets the stated objectives.

3.1 Intended Audience: Population and Samples

The videotape package was designed for CEGEP students currently registered in the second year of the Medical Laboratory Technology programme at Dawson College. Students in this course have little or no background knowledge on the topic, so the programme should be designed to begin with fundamental concepts and principles related to the material being taught. The vocational goals and future career plans of these students are oriented mainly towards employment in hospital laboratories.

3.2 Goals and Objectives

The goals of the designer were as follows:

1. To teach autoclave sterilization principles and procedures to students incorporating findings of research in learning and audio-

visual instruction in order to increase the effectiveness of the learning process.

2. To focus on the possibilities of the selected visual medium to illustrate concepts, principles and manipulations.

3. To provide a clear and concise presentation, using appropriate cues to gain and encourage observer's attentiveness.

4. To apply instructional programming techniques to the design of the videotape package.

5. To include overt-responding and feedback in the design of the package.

6. To present the material in such a way that students show a high level of understanding and a high gain in knowledge.

The objectives of the videotape package were:

To enable students to understand concepts, principles, facts and skills related to autoclave sterilization; specifically to be able to:

- state the principle of moist heat and compare it with dry heat.
- identify the different parts of the autoclave and state their functions.
- discriminate between moist heat and dry heat sterilization techniques.
- explain the autoclave sterilization process in a sequential order.

- discriminate among various items those which should be sterilized with the autoclave, and be able to select the appropriate technique and arrangement of the load.
- describe the main characteristics of the sterilization indicators
- feel confident in their knowledge and safely operate the autoclave when during their hospital internship, following demonstration, they will be asked to do so.

3.3 Constraints

1. The entire package and development procedure (from documentation, script-writing to design and production of videotape, adjunct material and tests) could take no more than six months. This is because these materials were intended to be used as an integral part of the curriculum and therefore had to be ready on time.

2. Videotape length had to be limited to 25 to 35 minutes since it was meant to be used in the regular CEGEP class. The total instructional procedure that is videotape presentation and time required by student's active participation had to fit easily into the scheduled class time slot of 80 minutes.

3. The materials chosen had to be easily available for student's use and easily portable and storable.

4. Equipment and studio facilities were to be available to reduce production cost.

5. Equipment such as television monitors to allow distribution within classroom were to be available.

6. The ratio of the production cost/per hour of student use had to be justified by its effectiveness.

7. The visuals and special effects selected had to fit the capabilities of the equipments available.

3.4 Task Analysis

As defined by Davies (1973, p. 74):

> Task analysis is concerned with gathering a particular range of interrelated information in order to allocate priorities and make optimal decisions about the design of the learning environment for a set of performance objectives.

Having selected and clearly stated the terminal objective concerned with the unit of instruction (section 3.2), that is:

- To enable students to understand concepts, principles, facts and skills related to autoclave sterilization.

The learners' characteristics were analysed (section 3.1) and entering competencies were identified as:

1. Knowledge of microbial nomenclature and classification.

2. Knowledge of bacterial morphology, anatomy, chemical composition and reproduction.

3. Knowledge of bacterial physiology and metabolism.

The general objective was then broken down into subordinate skills. A list of enabling objectives was formulated for each of the subordinate skills and priorities allocated. Bloom, Hastings and Madaus (1971) have described a method for identifying sequences of learning tasks that depends upon the hierarchical nature of the different outcomes described by the various levels of the taxonomy of educational objectives. Their table of specification for science education (p. 503) was consulted (Knowledge-level outcomes are prerequisite to comprehension outcomes which are prerequisite to observation and measuring outcomes and so on through the different levels of the taxonomy) and different elements selected keeping in mind the learner's entering competency, the instructional unit and the prerequisite necessary for the acquisition of new skills. This process forms the basis of the learning hierarchy (Gagné and Briggs, 1974, p. 109) that is the "arrangement of intellectual skill objectives into a pattern which shows the prerequisite relationship among them".

The following table (Table 1- A section of the learning hierarchy table.) is derived from an analysis of the instructional unit and its relationship with Bloom's hierarchy.

The list of enabling objectives derived from this task analysis have been incorporated within the viewing guide at the beginning of each sequence in order to orient the learner. (see appendix B).

3.5 Planning and the Design Process

This section concerned with the design process and formative evaluation will explain how scripts and adjunct materials were revised

TABLE 1

A Section of the Learning Hierarchy Table

Knowledge of concept	Knowledge of terminology	Knowledge of classification categorie & criteria	Knowledge of trends & sequences	Knowledge of techniques	Knowledge of scientific principles & generalization
Sterilization	in microbiology	implies the destruction of bacteria, fungi and viruses			
	autoclave	based on application of moist heat for microbial destruction	protein subject to boiling water coagulates. Bacteria are not exception to this rule		moist heat brings about protein denaturation at lower temperature than dry heat
	hot air oven	based on application of dry heat for microbial destruction	slow burning process brings about destruction by oxidation		

until they reached their final form.

The script was written keeping in mind the intended target audience, the designer and programme objectives as well as the constraints. As the producer is a subject matter specialist, the objectives to be met were already familiar. Reference textbooks (Perkins, 1973, and Rubbo, 1965) were selected for in depth analysis of the material. The following concepts, principles, facts and skills were to be taught: 1. Sterilization concept; 2. principle of moist heat; 3. autoclave principle and description; 4. operating process; 5. factors upon which autoclave sterilization is dependent; 6. load arrangement and preparation; 7. sterilization cycles; 8. autoclave controls and sterilization indicators.

The content was analysed in order to allocate priorities within the ordering of sequences. Prerequisites to the learning events were identified.

After consultations with several advisors, the following revisions were made. An introductory segment including motivating device to arouse the learner's interest was added and information on format presentation and general objectives to guide the learner and inform him about what he is expected to achieve at the end of the presentation was added at the outset of the programme. Cues to indicate the exact times for students' active participation were provided, and the script was revised in light of Gagné's theory of instructional events. Adjunct materials in form of viewing guide, evaluation questionnaire and tests were developed in conjunction with the script. Redundant information was added. An overview and specific objectives were incorporated in the viewing guide to cut down on production cost. This is presented to the learner at the beginning of each sequence in order to orient the student and give him a better understanding of the section.

The script and adjunct material were evaluated as to content and design. Professor Huntley pointed out a few areas which should be improved: for example, in the introductory segment, students were not alerted to all the material required for the instruction to follow such as viewing guide, pencil, evaluation questionnaire. No information was given indicating the signal to appear on the monitor for active student participation. The sections were not numbered to facilitate student review of question if so desired. In this way some of the weak areas were corrected and the storyboard was improved in order to clarify the visual representation. It proved to be another check-point stage in the development of the material. If the concept and sequences appeared to be well interrelated while reading the script, within certain areas the reorganization of the content proved necessary to allow an harmonious continuity through the visual information. The storyboard pointed out things that have been missed and sequences that need reorganization.

3.6 Available Resources

Search for existing commercial or instructional written and visual material on autoclave sterilization had been previously carried out among the different industrial companies distributing autoclave and among institutions offering the programme. A copy of a film (taken out of distribution) "Pressure Steam Sterilization" (American Sterilizer Company of Canada) was made available from the TIMT library. Screening of the film indicated that only a few animated sequences of two minutes total duration, illustrating principles, could be useful. Permission to insert these sequences within the package was requested and granted by the company. (See appendix B).

The most important item of the package, namely: a well-maintained autoclave located in a preparation room large enough to accommodate equipment and production crew proved difficult to obtain. After a thorough search of Montreal hospital laboratories and academic institutions, the Institut Armand Frappier (Laval-des-Rapides) facilities were selected. Recording studio, equipment and production help (cameraman, graphic artist, photograph, technical assistant) were made available by the Dawson College Audio-Visual Center. Video player used to insert Super-8mm film clips into the video programme was graciously provided by AVA Montreal.

3.7 Preparation and Production

This section will provide information on preliminary planning and preparation of visual materials keeping in mind the special requirements of the television medium.

The preparation for the production of the programme began by the final script breakdown into shots and sequence of scenes, the amount of action in each scene, the timing of each scene duration to provide for appropriate instructional pacing. Five to 10 seconds were calculated for a mute or static shot (i.e. section headings, slides of viruses, fungi...) as these shots could not sustain interest longer and this time was sufficient to convey its information (Millerson, 1974). Other shots or sequences were timed according to the amount of information to be conveyed. (An outline of the television script and storyboard is given in Appendix B).

In order to ensure that recording procedures would run smoothly, preliminary preparation of all inserts, lettering, charts and graphics was made. Rough pencil sketches of the visuals were done, displayed in front of the television camera to assess their visual impact, altered reviewed and then given to the graphic department for final production. The format and proportions of the diagrams were calculated for television use. The schematic representation of the autoclave created a few problems and asked for repeated alteration before reaching its final form. A detailed scheme as presented in most books on autoclave sterilization proved to be very confusing. Screen size demands television graphics to be simple and free from unnecessary details (Kemp, 1975). Secondary pipes and valves were gradually eliminated or simplified keeping in mind the working principle of the autoclave to be communicated.

Animation procedure appeared as the only way to indicate the circulation of steam within the autoclave to facilitate student's understanding of this process. Since an automatic editing system (to allow frame by frame editing and therefore to do animation with videotape) was not available in Dawson equipment, Super-8mm film was employed instead. Few techniques were tested before result proved partly satisfactory.

Arrangements were made at the Armand Frappier Institute for dry run and shooting. Talent had been chosen among former graduates on the basis of her ease in manipulation and other characteristics such as age, general appearance and sex to allow students to identify with her and to produce an emotional responsiveness (Bandura, 1971). Following shooting all materials were reviewed in the studio for selection and timing of relevant sequences.

The next step was concerned with the final production within the recording studio. Camera rehearsal and timing preceeded shooting of each sequence. At the end of each sequence, the material was reviewed, and the shots timed again, as the narration was intended to be added at the end of the final production. Special effects such as electronic colorization of inserts from "Pressure Steam Sterilization" was done to keep unity of style and presentation in the visual materials.

Inserts from Super-8mm film through Kodak video-player proved unsatisfactory due to lack of good synchronization.

Once video shooting and editing was completed, the next step was to find appropriate talent as narrator. Samples of voice were tested for clarity in expression. Following selection of the narrator, the content section of the script was typed on full-width, double-spaced page for ease in reading. Places that required cueing, pauses and special emphasis were marked. This was made available the week before recording to allow familiarization with the technical terms. Before recording, the narration was first rehearsed in order to eliminate any possible technical problems or speech difficulties, to stress certain passages and adjust pacing. Information and signal for cues were reviewed with audiotape recorder and narrator. After this, audio-section was recorded. Direct audio-recording on 1 inch videotape was done to avoid distortion of voice or lack of synchronization with visual presentation. As a final step, sequences of music meant to introduce title and indicate review sections were recorded.

In conjunction with the production of the videotape, production of all necessary printed materials was undertaken: viewing guide, evaluation questionnaire and pretest-posttest. These materials were examined by colleagues in the field and TIMT for relevancy and terminology, and also by thesis director as well as members of the thesis committee, and final corrections were made when necessary.

3.8 Analysis of Final Videotape Package

The final instructional package consists of the videotape to be used in conjunction with the viewing guide. Proper instructional process requires a systematic plan for the acquiring of new knowledge and skills. Gagné (1970) has emphasized the presence of certain events external to the lesson objectives within any instructional set. Gagné's ordering of events (1974, p. 123) were therefore used as an important model for the design of the videotape package and are as follows:

1. Gaining attention
2. Informing the learner of the objective
3. Stimulating recall of prerequisite learnings
4. Presenting the stimulus material
5. Providing "learning guidance"
6. Eliciting the performance
7. Providing feedback about performance correctness

8. Assessing the performance
9. Enhancing retention and transfer

The following section will indicate the technique used to meet design principles.

Several studies relate the arousal of attention to certain motivating conditions such as epistemic curiosity (Berlyne, 1966). The programme is introduced by informing the viewer that he will learn from the videotape "all that should be understood by the person responsible for the operation of the autoclave and the standardization of the sterilization procedures." This is done to encourage the student to engage in a learning activity that leads to some positive consequences associated with his future career. Values about vocational matters being constantly reinforced during the academic school year, the use of this motivating device should result in the development of favorable attitude toward future learning. This strategy is recognized by Gagné and Briggs (1974) as the first step in the sequence of instructional events and is called "gaining attention".

The learner is then informed of the general objectives of the videotape package and directed to the first pages of the viewing guide where programme format is outlined. So, at the end of the introductory segment, students are provided with a clear overview of the content and instructional sequences to follow. The use of objectives to alert and prepare the learner is recognized by Gagné (1974) and Mager (1962) as important events in instruction. Furthermore, this introductory material may act as an "advance organizer"

(Ausubel, 1969) by providing a broad framework or "ideational scaffolding" for the learning task to follow.

Several studies reviewed by Gagné and Rohwer (1969) suggest that given the option of presenting material in different forms, visual or oral, the stimulus type of choice is either object or picture, rather than words. Presenting the autoclave in operation at the outset of the programme, showing a diagram of the autoclave with the key words of the objectives superimposed in the introductory segment, provides students with stimulus material. This is recognized as the fourth step in Gagné's model.

Other techniques such as labeling of unfamiliar material, referred to as "stimulus shaping" (Gagné and Rohwer, 1969) are also used during the presentation of the videotape. Outline of content at the beginning of each section within the viewing guide, verbal explanations given by the narrator provides learner guidance (Step 5 in Gagné's model). In order to teach new concepts and principles, students are first provided with visual examples and related explanations pertaining to previous knowledge acquired during their training. For example, stimulating recall of previous experiments associated with principle of moist and dry heat before presentation of the autoclave sterilization principle facilitates the acquisition of new concepts and principles and allows a logical progression within the instructional process. This is recognized as Step 3 in Gagné's model. At the end of each sequence the students are asked to answer questions within the viewing guide. This is meant to elicit performance (Step 6). Following completion of the questionnaire students are provided with immediate feedback, as the correct answer is printed on the following page of the guide, they are therefore able to assess their performance (step 7 and 8). These events enhance retention and transfer and this is assessed at the end of the presentation by the use of a posttest (last step in Gagné's model).

The structure of each learning sequence has been planned in accordance with design principles, but with some flexibility to avoid irrelevancies within the lesson objectives. As pointed out by Gagné and Briggs (1974, p. 135).

> The order of these events for a lesson or a lesson segment is approximate, and may vary somewhat depending upon the objective. Not all of them are invariably used. Some are made to occur by the teacher, some by the learner, and some by the instructional materials.

3.9 Time Schedule Followed

A flexible time schedule was prepared in order to meet the completion date for each phase of the production. A certain number of fixed factors had to be considered, such as:

1. Studio availability.

2. The experiment at TIMT should run before September 26th, 1977, when a lecture on autoclave sterilization was scheduled.

3. The Dawson experiment would take place October 11th as scheduled on the timetable.

4. All other adjunct materials and tests should be ready and tested before the beginning of the academic school year.

The final schedule is presented on Table 2.

TABLE 2

Production Phases of the Videotape

PRODUCTION PHASES	DATE
Documentation Survey of available material Search for Autoclave	February-March 1977
Analysis of objectives and constraints Writing and Review of Script	April-May 1977
Shooting at Institut Armand Frappier	May 27 June 3 June 10
Selection of visuals and Testing	May-June 1977
Super-8mm film Experimentation and Production	June 27-July 5th, 1977
Final Shooting and Editing	July 6-July 29, 1977
Sound track	August 9th, 1977
Writing of Adjunct material	May-July 1977
Pilot Study	August 12th, 1977
Final Revision to package	August 13-17th, 1977
Final typing of Adjunct material	August 18-23rd, 1977

3.10 Pilot Study

For the purpose of formative evaluation, two students of different learning abilities were originally selected to assess certain factors during the production process. Unfortunately, due to constraints of studio and student availability, this was impossible.

Only after completion of the experimental package, that is, videotape, viewing guide, pre-posttest and evaluation questionnaire, did it appear feasible to carry out a pilot study with some of the students interning within hospital laboratories. Since at that time it was not possible to improve the videotape, the transformation of the viewing guide was intended to compensate for deficiencies which could have been detected. Another factor considered in running the pilot study was to determine the time requested for pre-and-posttest as well as carrying out the experiment.

Since these students had been exposed the year before to the traditional lecture on autoclave sterilization, they were familiar with the topic, but presented variations in the retention of the material. Their general reaction toward the videotape as well as the new approach was rather enthusiastic. One student from the group, who had completed her hospital internship on the sterilization sequence, mentioned that it was the first time that she was able to understand completely the principles related to autoclave sterilization and its mode of operation. The videotape weak points, already familiar to the designer, such as labeling of the autoclave, diagram, flickering of the section etc... were mentioned. Questions in the viewing guide that needed clarification as well as typographical errors were pointed out and subsequently corrected. Two students expressed the need for explanation of terms such as "ebullition", "kraft paper" etc... Following discussion with the group it became evident that a glossary providing information on a few terms as well as reviewing some prerequisite physics knowledge such as thermocouple should be added and provided to students before viewing in order to facilitate their understanding.

The adjunct material was revised accordingly and submitted to the thesis director, to the content advisor and to members of the committee for final revision and approval. (Results of the pilot study can be found in Appendix A).

CHAPTER IV

METHODS AND CONDUCT OF THE EVALUATION EXPERIMENT

This chapter presents the formulation of the hypotheses and the definition of the variables as well as the description of the procedures necessary to carry out the experimental design.

4.1 Definition of Variables and Hypotheses

As mentioned in the introduction under section 1-2, the following questions were considered:

1. Is the use of a videotape package covering the subject area an effective method of teaching "autoclave sterilization" to medical laboratory technology students?

2. Is the videotape approach more effective and/or more time-efficient than the traditional face-to-face lecture?

3. Is this approach a cost-effective way to achieve the instructional objectives?

Before presenting the hypotheses the variables may be defined as follows:

Videotape package approach: refers to videotape programmed instruction with viewing guide, the latter including objectives, adjunct questions and feedback.

Effective method: refers to a method which meets pre-stated programme objectives.

Time-efficient method: refers to a method able to communicate a greater amount of knowledge with identical student understanding than an other approach, given the same amount of teaching time.

Traditional face-to-face lecture: refers in general to a method where a teacher imparts knowledge to students using verbal explanations, graphics and by answering student questions.

Cost-beneficial method: refers to a method where the relative benefits of using it outweigh the cost.

With the above definitions in mind the hypotheses may be formulated as follows:

H_1 Videotape programmed instruction using viewing guide, including objectives, adjunct questions and feedback to teach autoclave sterilization to students meets pre-stated programme objectives and allow students to demonstrate understanding and recall of concepts, facts and principles, to discriminate among them, and explain them.

H_2 Videotape programmed instruction, using viewing guide including objectives, adjunct questions and feedback, communicate a greater amount of information and a greater student understanding within the same amount of time than the traditional approach where a teacher uses verbal explanations, graphics and answers student questions (a) as measured by the posttest, (b) as measured by the pretest-posttest gain.

H_3 The relative benefits resulting from the use of videotape programmed instruction outweigh production cost.

4.2 Rationale for the Hypotheses

The theoretical justifications for the hypotheses rely on the use of introductory material as "advance organizers" (Ausubel, 1969) which sensitize the learner to the major areas of instruction, guiding and controlling the learning process. Furthermore, Rothkopf's (1970) findings on "mathemagenic behavior" support the use of adjunct activity to shape student's attention and information-processing ability.

4.3 Subjects

The subjects for this study consisted of a total of 51 students drawn from two different English-speaking institutions in two different provinces, 22 from Dawson College (Montreal), and 29 from the Toronto Institute of Medical Technology (Toronto). Since Dawson College was the only English-speaking CEGEP in the province of Québec offering the Medical Laboratory Technology programme, it was felt necessary to select the second sample from outside the province.

Dawson College's student population has been traditionally known as coming from lower to middle-class families. The Toronto Institute of Medical Technology (TIMT), on the other hand, is usually referred to as serving students from middle to upper-class families.

Since no I.Q. scores were available for the subjects, their entering marks in general science courses were obtained in order to verify the homogeneity of the different treatment and control groups. The mean was calculated on available scores from the pre-requisite science courses (Biology, Physics, Chemistry and Biometrics or equivalent). Table 3 summarizes the classroom test scores of the different videotape, lecture and control groups. A t-test indicates the fact that at the .05 level, no significant differences exist between the lecture group mean (79.0) and the videotape group mean (73.7). (df = 21; t = 1.815).

4.4 Sampling Procedures

At TIMT the procedures were as follows: The student body (125) was approached during a lecture period and asked for volunteers to participate in an evaluation of a videotape presentation on the "Autoclave". They were also told that they would be divided into three groups. They were asked to sign a list outside the microbiology staff office. They were then assigned to the videotape lecture and control groups following the order that they enter their name on the list.

At Dawson, an intact class was used for the videotape treatment, presented as an integral part of the course programme. The subsequent division for the administration of the posttest after 24 and 48 hours was done using the existing division of students into two laboratory groups, as the laboratory size could not accommodate all students at once. The allocation to laboratory sessions was done during the registration day partly on a first-come first-served basis, and on the basis of time-schedule preferences.

4.5 Instructional Materials

The instructional material, developed for the purpose of this project consisted of a videotape and learning package. The videotape "Autoclave Sterilization" dealt with the principle of moist heat sterilization, the autoclave principle, description and operation, efficiency of autoclave sterilization, load arrangement and preparation, sterilization cycles, and autoclave controls. A videotape with a total length of 28 minutes was divided into seven segments, each segment related to one principle or aspect of autoclave sterilization. The length of each segment varied from 3 to 6 minutes depending on the amount of information related. (see table 4). The fact that sections varied in length was beneficial to the students since not only was time allocated to match the difficulty of each topic, but also concision and variety was achieved, thus sustaining attention.

The adjunct study material which formed part of the videotape package treatment consisted of a viewing guide containing general instructions, a list of behavioral objectives, a review section and an answer sheet for each section of the tape.

The general instructions indicated to the learner the sequencing of the videotape and the corresponding sections of the viewing guide, and also what he should be doing while viewing.

The list of behavioral objectives related to each section indicated what the student should be able to do after viewing the tape.

The review section or questionnaire to be completed at the end of each section when the tape was stopped, consisted of completion type and short constructed answers, labeling a diagram and multiple-choice questions.

TABLE 3

SUMMARY OF MEAN SCORES OVER FOUR PREREQUISITE COURSES FOR EACH GROUP

Institution	Group	No. of students	Mean score
Dawson	Videotape (1)	11	73.6
	Videotape (2)	11	73.6
TIMT	Videotape	12	73.7
	Lecture	11	79.0
	Control	6	75.0

TABLE 4

VIDEOTAPE "AUTOCLAVE STERILIZATION" SEQUENCING AND RUNNING TIME

Section	Title	Time
--	Instructions for the user	2':20
I	Principle of moist heat sterilization	3':25
II	Autoclave: Principle and description	3':47
III	Autoclave: Operation	3':07
IV	Efficiency of autoclave sterilization	3':30
V	Load arrangement and preparation	6':46
VI	Sterilization cycles	5':16
VII	Autoclave controls and sterilization indicators	2':32
	TOTAL TIME	30':43"

The answer sheet for the review section was provided so that the student could receive immediate feedback on his performance (see appendix B for viewing guide).

All these materials were made available to the lecturer in charge of the TIMT lecture group. The instructional material used for this group consisted of the film "Pressure Steam Sterilization" produced by the Amsco Company and the lecture instructional package with diagrams and questions that the student had to answer during the lecture. This material along with a two-hour laboratory session dealing with preparation of materials for autoclaving to which the students were exposed after the lecture was developed at TIMT and can be found in appendix D.

4.6 Measuring Instruments

Two measuring instruments were constructed. The first test was to be administered to the students as pretest and after the instruction had taken place as posttest. This test consisted of various item formats, namely, multiple-choice questions, matching items, labeling of diagram, true-false, fill-in-the-blanks and short-answer items. It was five pages long, most items were worth one point or subdivided into one point sections (for the short-answer items) providing a total score range from 0 to 62.

The content validity of the test was first checked by carefully matching each item to the objectives being measured and later on was verified by the TIMT instructor and by another advisor.

The test was found, with some minor revisions in terminology, to be an adequate measuring instrument for the topic. The test was also administered to a few students (Pilot study group) in order to determine the approximate time needed for completing the test in a pretest or posttest situation. Students took about 30 minutes to complete the pretest and about 25 minutes for the posttest. (The tests can be found in appendix C).

The reliability of the test was examined using the Kuder-Richardson formula 20 reliability test (Ferguson, 1971, p. 367-368), to determine the internal consistency or homogeneity of the test material. The overall reliability of the test was 0.826, which demonstrates a reasonable amount of internal consistency.

The second measuring device was an evaluation questionnaire developed to determine student's attitudes toward specific aspects of the package. It was administered following visualization of the videotape, and students had approximately 10-15 minutes to complete it.

The evaluation questionnaire consisted of three parts presented on a rating scale format ranging from 1 to 5, and on open-ended questions. The first part was used to measure the attitude of the students toward twelve different aspects of the videotape and to observe which sections they liked and which sections they disliked. The second part was concerned with the viewing guide, its organization and instructional value. In the third part, the students were asked some general questions about the entire package, to make comments and suggestions and whether or not they felt this material should replace the usual lecture on the topic. A sample of the evaluation questionnaire appears in appendix C.

4.7 Experimental Design

For the purpose of this study a five-group pretest-posttest control group design was used (Tuckman, 1972, p. 107). The justification for the pretest lies in the heterogeneity of educational background of the students. Some students working during the summer as assistants in hospital laboratories may have already been exposed to autoclave sterilization procedures. Others may have transferred from another para-medical programme (i.e. a nursing programme encompasses within its curriculum some knowledge of the sterilization process). This pretest design, therefore, was intended to obtain some information concerning the entry level of each student.

However, the use of a pretest is known to introduce design difficulties. As suggested by Ausubel (1969), it can serve as an "advance organizer" and facilitate learning and retention by "the advanced introduction of relevant subsuming concepts". In an attempt to control for this "testing effect", that is, the possible gain on the posttest due to experience on the pretest" which may reduce internal validity (Tuckman, 1972) and the "possible sensitization to the treatment that the subject might gain by having the pretest experience" thus affecting external validity, it was decided that a pretest-posttest no treatment control group would be used.

The experimental design selected can be diagrammed as follows:

T_1	0_1	X	0_2	(Dawson 24 hrs. posttest group)
T_2	0_3	X	0_4	(Dawson 48 hrs. posttest group)
T_3	0_5	X	0_6	(TIMT 48 hrs. posttest group)
T_4	0_7	Y	0_8	(TIMT Control group)
C	0_9		0_{10}	(TIMT pure control group)

In this design, (X) represents the videotape package treatment, and (Y) refers to the traditional face-to-face lecture.

The first two treatment groups (Dawson College) T_1 and T_2 belong to two intact laboratory sessions and were not randomly selected. These two groups were administered the pretest 0_1 and 0_3, then exposed to the videotape package (X) the following day. T_1 was given the posttest 0_2 24 hours after treatment, and T_2 was given the posttest 0_4 48 hours after the treatment.

Both Dawson treatment groups (T_1 and T_2) were administered the pretest at the same time in the regular classroom and view the tape the next day under the same condition. In order to eliminate the possibility of the Hawthorne effect (Tuckman, 1972), the videotape programme was administered as part of the regular course work and students were not informed that the videotape was being tested for the purpose of this study. Also, to minimize any effects that giving a pretest could have had, students were informed at the beginning of the semester that occasionally they were going to be administered pre-and-posttest during the academic school year in view of assessing the effectiveness of lectures or other approaches in instruction. Since the students belong to a vocational programme where steady attendance is required, and since the treatments were administered during the regular class and laboratory time it was certain that all experimental data would be collected and therefore experimental mortality could be controlled.

It seems important to mention that in the original design all the Dawson subjects were intended to be treated as one single videotape treatment group, and that the administration of the posttest was planned to occur immediately after the viewing in order to control threats to validity due to maturation and history. The subsequent changes were introduced in order to compare the results with those of TIMT.

The TIMT T_3, T_4 and C (no treatment control) groups were given the pretest at the same time within the same classroom; T_3 was exposed to the videotape package (X) three hours later, and received the posttest two days later at the same time as the non-treatment control group. The following week, the lecture group (T_4) attended the regular lectures (Y) on the topic. This, as schedules on the timetable, is spread over two weeks and encompasses the viewing of a commercial film on autoclave sterilization, 4 hours of lecture period and a two-hour laboratory session. The posttest was given to the subjects the day after the last lecture on autoclave sterilization. (see table 5 for operational details).

4.8 The Variables

The variables were identified as follows:

A. Independent variables:

The videotape approach,

The lecture approach,

The null treatment

B. Dependent variables:

Student scores on posttest,

Student overall 'attitude' towards the videotape package so measured by the evaluation questionnaire.

C. Control variables:

Time span between treatment and posttest,

Student's previous academic achievement in general science courses,

Time during treatment,

Delay during treatment

TABLE 5

DETAILS OF THE ADMINISTRATION OF THE EXPERIMENT

Group	Pretest Date	Pretest Time	Treatment	Date	Time	Posttest Date	Posttest Time
TIMT VT	Sept.21/77	12:25-12:55	Videotape	Sept.21	4:00-6:00p.m.	Sept.23	12:25-12:55
Control	Sept.21	12:25-12:55	---	---	---	Sept.23	12:25-12:55
Lecture	Sept.21	12:25-12:55	Film:"Pressure Steam Sterilization"(Amsco)	Sept.26	4:00-5:00		
			Lecture on Autoclave. Reviewing of first half of film.	Sept.29	2 hours		
			Lecture: Sterilization Hot Air Oven. Ethylene-oxide. Filtration.	Sept.30	1 hour		
			Lecture: Sterilization, Evaluation and Controls	Oct. 6	1 hour		
			Laboratory = "Preparation of material for sterilization"	Oct. 6	2 hours	Oct. 7	12:25-12:55
Dawson VT (1)	Oct. 10	2:00-2:30	Videotape	Oct.11	10:00-11:30	Oct.12	1:30-1:55
VT (2)	Oct. 10	2:00-2:30	Videotape	Oct.11	10:00-11:30	Oct.13	3:00-3:25

CHAPTER V

RESULTS

This chapter provides scores and the results of the data analysis.

5.1 Data Analysis

Once the data from the tests were scored and coded, an item by item analysis using the t-test for independent samples was done in order to discriminate between the videotape treatment and the lecture groups. This was carried out separately on pre-and-posttests. For the posttest analysis, the videotape groups were analysed as one sample, despite the fact that the posttest was administered after 48 hours and 24 hours, whereas the lecture group had been tested within 24 hours. The item analysis was then extended to each of the sub-samples.

Due to the small sample size (Ferguson, 1971, p. 142) a t-test has also been used to compare the mean total scores of the different groups and to investigate the possibility of a relationship between level of performance on prerequisite science courses and posttest achievement.

Differences between pretest and posttest scores were examined to determine the relative merits of the two treatments. The general discussion will be based on raw scores rather than gain scores, following the advise of Cronbach and Furby (1970, p. 80).

The evaluation questionnaire was administered after the videotape programme to provide the investigator with student feedback on attitudes as well as suggestions for improvement in specific areas.

5.2 Entrance Level of Student Samples

The means of pretest scores of the different control and experimental groups are given in Table 6. The mean on the pretest for the lecture group is approximately twice the mean of the Dawson videotape groups. This is statistically highly significant ($p < .005$).

Also, the mean of the pretest for the TIMT videotape group indicate superiority ($p < .05$) over the mean of the Dawson videotape groups (see table 7).

5.3 Differences Between the Lecture and Videotape Groups on Posttest Items

Differences between the mean scores for each item for the lecture versus videotape groups were investigated. The item by item analysis using a t-test of the lecture versus the videotape treatment (table 8) indicates superiority ($p < .001$) of the lecture sample on two items (quest. 6,9) over the videotape treatment. These two items are concerned with the sterilizing effect of the hot air oven.

On the other hand, students exposed to the videotape proved able to exhibit superior knowledge of:

- the autoclave principle (quest. 7, 10; $p < .01$, $p < .05$)
- physical features and functions (quest. 22, 23, 24, 16, 12; $p < .05$ to $p < .001$)

TABLE 6

A t-test of Differences of the Means of Lecture Versus Videotape Treatment Groups on Pretest Scores

Groups	Mean	Standard Deviation	t-value	df	2-tail probability
TIMT Lecture TIMT Control	16.909 14.166	4.085 5.565	1.17	15	0.26
TIMT Lecture *TIMT Videotape	16.909 14.083	4.085 3.528	1.78	21	0.09
TIMT Lecture *Dawson Videotape	16.909 8.454	4.085 6.890	3.50	20	0.002
TIMT Lecture Dawson Videotape	16.909 9.545	4.085 5.646	3.50	20	0.002

*Posttest was administered after 48 hours, whereas for the other groups posttest was administered after 24 hours.

TABLE 7

A t-test of Differences of the Means Among Videotape Treatment Groups on Pretest Scores

Groups	Mean	Standard Deviation	t-value	df	2-tail probability
*TIMT Videotape	14.083	3.528			
*Dawson Videotape	8.454	6.890	2.50	21	.021
*TIMT Videotape	14.083	3.528			
Dawson Videotape	9.545	5.646	2.33	21	.030

*Posttest was administered after 48 hours.

- efficiency (quest. 35, 59)
- preparation of load (quest. 42, 44, 61; $p < .05$ to $p < .01$)
- indicator (quest. 47)

as can be seen on table 8. (A complete table can be found in appendix E, table).

Considering the item analysis for each individual videotape treatment, the lecture group (besides superiority on quest. 6 and 9 as previously mentioned) showed superiority only on one item over the Dawson 48 hours posttest group (quest. 49; $p < .05$). The Dawson 24 hours posttest group proved to be superior to the lecture group on questions related to autoclave mechanism and loading (questions, 14, 31, 62; $p < .05$ to $p < .005$), and along with the TIMT videotape group on two questions (quest. 53, 54; $p < .01$ to $p < .05$) related to sterilization control.

5.4 Analysis of Posttest Scores: Effects of Delaying the Posttest

Under similar posttest situation, that is, testing after 24 hours, a t-test used to compare the scores of the TIMT lecture group versus the videotape group (Dawson) indicates that the videotape group achieved better ($p < .05$) than the lecture group. Under delayed condition, that is, posttest administered after 48 hours for the videotape samples only, the achievement of the TIMT videotape group is superior to that of the lecture group ($p < .05$), whereas the videotape Dawson sample presents scores similar to that of the lecture group. (see table 9).

5.5 Statistical Analysis of Gains Between Pretests and Posttests

Table 10 indicates the absence of sensitization of the pure control group by having pretest experience, as no gain was observed on the

TABLE 8

Item by Item Analysis Via a t-test of Differences on the Posttest Items for the Lecture Group Versus the Videotape Groups Combined. Only Differences where $p \leq .05$ are presented

df=43

Item	Group	Mean	Standard Deviation	t-value	2-tail probability
6	Lecture	1.000	0.000		
	Videotape	0.265	0.448	5.40	.001
7	Lecture	0.363	0.505		
	Videotape	0.794	0.410	-2.86	.007
9	Lecture	1.000	0.000		
	Videotape	0.294	0.462	5.02	.001
10	Lecture	0.545	0.522		
	Videotape	0.853	0.359	-2.20	.030
12	Lecture	0.727	0.467		
	Videotape	0.941	0.239	-2.01	.051
16	Lecture	0.363	0.505		
	Videotape	0.794	0.410	-2.86	.007
22	Lecture	0.727	0.467		
	Videotape	0.970	0.171	-2.59	.013
23	Lecture	0.272	0.467		
	Videotape	0.676	0.475	-2.46	.02
24	Lecture	0.273	0.467		
	Videotape	0.853	0.359	-4.32	.001
35	Lecture	0.000	0.00		
	Videotape	0.265	0.448	-1.95	.058
42	Lecture	0.454	0.522		
	Videotape	0.764	0.431	-1.97	.055
44	Lecture	0.182	0.405		
	Videotape	0.529	0.507	-2.07	.045
47	Lecture	0.181	0.405		
	Videotape	0.500	0.508	-1.89	.066
51	Lecture	0.636	0.505		
	Videotape	0.882	0.327	-1.89	.066
59	Lecture	0.363	0.505		
	Videotape	0.676	0.475	-1.87	.068
60	Lecture	0.545	0.522		
	Videotape	0.823	0.387	-1.90	.064
61	Lecture	0.636	0.505		
	Videotape	0.941	0.239	-2.74	.009

TABLE 9

t-test on Total Posttest Scores Lecture Versus Others

Groups	N	Mean	Standard Deviation	t-value	df	2-tail probability
*TIMT Lecture	11	36.364	9.801			
*Dawson Videotape	11	44.818	9.631	-2.04	20	.05
*TIMT Lecture	11	36.364	9.801			
**TIMT Videotape	12	43.750	5.311	-2.27	21	.034
*TIMT Lecture	11	36.364	9.801			
**Dawson Videotape	11	37.000	8.149	-0.17	20	.870

*Posttest administered after 24 hours
**Posttest administered after 48 hours

posttest, therefore, the threat of a testing effect (Tuckman, 1972, p. 108) is eliminated. Furthermore, a trend of superiority is evidenced in all the videotape treatment groups versus the lecture group in mean gain scores. The increment of the lecture group is 31%, whereas the increment of the different videotape groups is approximately 48% for TIMT, 45% and 57% for the Dawson groups. Since the two Dawson samples present pretest scores inferior to the TIMT groups no comparison can be made.

5.6 Evaluation Questionnaire: Summary of Results

The evaluation questionnaire was administered after viewing to the TIMT and Dawson samples to provide the investigator with student feedback on the videotape package. In general, students thought that the presentation was useful, interesting and clear, they liked the sequencing and the use of the viewing guide. Some students felt they required additional repetition of name of indicators, parts of autoclave (since the labeling was inadequate), that the pace was too fast in general and especially in certain sections (see Tables 10 - 11 - 12 - 13).

The programme was generally evaluated as a good way to learn autoclave sterilization; 68% thought that it could replace the traditional lecture, others that it should be used in conjunction with a brief lecture (since they enjoyed the interaction between teacher and student in the traditional face-to-face lecture and could stop the lecturer for clarification). A few mentioned that it should be used for revision only.

One Dawson student developed a completely negative attitude; this became evident to the teacher-observer during the presentation. He abstained from answering the questions on the viewing guide, and gave a

TABLE 10

t-test of Mean Gains between Pretest and Posttest Performance Scores

Groups	Test	Mean	Standard Deviation	Mean Difference	df	t-value
TIMT:						
Pure Control	Pretest	14.166	5.565			
	Posttest	14.833	2.926	-0.667	5	-0.40
Lecture	Pretest	16.909	4.085			
	Posttest	36.364	9.801	-19.46	10	-6.34**
*Videotape	Pretest	14.083	3.528			
	Posttest	43.750	5.311	-29.67	11	-19.72**
DAWSON:						
*Videotape	Pretest	8.455	6.890			
	Posttest	37.000	8.149	-28.55	10	-16.41**
Videotape	Pretest	9.546	5.646			
	Posttest	44.818	9.631	-35.27	10	-11.66**

* Posttest administered after 48 hours
** p. .001

TABLE 11

TIMT = EVALUATION QUESTIONNAIRE

SUMMARY OF ANSWERS TO QUESTIONS 1 AND 2

QUESTION 1	QUESTION 2
Name one or more characteristics that you would consider as the strongest points of this package.	Name one or more characteristics that you would consider as the weakest aspects of this package.
Emphasis on the importance of maintaining constant pressure, temperature, use of indicators, knowledge of material and their time periods etc...in autoclave.	Not enough repetition of name of indicators, parts of autoclave, difference between saturated and supersaturated heat.
Made sterilization which is not that interesting, interesting.	A bit of a rush on section VII (2)
Visual demonstration - you can see the autoclave in operation etc...(3).	I was too intent on the spelling of the Bacillus that I missed what was being said.
The actual footage of real equipment equated with graphic representation.	Not enough time to digest information.
Concise presentation. I felt that I should gain some benefit from this demonstration.	Need more repetition of details and new terms (3).
Colour. Narrator easily understood.	Some names of chemicals should be on the glossary, e.g. the indicators.
The videoguideline. Writing answers and then checking them.	Information given too quickly in some areas, (2) just introduced then proceeded on again.
The use of numbered points so you can see the words.	I think I missed some of the why's in the methodology.
Watching operation as they were spoken of. Cover quite a lot of detail in autoclave (2).	Speed of the introduction of material, lack of continuing repetition of details.

TABLE 12

DAWSON COLLEGE - EVALUATION QUESTIONNAIRE
SUMMARY OF ANSWERS TO QUESTIONS 1 AND 2

QUESTION 1	QUESTION 2
Name one or more characteristics that you would consider as the strongest points of this package.	Name one or more characteristics that you would consider as the weakest aspects of this package.
Very clear and easy to understand. Helpful in doing questions at the end of each section. Able to apply what you have recently learned.	Some important features were done a bit fast, and it was hard to grasp them, especially on the parts of the autoclave (2).
Well organized (2).	Too slow.
Visualization of the actual use of autoclave makes it easier to understand (6).	Going over some information too quickly - pace (5).
Precise, clear.	Ridiculous distracting music. Music not necessary (2).
Arrangement of the material into separate sequences. Intervals for completion of review questions (5).	Stopping the tape, it should run through, then if something is not clear, go back to that section.
Viewing guide well made up, very helpful (2).	Too much information that has to be memorized is given (2).
Clarity in the explanation made on the topic being discussed and demonstrations set up to show us and give us a clearer point of view on what we are being taught.	You do not have the opportunity to ask questions. Pace was too slow, the sections could contain more information so that there may be less stopping.
Clear, systematic pattern of presentation.	
Very good diagrams and explanations.	Poor diagrams and labeling.
None.	Watching this on television is boring and apt to too many distractions while viewing. Cannot ask videotape to repeat unclear material.

TABLE 13

MEDIAN RATING AND RANGE OF QUESTIONS 1 - 12
(SECTION A - VIDEOTAPE EVALUATION)
ON EVALUATION QUESTIONNAIRE

Questions	TIMT Median Rating	TIMT Range	DAWSON Median Rating	DAWSON Range
1. Is the material explained in the right order.	3.50	1 - 5	4	2 - 5
2. Are information clear and well explained.	3	2 - 4	3	2 - 5
3. Pacing.	2.5	1 - 5	2	1 - 5
4. Clarity of voice.	4	2 - 5	3.5	2 - 5
5. Selection of visual representation.	4	2 - 5	4	3 - 5
6. Schematic representation of autoclave and labeling.	2.5	1 - 5	4	1 - 5
7. Selection of technologist and identification.	3	1 - 4	3	2 - 5
8. Quantity of music during presentation.	3	1 - 3	3	1 - 5
9. Selection of music as indicative of review section.	3	2 - 4	3	1 - 5
10. Amount of interest generated.	3.5	3 - 5	4	2 - 5
11. Student understanding.	3	2 - 5	3	1 - 4
12. Selection of color as opposed to black and white.	5	4 - 5	4	3 - 5

(scale ranged from 1 - 5)

TABLE 14

MEDIAN RATING AND RANGE OF:
QUESTIONS 1 - 5 (SECTION B: VIEWING GUIDE EVALUATION)
QUESTIONS 1 - 2 (SECTION C: GENERAL INFORMATION)
ON EVALUATION QUESTIONNAIRE

Questions	TIMT Median Rating	TIMT Range	DAWSON Median Rating	DAWSON Range
Section B.				
1. Clarity of presentation.	3	2 - 5	3	2 - 5
2. Part one of each section: Content and Objectives.	4	2 - 5	4	1 - 5
3. Questions clarity and usefulness.	3	2 - 5	4	2 - 5
4. Need for answer sheet within the viewing guide.	5	3 - 5	5	2 - 5
5. Glossary	3	1 - 5	3	2 - 5
Section C.				
1. General Rating of the videotape package.	4	3 - 4	3	2 - 4
2. Would you like to continue learning in this fashion.				

(scale ranged from 1 - 5)

very negative feedback on the evaluation questionnaire. His only appreciation was for the selection of color as opposed to black and white. During the follow up evaluation when students were asked to operate the autoclave, he refused to do so, stating that he did not understand it and he was never going to manipulate this equipment.

Since the objective of the videotape was concerned with the knowledge of the autoclave and its principles and not the development of motor-skills. One question asked was whether the learner would feel confident to load and operate the autoclave after completing this package. Forty-three percent of the Dawson students answered positively, 30% asked for a live demonstration before, the remaining answered negatively but did not explain their reasons. Forty-one percent of the TIMT students also felt confident to operate an autoclave on their own. The 59% answering 'no' justified their answer, some mentioned that they would like to practice first with the instructor; others stated an area that needed revision or clarification (use of fast exhaust, type of indicators to be used, their location...) before performing on their own.

A follow up evaluation of the tape was done at Dawson College during the following weeks. Students were requested two at a time, at the outset of each laboratory session to sterilize under supervision the load prepared by the technician. Before autoclaving they had to complete a questionnaire (see appendix C) related to the treatment of the load. As the autoclave at Dawson is more automated than the one used for the videotape, they were then provided with a labeled chart of the cyclomatic control system. They proved in general to be rather confident in their knowledge and to need only light guidance in their manipulation. It became evident that they reviewed their material and that their performance could not be accounted for by simple retention. The viewing guide had been given back to the students and this confirmed its usefulness for review purposes.

CHAPTER VI

SUMMATIVE EVALUATION AND CONCLUSION

This chapter discusses and interprets the results, presents a relative cost-and-benefit analysis of both methods, and examines if the hypotheses are met within the context of the experiment. Finally, some suggestions for improving the videotape are added to conclude this chapter.

6.1 Interpretation of Results and Verification of the Hypotheses

Results in general showed that those students having received the videotape package instruction had a significantly higher degree of understanding than did students learning from the traditional lecture. In fact, under the similar testing situation, that is, both (lecture and videotape samples) tested 24 hours after instruction, the scores of the videotape sample indicate superiority (see table 9). Even under delayed testing, when the posttest was administered 48 hours after treatment for the two other samples, the TIMT videotape group still exhibits superiority; however, the Dawson sample exhibits results similar to that of the lecture group.

An in-depth consideration of the results based on an item by item analysis using a t-test (see table 22, appendix E) indicates that students exposed to the videotape instruction proved to understand better the effectiveness of pressure steam sterilization by the autoclave based on liberation of latent heat (question 7) and on the highly penetrating power of steam (question 10). They also showed significant superiority over the lecture group on some physical features of the autoclave. They were able to indicate for example:

- The location of the temperature gauge on the exit channel (question 22). This is very important as this gauge indicates the beginning of the sterilization process (that is, it shows a reading on the presence of pure steam within the autoclave chamber).
- The location of the pressure regulator (question 23).
- The location of the thermostatic valve that controls the discharge of air and steam (question 24).
- The role played by the operating valve that allows steam to enter the autoclave chamber (question 12) and were able to indicate the direction of flow of steam through the system (question 16) more accurately than the lecture group.

They also recorded better (question 35) the importance of saturated steam in the efficiency of the sterilization process, and the process by which air is removed from the autoclave chamber and replaced by steam. (question 59).

In the section concerned with the preparation of the load (question 42, 44) they indicated how to place empty tubes within the autoclave, the purpose of doing so, and the percentage of liquid accepted within flasks for the sterilization of aqueous solution (question 61) much better than the lecture group.

They seemed also to have grasped better the name of one of the biochemical indicators used to check the efficiency of the sterilization process (question 47) and its location within the autoclave. Furthermore, by examining table 15, appendix E) it can be observed that in general superior knowledge was shown by the videotape groups on most of the questions.

The lecture sample indicated a significant superiority over the videotape samples on only two questions (questions 6 and 9) pertaining to the sterilizing effect of the hot air oven.

The result can easily be explained, since the hot air oven was only briefly used within the videotape as a means to compare the highly penetrating power of steam as used in the autoclave (sterilization achieved at 121^{o}C) as opposed to the poorly penetrating power of hot air as used in the hot air oven (sterilization achieved at 160^{o}C). By examining the frequencies of wrong answers for these questions, it was observed that 73% of the students exposed to the videotape ignored the word "sterilization" within the statement "hot air oven sterilization" and concluded that the effectiveness of the hot air oven was limited to vegetative cells and that the more resistant microbial forms, known as spores, were able to resist such a treatment. On the contrary, the lecture group had been exposed (see table 5) to the sterilization process using the hot air oven and therefore was more aware of this sterilization procedure.

By extending the item analysis to each individual videotape treatment, it was found that the lecture group showed superiority

($p < .05$) on only one item over the Dawson 48 hour posttest group. The item (question 49) was related to the greater reliability of the biological sterilization indicator. The Dawson 24 hour posttest proved to be superior to the lecture group on items concerned with the mechanisms of the thermostatic valve (question 14), the selection of autoclave sterilization process for membrane filter (question 31), the estimation of the total sterilization time (question 62) and along with the TIMT videotape sample on questions (53, 54) related to autoclave sterilization control.

As observed on Table 10, students showed a significant gain in knowledge. They scored an average of 71% correct response after 24 hours, and 66% after 48 hours indicating that a good degree of student understanding was achieved (versus only 59% of the lecture group.)

Median rating on section A (questions 1, 2, 5, 10, 11) of the evaluation questionnaire (table 13) indicates that the criteria tested (sequencing, explanation, visual presentation and understanding) were within a good range (3 - 4).

With reference to table 5, it can be seen that the lecture group was not only exposed to a traditional lecture, in this comparative experiment, but to an approximate total time of four hours of instruction, with exposure to a commercial film, workbook (see appendix D) and two hours of laboratory session concerned with preparation of material for sterilization.

Interpretation of these results indicated that the videotape approach, in general, met the production and programme objectives (see section 3.2) and enabled students to demonstrate a good level of understanding on the posttest (Table 9), but not necessarily to discriminate among all the material taught (section 6.1). Also, the videotape approach was able to communicate a larger amount of information in a smaller amount of time than the lecture.

Therefore, the results support the hypotheses which are as follows:

H_1 Videotape programmed instruction using viewing guide including objectives, adjunct questions and feedback to teach autoclave sterilization to students meets pre-stated programme objectives and allows students to demonstrate understanding and recall of concepts, facts and principles, explain them without necessarily providing a discrimination among them.

H_2 Videotape programmed instruction using viewing guide including objectives, adjunct questions and feedback communicate a greater amount of information and student understanding within the same amount of time than the traditional approach where a teacher uses verbal explanations, graphics and answers student's questions, a) as measured by the posttest, b) as measured by the pretest-posttest gains.

6.2 A Comparison Between Institutions

Upon examination of the pretest scores for both institutions table 6), it can be observed that the samples within each institution are fairly homogeneous, although not so between institutions. The TIMT control and videotape groups means are 14.16 and 14.08, whereas that of the lecture group is 16.91. For Dawson College the videotape groups means are respectively 8.45 and 9.54. The difference between institutions for the various experimental groups is statistically significant at the .05 level (see table 7).

The investigation of overall performance seems to suggest that on the average the quality of the student registering at TIMT is higher than that of Dawson College. Furthermore, the lecture group mean indicates a general trend of superiority. This could be explained by superior academic aptitude and reasoning ability, as this result seems consistent with previous observations (see table 3 - Summary of Mean Scores Over Four Prerequisite Courses for Each Group), where the mean score of the lecture group is larger than the one of the other groups. Another possible explanation is that a transfer of knowledge took place from other courses whose curricula contained similar or related scientific principles and laws. Also, it must be considered that several Dawson students operate in English as a second language whereas at TIMT English would be the mother tongue of most students.

Upon examination of the posttest scores we find a shift in the results, as the Dawson videotape group mean was 44.8, whereas that of the lecture sample is only 36.36, and as after delayed testing the TIMT videotape mean was 43.75 and the Dawson group was 37.00. These results emphasize the effectiveness of the videotape since superiority is indicated by all videotape treatments independently of testing situation over the lecture group. As the TIMT videotape group scored higher than the Dawson samples it seems appropriate to investigate if entrance capability had any effect on post-treatment performance.

6.3 Effect of Achievement Level in Prerequisite Science Courses on Test Performance

To explore whether or not the entrance level of the students as reflected by their overall achievement in science courses was influential in determining difference in scores, a comparison of mean percentage and raw-score on their pretest-posttest performance with their previous achievement level was done as indicated on tables 15 and 16. Low entrance level delineates students with a 60-75% score-range; and high entrance level delineates students within a 76-90% score-range. No significant difference was recorded on a t-test between high and low achievers performance.

6.4 Cost-Benefit Analysis

Cost-benefit analysis as defined by Wilkinson (1972, p. 35)

> involves the comparison of all the relevant resources (such as dollar value of personnel, equipment, etc...) required to achieve an objective with the likely benefits (dollar value of results) to be obtained from the achievement of the objective

As mentioned previously, the production of the videotape was the only viable alternative to improve the learning process of auto-clave sterilization. Resources (such as equipment, camera, personnel, classroom television monitor, monitor for individual learner) needed to develop and maintain the system were available.

Table 17 exhibits the direct cost involved. Indirect cost (technical man hours) were incurred but are not readily estimated.

TABLE 15

Comparison of Raw Score on Pretest Performance with Entrance Achievement in the Prerequisite Science Courses

	TIMT		DAWSON	
	lecture	videotape*	videotape*	videotape
High Entrance score — Raw score	15.14	15.66	5.5	10.8
High Entrance score — Mean percentage	24.42%	25%	8.8%	17.41%
Low Entrance score — Raw score	20.25	12.5	10.14	8.5
Low Entrance score — Mean percentage	32.66%	20.16%	16.35%	13.70%

TABLE 16

Comparison of Raw Score on Posttest Performance with Entrance Achievement in the Prerequisite Science Courses

	TIMT		DAWSON	
	lecture	videotape*	videotape*	videotape
High Entrance score — Raw score	33.42	45.33	38.75	44.8
High Entrance score — Mean percentage	53.9%	73%	62.5%	72.25%
Low Entrance score — Raw score	41.5	42.16	36.0	44.83
Low Entrance score — Mean percentage	66.9%	68%	58.06%	72.31%

*Posttest administered after 48 hours

The continuing availability of the necessary instructional material to the lecturer, to the individual student and successive classes of students outweigh the production costs.

Also, copies of the material may be reproduced in quantity from the master and made available for training centers. "Autoclave sterilization" is a rather stable content, and therefore the risk of having to redesign for new content, in the near future is not likely to occur. More automatized autoclave will still require the student to know all sequences that do occur when the button is pushed, and to understand the principles. Moreover, transfer of knowledge is facilitated when done from complex to a simpler piece of equipment.

Student's attitude as indicated on the evaluation questionnaire (tables 13 and 14) was in general positive, and exposure to the real equipment during instruction had allowed them to operate the autoclave under supervision (see section 5.6).

To conclude, it seems that the videotape production has solved the instructional problem, and so, since it was educationally justifiable, we can claim that it is economically justifiable as well.

Therefore, the following hypothesis can be accepted:

H_3 The relative benefits resulting from the use of videotape programmed instruction outweigh production cost.

6.5 Summary of the Evaluation of the Videotape Package and Suggestions for Improvement

The students who learned through the videotape package reported as the strongest aspects of the presentation the following: clarity of material, concision, facility in understanding and that in general the demonstration of autoclave sterilization helped them to grasp the material.

The weak points centered around pace in general and mainly in the area related to the diagram of the autoclave and the indicators for sterilization. The labeling of the diagram was also reported as being unclear. Two students found the music distracting and not necessary.

By examining the package in light of the programmed instruction format and media attributes selected, it appears that most of the designer's objectives were met. The majority of the students answered that they would like to continue learning in this fashion "sometimes". They found the use of colour more pleasant than black and white. In general, the selection of the model to communicate skills in preparing, loading and operating the autoclave was felt positively, and students could associate with the model. Two male students felt that the technologist selected as demonstrator looked unexpressionable and uninterested by the whole procedure, and therefore could associate with her. A third one mentioned that he felt ignorant since the demonstrator was too professional whereas he was not. One female student would have preferred a man, and another one did not notice the model as a person as she was concentrating on the technical aspect of the presentation.

Turning now to the use of introductory materials, some students found that outline of content and objectives were very

TABLE 17

VIDEOTAPE PRODUCTION COST

Materials	Cost
Videotape:	
1 inch master (2 tapes)	$ 80.00
videocassette	$ 25.00
Graphics:	
Cardboard and lettering	$ 65.00
Photographs	$ 9.00
Super-8mm film (2)	$ 14.00
Narrator	$ 45.00
Printing	$ 76.00
Transportation (on location Institut Armand Frappier)	$ 26.00
Total	$340.00

useful as a clear indication of the material to be covered. Others found it redundant since the information was given on the monitor at the outset of each sequence and that the sections were well explained.

Concerning programmed format and active student response as well as providing immediate feedback, the great majority of the students found that it was a very good approach towards instruction and enjoyed active participation.

As major suggestions for improving the programme, it was indicated that pace should be adjusted in general and more specifically on section VII of the videotape, and on the autoclave diagram, that the labeling of the autoclave should be larger and that some unnecessary pauses resulted from inadequate timing of the visuals within two areas of the production should be eliminated.

At the end of the evaluation questionnaire students were asked to list any questions they might have on autoclave sterilization. The following were mentioned: information on the historical background of the autoclave, from the origin to what it is known presently; what would happen in case of power failure in the middle of the sterilization process; explanation of the hot air oven; the possibility of reviewing the sequence related to the selector position; further explanation of the chemical indicator; repetition of the order in which the valves are turned on.

Since the students found (Evaluation questionnaire, Section C, question 5) that the main positive aspect offered by the traditional lecture instead of the package approach, was the possibility to ask questions; another suggestion for an ideal learning situation would then be to have the programme followed by a discussion session where the teacher could bring clarification and emphasize key areas if needed.

6.6 Conclusion

The main hypotheses of the experiment predicted that the videotape approach would be more effective and more time-efficient than the traditional lecture approach. The results have shown that these hypotheses hold true for the TIMT and Dawson student samples. Due to the diversity of both samples in socio-economic background and apparent intellectual ability they could be considered as representative of a large portion of the student population in this curriculum area.

The expectation that the design procedures selected would profit this student population seems in general realized and follows Allen's observation (1975, p. 164)

> The great body of research done on media design factors probably pertains to middle ability group, and it points clearly to the efficacy of use of such instructional procedures as eliciting student participation and response, furnishing of feedback and knowledge of results, directing of attention to relevant cues essential to learning, and using repetition and redundancy in the presentation of material to be learned.

Other aspects of production design such as the use of preparatory procedures that introduce the learner to the subsequent material (objectives, outlines), internal structuring of the content to guide the learning process (logical sequencing, headings or subheadings), motivation procedures to arouse or motivate the learner (motivation devices, use of colour) were also employed. The compilation of results (evaluation questionnaire) seems to support findings and theory that recommend their use. (Allen, 1975).

However, it seems also important to look closely at one of the weak areas in the design elements. As pointed out by Gropper and Kress (1965) in programmed instruction, a fast tempo or pacing of presentation impedes learning by low ability students. If in spite of the pace students were able to process a great deal of information, the stress thus created may have deterred them in their learning process.

Turning now to the experiment, certain threats to the internal validity have already been mentioned (section 4.7) and the problem of maturation can be raised considering the more complete, longer but spaced training of the lecture group.

In conclusion, this experiment demonstrated that the use of programmed instructional visual material and adjunct material on autoclave sterilization can be a valuable means to teach students. After appropriate revisions, as noted above, it could be made available to other CEGEPs offering similar programms (particularly since copyright and permission resides with the present author).

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APPENDIX A

Pilot Study:

Results derived from student evaluation questionnaire

TABLE 18

Pilot Study: Summary of Answers to Questions 1 and 2 on Evaluation Questionnaire

QUESTION 1 Name one or more characteristics that you would consider as the strongest points of this package	QUESTION 2 Name one or more characteristics that you would consider as the weakest aspects of this package
All characteristics are strong points in my opinion = presentation, explanation, etc...are excellent	If I have to choose a weak point I would say that pacing still has to be adjusted but otherwise everything is very well done
The diagrams and flow of steam showed in the videotape were excellent	I found marking of autoclave hard to read
Very well organized with very clear animation that helps to get the message across	A few pauses that occur could be eliminated (3)
Demonstration and diagrams	It was a bit slow paced. I really could not comment on the form as a first learning experience since the material was all basically familiar
The viewing guide is very good. Having questions asked immediately after and then corrected helps to reinforce points that might otherwise be forgotten (2)	Certain important points were made fast.
The review sections were very helpful and allow you to see where you went wrong and correct it	Music, repetitive music at end of each section
Can arouse the interest and lead to a better understanding of the autoclave mechanism than just a plain lecture	A little too long for one stretch

TABLE 19

Pilot Study: Median Rating and Range of Questions 1 - 12

(Section-A, Videotape Evaluation) on Evaluation Questionnaire

QUESTIONS	MEDIAN RATING	RANGE
1. Is the material explained in the right order?	5	4 - 5
2. Are information clear and well explained?	4	3 - 5
3. Pacing.	3	2 - 5
4. Clarity of voice (narrator)	4	3 - 5
5. Selection of visual representation	4	3 - 5
6. Schematic representation of autoclave and labeling	4.50	3 - 5
7. Selection of technologist and identification	4	3 - 5
8. Quantity of music during representation	3	1 - 5
9. Selection of music as indicative of review section	3.00	1 - 4
10. Amount of interest generated	4.00	3 - 5
11. Student understanding	4.00	3 - 5
12. Selection of colour as opposed to black and white	5	3 - 5

(scale ranged from 1 - 5)

TABLE 20

Pilot Study: Median Rating and Range of:
Questions 1 - 4, Section B (Viewing Guide Evaluation)
Questions 1 - 2, Section C (General Information)
on Evaluation Questionnaire

QUESTIONS	MEDIAN RATING	RANGE
Section B		
1. Clarity of presentation	4.5	3 - 5
2. Part I of each section: content and objectives	3.5	1 - 5
3. Questions clarity and usefulness	4.0	3 - 5
4. Need for answer sheet within the viewing guide	5	4 - 5
Section C		
1. General Rating of the videotape package	4	4 - 5
2. Would you like to continue learning in this fashion	4	3 - 5

(scale ranged from 1 - 5)

TABLE 21

Pilot Study: Summary of Questions 4 and 5 (Section E) on Evaluation Questionnaire

4. What are the positive aspects that this videotape package offers in comparison to the traditional lecture session.	5. What are the positive aspects that the traditional lecture session offers in comparison to this method.
- More interesting and more easily understandable (2)	Ability to stop and ask questions (3)
- It shows you exactly how to operate an autoclave.	Not as rigid.
- More complete.	Questions can be answered by a lecturer, whereas a machine cannot.
- It tests comprehension immediately. Since the answers are given at the end of each section, the student recall and understanding level are monitored by him.	Faster.
- It coordinates audio and visual learning, therefore reinforces the learning process.	Not as tedious in some ways, but then means must do more study and reviewing of it on own time later.

TEACHER'S GUIDE

The videotape package on "Autoclave Sterilization" will teach students about the basic concepts and principles of autoclave sterilization, as well as the mode of operation and the standardization of the sterilization procedures. It is divided into 7 sequences:

1. Principle of moist heat sterilization;
2. Autoclave principle and description;
3. Operation;
4. Efficiency of autoclave sterilization;
5. Load arrangement and preparation;
6. Sterilization cycles;
7. Autoclave controls and sterilization indicators.

For effective learning, the viewing guide provided with the videotape must be used by the student during the viewing session. Following the introductory instructions, the student is requested to read Part A of each section of the guide before viewing the related sequence. This will familiarize her/him with the content and will indicate what she/he is expected to know at the end of each sequence.

When the sign "Stop - Review Section 1 .." appears on the monitor, she/he should then stop the videotape, answer the questions within the guide, check her/his answers and read Part A of the following section.

This package is designed for Medical Laboratory Technology students having little or no background in autoclave sterilization.

Since this material is in the form of programmed instruction, it can be used for individual learning or classroom instruction. For the purpose of this study, it will be used for classroom instruction. The material is first presented on the videotape under the heading "Instructions for the user", this includes explanations of the sequencing of the programme and indicates the specific objectives to be mastered at the end of the presentation.

APPENDIX B

Instructional Package

a) Teacher guide

b) Glossary

c) Viewing guide

d) Script "Autoclave Sterilization"

MATERIALS PROVIDED

1. Pretest to be administered the day before viewing.
2. Glossary to be read by the student before viewing time, and handed to the student after the pretest.
3. Videotape programme "Autoclave Sterilization".
4. Viewing guide to be used during the viewing.
5. Evaluation questionnaire to be completed at the end of the presentation.
6. Posttest to be administered half an hour after the viewing, unless time constraints necessitate postponing it for a later time, not exceeding 2 hours.

INSTRUCTIONS

1. In order to repress any anxiety that could be associated with the administration of the pretest, students should be informed that no marks will be given for it, and that it is only used as a means to observe their actual knowledge of "Autoclave Sterilization".
2. Since this videotape package will be used for the purpose of this study in a classroom situation and not in individual learning situation, the classroom teacher or instructor will therefore begin the tape and turn it off at the appropriate time during the presentation.

3a. Teacher's recorded observations of student's reactions and attitude during viewing would be very useful for the designer of the programme.

b. Also, if subsequent activities during the week or later on include autoclave sterilization procedures, the attitude of students exposed to the videotape versus other students should be recorded as an indication of the positive or negative effect of the package.

4. The following time chart recorded during the pilot study can be used as a guide.

TIME CHART
(Pilot Study)

Time Alloted:

Pretest = 30 minutes

Posttest = 30 minutes (completed during pilot study in 20-25 minutes)

Evaluation questionnaire: 10-15 minutes

VIDEOTAPE PACKAGE

	Videotape Presentation	Approximate time spent with viewing guide	Total Time
Instructions for the user	2:20	3 min.	5:20
Section 1	3:25	7 min.	10:25
Section 2	3:47	13 min.	16:47
Section 3	3:07	9 min.	12:07
Section 4	3:30	10 min.	13:30
Section 5	6:46	15 min.	21:46
Section 6	5:16	8 min.	13:16
Section 7	2:32	8 min	10:32
TOTAL TIME	30 min. 43"	73 min.	1 hour 43' 43"

GLOSSARY

Ebullition -boiling

Kraft Paper -Coarse paper made entirely from wood pulp produced by an alkaline process. This paper when unbleached has a brown color. By using semibleached or fully bleached sulfate pulp, it can be produced in lighter shades of brown or white. It is used primarily as a wrapping material.

Latent Heat Refers to the amount of heat gained or lost by a substance, without an accompanying change in temperature during a change in state (e.g. solid to liquid, or liquid to gas, or vice versa).
One calorie is the amount of heat required to raise the temperature of 1 gram of water 1°C. It takes 100 calories to raise the temperature of water from 0°C to 100°C and it takes 540 calories to convert the water (at 100°C) to steam at 100°C. Therefore, steam has available alot of heat energy gained as it went from water to steam. The 540 calories is known as the latent heat of vaporisation of water or simply the latent heat of steam.

Monel Metal Trade Mark. Corrosion resistant alloy mainly consisting of nickel and copper.

Thermocouple A device used for measuring temperature differences. The function of a thermocouple depends on the following phenomenon: when two different metals (or alloys of metals) are joined at both ends and the temperature is the same at both junctions, nothing much happens in the circuit. When one of the junctions between these 2 wires is heated or cooled creating a change in temperature at one junction, an electromotive force is generated and an electric current flows within the circuit. [It appears that the joining process disturbs atomic orbits at this point so that outer electrons in both metals are but loosely held. Any small addition or subtraction of energy will set them free.] The amount of electromotive force (EMF) is proportional to the temperature difference between the two junctions, and can be used to measure temperature changes by connecting a potentiometer into the thermocouple circuit.

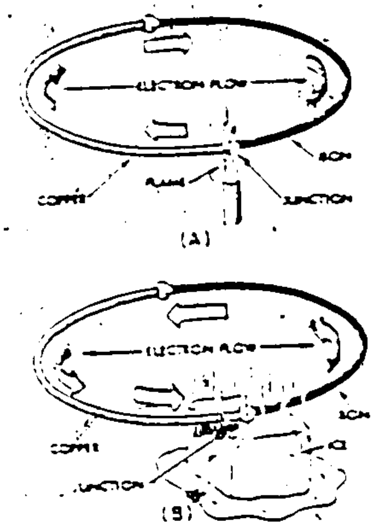
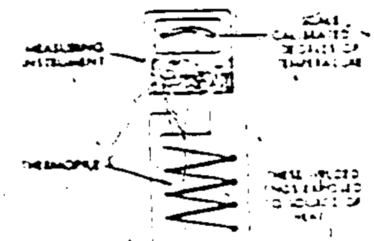


Fig. 1 . The operation of a thermocouple is illustrated here. In (A), heat creates a current flow. In (B), cooling results in a current flow opposite to that created by heat.

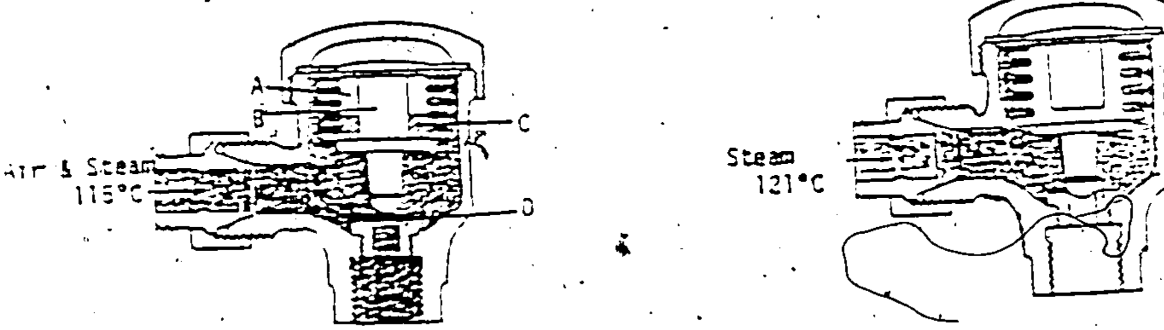


Thermostatic Valve Also know as thermostatic steam trap, is located on the discharge line and allows air and water, but not steam to pass through to waste. As long as air or condensed steam enters the trap, the water in the bellows remains liquid and the bellows remains contracted against the stop, leaving the orifice wide open for free discharge. Air and condensate can then pass through to waste.

When pure steam enters the trap, the water in the bellows vaporizes and the consequent rise in pressure extends the bellows and closes the orifice, the valve is then shut.

This thermostatic element is extremely sensitive and throughout sterilization, as condensate or air pockets gravitate to the valve, it will open slightly until the cooler fluid has been discharged.

Fig. 2. Longitudinal Section of a balanced Thermostatic Steam Trap



A. - evacuated metal bellows C - water

VIEWING GUIDE

AUTOCLAVE STERILIZATION

INSTRUCTIONS

1. This viewing guide will help you learn from the videotape "Autoclave Sterilization". It is divided into seven sections corresponding to those of the video-tape.

2. Each section of the viewing guide is divided into three (3) parts

   i) the first part consists of an outline of the section, and a list of objectives indicating what is expected from you at the end of this presentation. This is done in order to guide you during the learning of the section

   ii) the second part consists of review questions on the content of the section. This will indicate to you how much you have learned from the programme.

   iii) the third part provides you with the correct answers. This will help to assess your understanding of the material.

   NOTE: Do not check the correct answers before completing your questionnaire. No marks are allocated for the complet-ion of the questionnaire, you are your own evaluator.

3. Procedure:

   The procedure for each section is as follows:

   i) read PART 1 of the appropriate section before turning on the video-tape.

   ii) view the section

   iii) turn off the monitor when the sign "STOP - REVIEW SECTION 1 or 2 ......" shows on the screen and answer PART 2.

   iv) after completion of PART 2, turn the following page of your viewing guide and check the correct answers.

   NOTE: Repeat the procedure till the end of the programme.

4. Evaluation Questionnaire:

   After completion of the programme, fill in the "Evaluation Questionnaire" and hand it in to your instructor.

5. Testing:

   You will be tested on your knowledge on autoclave sterilization within 30 minutes.

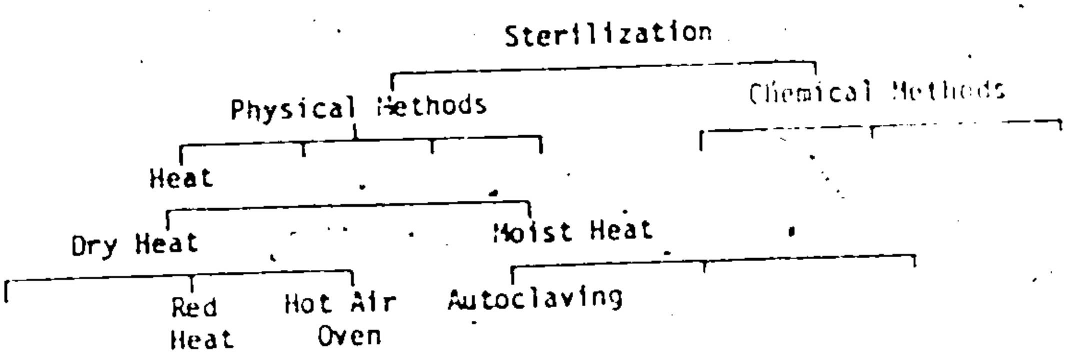
INTRODUCTION

Before starting this programme, you should have been taught that: control of microbial population and sterilization can be achieved by physical and chemical methods.

Among the physical methods regularly employed, one of the most important is "heat", that can be divided into "moist heat" and "dry heat"..

From the following diagram, you will notice where autoclave sterilization stands in microbial control.

MICROBIAL CONTROL TECHNIQUES



SECTION I:

Part 1: Read this part before starting Section I of videotape.

Content:

-Definition of Sterilization
-Principle of moist heat sterilization
-Principle of dry heat sterilization
-Characteristics of steam that favors sterilization process

Educational Objectives:

1. Define in your own words, the term "sterilization" as applied to microbiology, and include a list of the microorganisms concerned.

2. Name the type of moist heat that is considered the most dependable method of destroying microorganisms.

3. a) State in your own words the principle of moist heat sterilization and that of dry heat, and give an example of each.
   b) List two characteristics of steam which render it a more effective sterilizing agent than dry heat.
   c) Briefly explain, using your own words, how the temperature of the articles being sterilized is raised to that of the steam.

4. State which of the two physical methods of destroying microorganisms (moist heat and dry heat) will bring about bacterial destruction at a lower temperature.

Part 2: Review of Section I

Complete this part after viewing Section I.

Complete the following statements with the correct words:

1. In microbiology, a sterile object is one that is free of ______ and their ______, ______, ______, and their ______ ______.

2. Moist heat sterilization, which makes use of ______ is provided by the autoclave and is considered the most dependable method of destroying microorganisms.

3. According to the principle of moist heat sterilization, microorganisms are destroyed by ______ whereas dry heat sterilization is based on a/an ______ process.

POOR COPY

4. a) Indicate which of the two methods (moist heat and dry heat) is the more effective, that is, will bring about bacterial destruction at a lower temperature.

   ____

   b) Name two characteristics of the agent used in autoclave sterilization that justifies your answer.

   i) ______________________

   ii) ______________________

5. Indicate which of the following occur during steam sterilization by circling the letter in front of the correct statement.

   a) Following contact with articles, steam liberates heat and automatically brings their temperature up to that of steam.

   b) Following contact with colder articles, steam condenses providing water and raises their temperature to that of steam.

   c) By condensing into water following contact with colder articles, latent heat is liberated and a vacuum is created, attracting more steam; the process continues till the temperature of the articles are raised to that of steam.

   d) By condensing into water following contact with a colder article, a vacuum is created that kills bacteria and raises the temperature of steam.

   e) As the water formed (when steam condenses following contact with a colder article) is a poor conductor of heat, the remaining dry heat produces a rise in temperature of the article.

N.B. AFTER COMPLETION OF THIS SECTION, TURN TO THE NEXT PAGE TO CHECK YOUR ANSWERS.

ANSWER SHEET FOR REVIEW OF SECTION I:

1. Bacteria and their spores
   -viruses
   -fungi and their spores

2. Saturated steam under pressure

3. Protein coagulation
   Oxidation process

4. a) moist heat
   b) i) liberation of latent heat
      ii) penetrating power

5. C

SECTION II:

Part 1: Read this part before Section II starts:

Content:

-The working principle of the autoclave
-Demonstration and explanation
-Identification of the different parts of the autoclave

Educational Objectives:

1. Explain in your own words, the principle of autoclave sterilization using the following guidelines:
   a) a brief explanation of how the temperature of the steam employed is raised beyond 100°C
   b) amount of extra pressure necessary to provide the steam temperature required.
   c) temperature required for sterilization
   d) one factor which prevents the temperature rise.

2. Provided with a diagram representation of the autoclave, identify and label each part.

3. State the purpose of each identified part.

Part 2: Review of Section II

Complete the following statements with the correct words or phrases.

1. State the steam temperature required for sterilization.

____

2. State the pressure above sea-level necessary to obtain this rise in temperature.

____

3. State the working principle of the autoclave that meets the above conditions.

____
____
____

4. State one factor which prevents the temperature rise necessary for autoclave sterilization.

____

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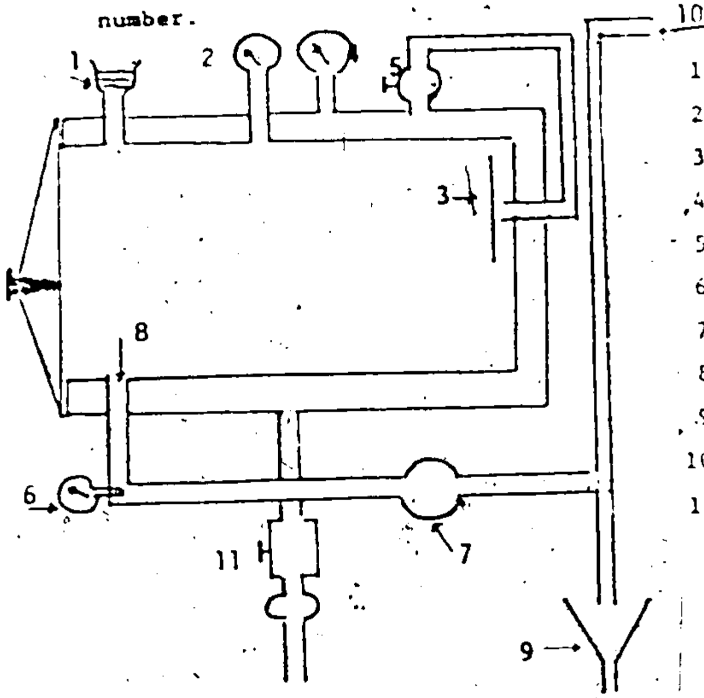
5. In the diagram of autoclave, there are numbered parts. Enter the name of the appropriate part in the space corresponding to each number.



1. ______
2. ______
3. ______
4. ______
5. ______
6. ______
7. ______
8. ______
9. ______
10. ______
11. ______

6. Indicate the correct answer in the space provided.

The operating valve:

a. allows steam to enter the jacket
b. allows air to penetrate the chamber
c. pushes steam towards the exit channel
d. allows steam to leave the jacket and enter the chamber
e. removes condensation formed within the jacket

______

7. State the reason why the thermometer is placed at the discharge channel.

______
______
______
______
______
______

N.B. AFTER COMPLETION OF THIS SECTION, TURN TO THE NEXT PAGE TO CHECK YOUR ANSWERS.

ANSWER SHEET FOR REVIEW OF SECTION II:

1. 121°C

2. 15 lbs/pressure/square inch (psi)

3. The principle of the autoclave depends on the fact that as the water is boiled in a closed chamber, the temperature at which water boils and of the steam it generates is increased.

4. presence of air

5. 1. air intake
   2. chamber pressure gauge
   3. deflector (baffle plate)
   4. jacket pressure gauge
   5. operating valve
   6. thermometer
   7. thermostatic valve
   8. discharge channel
   9. drain
   10. exhaust pipe
   11. pressure regulator

6. d

7. To measure the effectiveness of air discharge. As the temperature of pure steam is 121°C, any air present with steam will lower this temperature and indicate that the required sterilizing condition is not met.

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SECTION III: OPERATION

Part 1: Read this part before starting section III of video-tape.

Content: Diagram representation of operation.

-penetration of steam into autoclave chamber
-automatic internal control
-re-admission of air

Educational Objective:

1. Indicate the direction of the flow of steam (starting from the main steam line) through a diagram representation of the autoclave by placing arrows directly on the diagram.

2. Explain in your own words the gravity displacement method of removing air from an autoclave using the following guidelines.

   a. principle on which this method depends
   b. area of the chamber which is thr hottest
   c. location of the steam outlet through which air leaves the autoclave

3. List in sequential order the different steps happening within the autoclave after the penetration of steam into the chamber.

4a. State the criterion of autoclave sterilization that is satisfied when the thermometer indicates 121°C

b. Briefly explain in your own words two mechanisms that occur automatically within the autoclave when this criterion has been met.

5. With reference to the displacement of air within the autoclave, explain in your own words why the temperature is taken at the steam outlet.

6. List in sequential order the events occuring within the autoclave after exposure of articles to saturated steam for the required time (that is at the end of the sterilization period.)

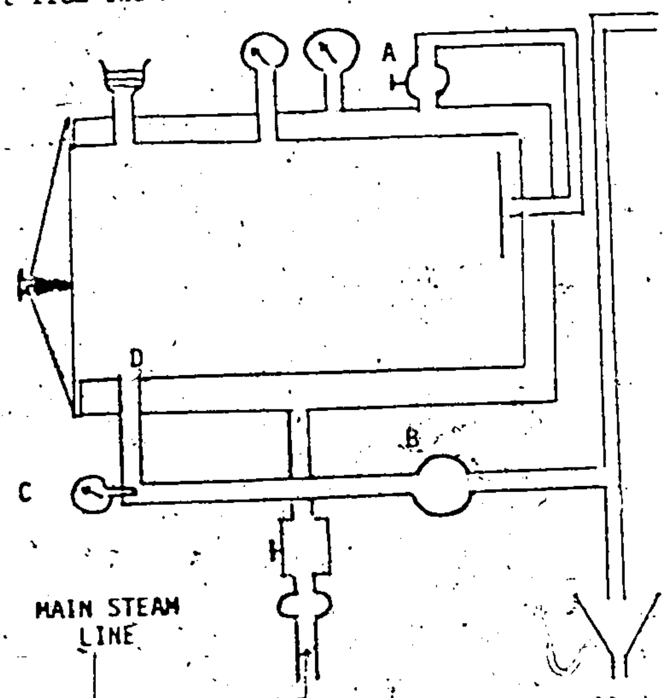
Part 2: Review of Section III

Complete the following statements with the correct words.

1. As steam leaves the jacket and enters the chamber, air is removed by ______________. Since the density of steam is ______________ that of air, steam tends to remain at the top. This explains why the temperature at the top of the chamber is the ______________.

[POOR COPY]

2. Indicate the direction of the flow of steam through the system by plating arrows directly on the diagram.
Start from the main steam line.



3. State the name of the autoclave devices labelled:

A. ______________________________

B. ______________________________

C. ______________________________

D. ______________________________

4a. Briefly describe the mechanism that occurs in B at the same time that the thermometer indicates 121°C

____

____

b. Briefly explain in your own words why the temperature is taken at the steam outlet.

____

____

____

5. The following events occur within the autoclave after the correct exposure to steam under pressure. Number them in the correct sequence:

_____ reduction in pressure follows

_____ unlocking of door

_____ entry of sterile air through filter

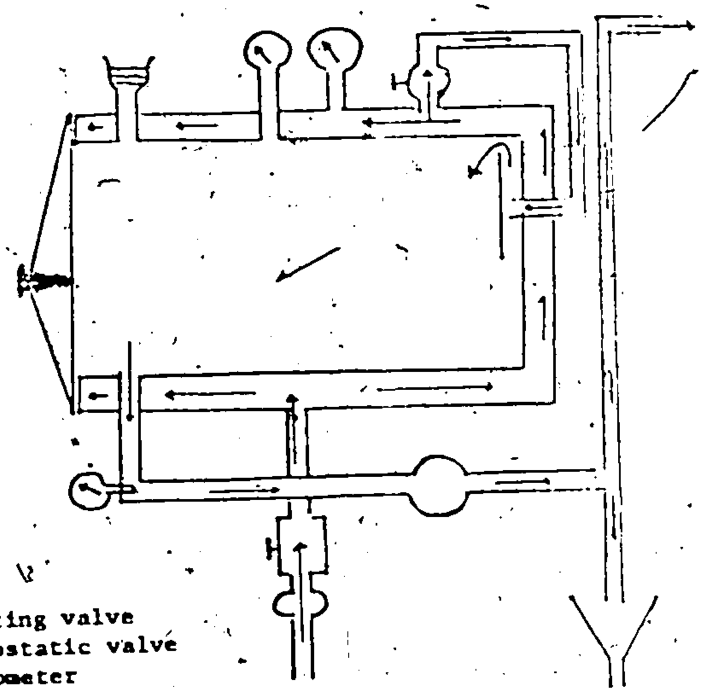
_____ closure of operating valve

_____ release of steam through the exhaust pipe

ANSWER SHEET FOR REVIEW OF SECTION III

1. gravity displacement
   half
   hottest

2.



3. A. operating valve
   B. thermostatic valve
   C. thermometer
   D. Discharge channel

4a. A thermostatic element withing the valve expands and closes the orifice when pure steam (following the flow of air, and air-steam mixture) comes in contact with it. As the temperature of pure steam at 15 psi is 121°C, the thermometer placed on the discharge channel will indicate this temperature at the same time that the thermostatic valve closes.

b. The thermometer is located on the steam outlet to indicate the complete discharge of air. If air and steam are mixed the temperature will be lower than that expected for pure steam at the same pressure.

5. 3. reduction in pressure follows
   5. unlocking of door
   4. entry of sterile air through filter
   1. closure of operating valve
   2. release of steam through the exhaust pipe

SECTION IV:

Part 1: Read this part before starting Section IV of the video-tape.

Content:

-factors affecting the efficiency of autoclave sterilization ..

Educational objectives:

1. List the requirements upon which the efficiency of autoclave sterilization is dependent.

2a. Distinguish saturated, superheated and supersaturated steam with reference to efficiency during the sterilization process.
 b. State one cause for the production of superheated steam.

3a. State the time required to kill vegetative cells as opposed to spore forms when exposed to saturated steam.
 b. Mention one reason that attributes to the higher resistance of spores to heat.

4. Name one factor that will affect the autoclave sterilization temperature, even though saturated steam is admitted under 15 lbs/sq. inch pressure.

Part 2: Review of Section IV

1. List the requirements upon which the efficiency of autoclave sterilization is dependent.

   A. ______________________ C. ______________________

   B. ______________________ D. ______________________

2. Distinguish the following with reference to their effectiveness as sterilizing agents and using knowledge acquired in Section 1.

   A. Saturated steam: ______________________

   ____

   ____

   ____

   B. Superheated steam ______________________

   ____

   ____

   ____

   C. Supersaturated steam: ______________________

   ____

   ____

   ____

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3. State the time necesary to kill:

   a) vegetative cells ____________________

   b) spore cells ____________________

4. Mention one reason that could be used to explain the higher resistance of spores to heat.

   ____

   ____

   ____

5. Name one factor that will affect the autoclave sterilization temperature even though saturated steam is admitted under 15 lbs/sq. in.

N.B. AFTER COMPLETION OF THIS SECTION, TURN TO THE NEXT PAGE TO CHECK YOU ANSWERS.

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ANSWER SHEET FOR REVIEW OF SECTION IV

1. A. Saturated steam
   B. Complete removal of air
   C. Time and temperature
   D. Careful loading

2a. Saturated steam refers to water vapor, its efficiency as a sterilizing agent is due to its condensation accompanied by liberation of latent heat and moisture.

b. Superheated steam implies that due to a rise in temperature and subsequent fall in moisture, condensation cannot occur. Steam is unsaturated and dry, its efficiency as a sterilizing agent is no better than hot air.

c. Supersaturated steam refers to wet steam, that is, steam that carries droplets of condensation. Its efficiency is reduced as droplets will saturated fabrics and hinder the penetration of steam.

3a. 1 minute

b. 10-12 minutes

4. The higher resistence of spores to saturated steam is partly attributed to their low content of water. (by opposition to vegetative cells.)

5. presence of air

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SECTION V:

Part 1: Read this part before starting Section V of videotape

Content:

1. Preparation and loading of the following articles for autoclave sterilization.
   - surgical packs
   - empty and dry containers
   - Seitz filters
   - liquid culture media

2. Articles impervious to steam should be sterilized in the hot air oven.

Educational Objectives:

1a. State upon which criterion the placing of the load is dependent.

b. Basing your answer on this criterion, state how packs or other material should be placed within the autoclave chamber

2a. State the maximum size of dressings acceptable for autoclaveing.

b. State the time of exposure for this type of pack

3. Briefly describe in your own words:

   a) how empty containers or tubes to be sent for autoclave sterilization should be stoppered.

   b) how they should be placed in the autoclave and why.

4. List articles that should not be sterilized in the autoclave, but in the hot air oven and state why.

5a. Briefly describe the preparation of Seitz filters for autoclave sterilization.

b. State the sterilization time that can be withstood by Seitz and membrane filters.

6. With reference to sterilization of culture media:

   a) state the maximum volume of culture media within containers and why they should not be filled to capacity.
   b) state a reason for covering cotton wool stoppers with Kraft paper.
   c) state the location of sterilization in dicators within the chamber

7. List the 3 characteristics that should be taken into consideration for selecting the proper sterilization time of culture media.

8a. State the reason why ebullition of culture media does not occur during sterilization at 121°C.

b. State the precaution to be taken during the cooling period to avoid ebullition.

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9a. State the safety standard time of sterilization.

b. State how the total holding time is calculated.

10a. Provided with schematic representations of load arrangement, indicate the correct one.

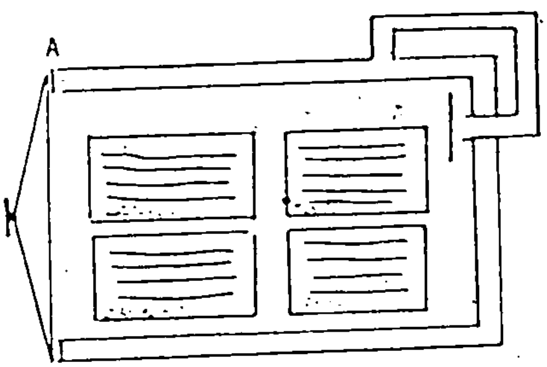
b. Given a list of articles not necessarily mentioned in the videotape, select for each of them the appropriate heat technique from the following:

Red heat, hot air oven and autoclave.

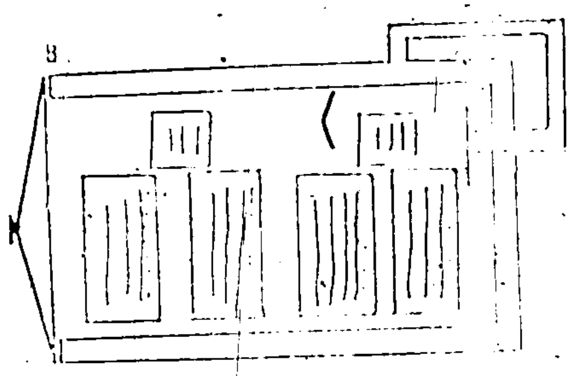
Part 2: Review of Section V

1a. Indicate the correct loading of surigical dressings by circling the appropriate letter.

A



B



b. State the reason why you selected it.

____

____

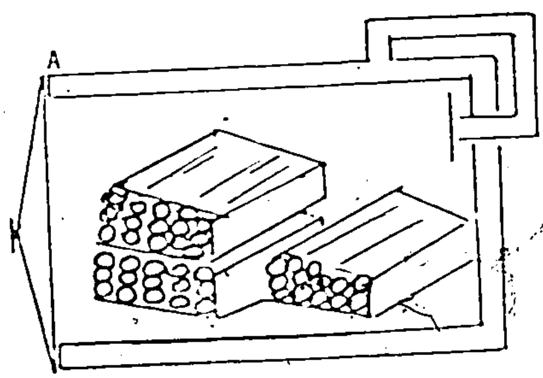
____

c. State the size of the largest acceptable pack of surgical dressing, and the time required for sterilization.

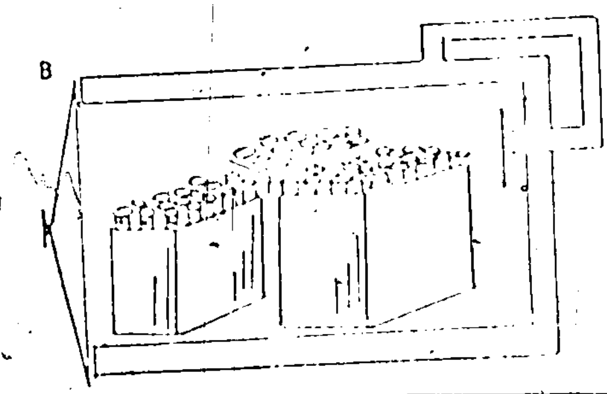
______________________; ______________________

2a. Indicate the correct placing of screwcap tubes in the autoclave by circling the appropriate letter.

A



B



2b. State the reason why you selected this arrangement;

____

____

c. State how the screw cap should be stoppered and why.

____

____

____

d. State a possible reason why these tubes are sterilized in the autoclave and not the hot air oven.

____

____

____

3. A list of articles each identified by a number is given below. Place the letter corresponding to the appropriate method of sterilizating in the space provided.

1. oil	____	A.	Autoclave
2. Seitz filter	____	B.	Hot air oven
3. grease	____	C.	Red heat
4. glass petri plates	____		
5. rubber tubing	____		
6. talc	____		
7. membrane filter	____		
8. rubber gloves	____		
9. inoculating loop	____		

4. Complete the blanks with the correct words or phrases.

For the sterilization of aqueous solution:

a) bottles should not be filled to more than ____% of their capacity

b) Cotton wool stoppers should be covered with ______________ to ______________.

c) Sterilization indicators are placed ______________________________

____

d) Sterilization time of culture media varies according to ______________, ______________, and ______________ of the containers used.

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5. Calculate the holding period of a load where the penetration time has been estimated to be 15 min.

6. State the reason why ebullition of culture media does not occur during sterilization at 121°C.

NB. AFTER COMPLETION OF THIS SECTION, TURN TO THE NEXT PAGE TO CHECK YOUR ANSWERS.

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ANSWER SHEET FOR SECTION V

1a. B

b. As air gravitates downward, they should be placed on edge to that the layers of cloth are vertical. This way, no resistance will be offered to the evacuation of air and passage of steam.

c. 12 X 12 X 20 inches - 30 minutes

2a. A

b. to allow a horizontal path to the entry of steam and escape of air.

c. screwcap should be loosened to allow penetration of steam

d. presence of rubber liner inside the screw cap

3. 1. B 5. A 9. C

2. A 6. B

3. B 7. A

4. B 8. A

4a. 75%

b. Kraft paper, to avoid drenching of cotton wool stoppers during sterilization

c. At the bottom of the chamber where air tends to collect (therefore the coolest part)

d. size, shape and thickness

5. 30 minutes

6. Ebullition of culture media does not occur during autoclave sterilization at 121°C because of the steam pressure maintained in the chamber.

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SECTION VI

Part 1: Read this part before starting Section VI of the videotape.

Content:

-Sterilization cycles
-Manipulation
-Processing

Educational Objectives:

1a. List in sequential order the 4 stages of the sterilization cycle

b. Briefly describe in your own words each of them and include:

i) the general purpose of the 4 different position of the selector
ii) the appropriate time to initiate heating-up of the jacket

2. State the criterion used to determine the start of the holding period.

3. State what will happen if the temperature falls below 121°C during the holding period in an autoclave equipped with a cyclomatic control system.

4. Given a list of articles to be autoclaved, select the appropriate position of the selector for each of them.

Part 2: REVIEW OF SECTION VI

1. List in order the 4 steps of the sterilization cycle:

i) ________________
ii) ________________
iii) ________________
iv) ________________

2. A list of articles each identified by a number is given below. Place the letter corresponding to the appropriate position of the selector in the space provided.

1. distilled water in Erlenmeyer ____
2. surgical instruments ____
3. culture medium containing agar ____
4. rubber tubing ____
5. surgical pads ____
6. tubes with rubber liner inside the screwcap ____

Select position

a) dry
b) fast exhaust
c) slow exhaust
d) manual

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3a. The steam supply valve allows steam to enter the ______________________.

b. Indicate the correct answer by placing the letter in front of the correct statement on the space provided.

_______ The steam supply valve

a. should be kept open during the whole day
b. should always be closed during sterilization time in the chamber
c. should be closed between successive sterilization sessions
d. does not need to be turned off at the end of a working day because it automatically closes
e. none of the above

4. The operating valve allows steam from ______________________________

to enter the ______________________________.

5. State the criterion used to determine the start of the holding period.

____

____

6. If the temperature falls below 121°C during the sterilization period of a cyclomatic control autoclave.

a. the process should be stopped, the material cooled and the process repeated for a shorter period
b. an alarm sound to indicate a problem in the process
c. the process stops automatically, and a green light will come on
d. the timer resets itself to the starting position of the selected exposure period.

N.B. AFTER COMPLETION OF THIS SECTION, TURN TO THE NEXT PAGE TO CHECK YOUR ANSWERS.

ANSWER SHEET FOR SECTION VI

1. i) heating up
   ii) holding
   iii) cooling
   iv) drying

2. 1. c
   2. b
   3. c
   4. b
   5. a
   6. b

3. a) ____________ jacket

   b) a

4. jacket, the chamber

5. When the thermometer in the discharge channel indicates 121°C

6. d

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SECTION VII

Part 1; Read this part before section VII starts.

Content:

-built-in autoclave control
-chemical sterilization indicators
-Biological indicators

Educational Objectives:

1. List tow autoclave controls

2. List two chemical indicators and indicate change in color following effective sterilization procedure and state their reliability.

3a. Write without spelling mistakes the name of the microorganism used as a control for autoclave sterilization

b. state if used in the vegetative or spore form

c. describe in point form, the manipulation necessary to check the viability of the organism

d. state the incubation temperature required for this organism.

4. State where sterilization indicators are placed during the sterilization process.

5. Given the information provided in the videotape for assessing the sterility of the load through examination of biological and chemical indicators, deduct one disadvantage of the biological indicators even if more accurate.

Part 2: Review of Section VII

1. List the two autoclave controls

i) ____________________

ii) ____________________

2. List two chemical indicators and indicate their change in color

i) ____________________

ii) ____________________

3a. Write the name of the biological indicator
b. state the developmental stage of this organism that is used as an indicator, and why this stage has been selected.
c. briefly describe the method used to check its viability, and, state the incubation temperature required.

a. ____________________

b. ____________________

____

c. ____________________

____

4. State the proper locations of sterilization indicators within the chamber.

____

____

____

5. State one disadvantage of the biological indicator as compared to chemical indicators.

____

____

N.B. AFTER COMPLETION OF THIS SECTION, TURN TO THE NEXT PAGE TO CHECK YOUR ANSWERS

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ANSWER SHEET FOR QUESTION VII

1. a) graphic time recording thermometer

   b) thermocouple

2. Bowie Dick tape turning from colorless to black

   Browne's tube turning from red to green

3. a) Bacillus stearothermophilus

   b) spore state, due to the higher resistance of spores to heat, this being due to their smaller content of water that vegetative cells.

   c) their viability is checked by inoculating the paper strips impregnated with spores within culture medium and incubation at 55°C.

4. a) Sterilization indicators should be placed in the more densely packed items of the load

   b) At the bottom of the chamber where air tends to collect.

5. Following autoclaving, immediate result of sterility is provided by observing color change in chemical indicators whereas a minimum of 48 hours incubation is necessary to asses the viability of the biological indicator.

TELEVISION SCRIPT

	Video.	Audio.
1.	(title) Instructions for the user KEYED IN TC slide #1 (Autoclave)	
2.	MS (Technician loading autoclave)	You will learn from this videotape all that should be understood by the person responsible for the operation of the autoclave and the standardization of the sterilization procedure.
3.	CU (on viewing guide) SLOW ZOOM OUT (to include pencil and questionnaire)	Do you have a viewing guide, a pencil and an evaluation questionnaire?
4.	ZOOM OUT TO MS (student opening viewing guide)	Do not proceed with the tape without any of these. Your instructor will provide you with any material that is missing, and will answer any questions you might have.
5.	MS (student reading in viewing guide)	Now turn off the videotape and read carefully the first page of your guide "Instructions for the user" as well as the "Introduction" then turn on the monitor for further instructions.
6.	TC (slide #2 - Autoclaves) KEYED IN Graphic #1 (Stop Review Section)	Now keep in mind that this programme is divided into seven sections. At the end of each section when this sign appears on the monitor, stop the videotape and answer questions within your guide, under Part II of each section.
7.	Graphic #2 (Sterilization chart) KEYED IN	By now, you should know that sterilization can be achieved by physical and chemical methods. By observing the following diagram you will remember where autoclave sterilization stands.

	Video	Audio
8.	Graphic #3 (Autoclave diagram)	At the end of this presentation you should be able:
		To state the principle of moist heat sterilization and compare it with dry heat.
9.	Heading #1 KEYED IN	
10.	Heading #2 KEYED IN	To identify the different parts of the autoclave and state its principle.
11.	Heading #3 KEYED IN	As steam penetrates the chamber, you should be able to explain the entire process in a sequential order.
12.	Heading #4 KEYED IN	And in addition, list the 4 factors upon which the efficiency of autoclave sterilization is dependent.
13.	Heading #5 KEYED IN	Provided with a list of articles, you should be able to select the appropriate sterilization technique and arrangement of the load.
14.	Heading #6 KEYED IN	Finally after listing the four stages of the sterilization cycles, you should be able to describe the characteristics of the sterilization indicators.
15.	Heading #7 KEYED IN	
16.	Graphic #3 (Autoclave diagram)	We are now ready to begin, turn off the videotape and read Part I of Section I.
17.	TC slide #3 (Autoclave door) KEYED IN Title (Autoclave Sterilization)	MUSIC
18.	Graphic #4 (Sterilization-Definition)	Sterilization is the complete destruction of all forms of life.
	FADE IN	
19.	TC slide #4 (bacteria)	In microbiology, a truly sterile object is one that is free of all

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	Video	Audio
		forms of microbial life that is: -bacteria and their spores
20.	TC slide #5 (viruses)	-viruses
21.	TC slide #6 (fungi)	-and fungi and their spores.
22.	VTR MLS (Autoclave)	Today, the application of moist heat produced by saturated steam under pressure is considered the most dependable method of destroying microorganisms.
23.	VTR CU (cyclomatic control system)	And the modern autoclave equipped with automatic control and made of corrosion resistant monel metal is accepted as the most flexible and efficient instrument for providing this means of sterilization.
24.	TC slide 1 (Autoclave) KEYED IN: Section Heading #1 (principle of moist heat sterilization)	
25.	CU (Half-filled Beaker) KEYED IN Graphic #5 (moist heat: coagulation) FADE OUT	When living protoplasm is subjected to moist heat, its protein is coagulated and the organism is killed.
26.	CU (Beaker, egg-white dropping in hot water: coagulation occurs)	Remember for example the way an egg-white coagulates once it is immersed in boiling water. Bacteria are not exception to this rule. Heat destroys various essential enzyme systems and these organisms are no longer viable.
27.	CU (Bunsen burner) KEYED IN Graphic #6 (dry heat: oxidation) FADE OUT	In dry heat techniques such as, holding an object in the flame of a bunsen burner until it is red hot, or using hot air ovens,

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	Video.	Audio.
28.	CU (inoculating loop flamed in till red hot)	bacteria are destroyed by an oxidation or a slow burning process, as bacteria exposed to hot air may be dehydrated greatly before the temperature rises sufficiently to cause death by coagulation.
29.	Graphic #7 temperature chart related to protein denaturation	As seen by this graph, moist heat such as flowing steam which is saturated with the maximum amount of water vapour will bring about protein denaturation and coagulation, that is, bacterial destruction at a much lower temperature than dry heat such as hot air.
30.	TC (film-Amsco steam condensation process)	One factor which favors this is that an enormous amount of heat energy is present in steam. Steam condenses when it comes in contact with anything colder than itself providing water to help protein coagulation as well as liberating great amounts of latent heat. More steam fills the vacuum created by the previous condensation, and the process continues until the temperature of the substance is raised to that of the steam.
31.	TC (film-Amsco steam penetrating through layers of material)	In addition, steam penetrates easily through successive layers of porous material, sterilizing each in turn, whereas air being a poorer conductor of heat penetrates slowly.
32.	TC (slide #2 - Autoclave) KEYED IN Graphic #1 (Stop Review Section 1) FADE OUT	MUSIC

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	Video.	Audio.
33.	TC (slide #1) KEYED IN Section Heading #2 (Autoclave: principle and description)	
34.	TC (slide #7) (Chamberland's Autoclave)	The principle of the autoclave depends on the fact that as the water is boiled in a closed chamber, the temperature at which water boils and of the steam it generates is increased.
35.	TC (film-Ansco; effect of pressure on temperature)	Steam has the same temperature of boiling water -100 degrees centigrade at sea level. To raise the temperature of steam, the boiling point of water must be raised by increasing the pressure above the normal atmosphere which is 15 lbs. per square inch at sea level. Each extra pound will raise slightly above 1 degree centigrade in the sterilizing range, thus the application of 15 lbs. extra pressure will provide the steam temperature for sterilization 121°C. However, this rule applies only to pure steam, even a slight residue of trapped air mixed with it prevents this temperature rise.
36.	VPY Super-8mm film diagram of autoclave with successive labeling of parts, and circulation of steam)	On this diagram of a typical double-walled autoclave, we see that an autoclave is composed of: -a rectangular chamber, at the front of which is a swing door fastened by a capstan head which operates radial bolts -a supply of steam from an external source that can be an independent boiler beside the autoclave or more usually the main steam supply of the building -a pipe through which steam travels to the supply valve -a pressure regulator to maintain an accurate and constant pressure in the steam jacket which surrounds the inner chamber.

	Video.	Audio.
		-a jacket pressure gauge to indicate pressure maintained in the jacket -an operating valve to admit steam into this chamber. Its pressure registers on the chamber pressure gauge. -a channel for discharging air and steam, at the base of which the thermometer is placed to indicate the temperature. -a thermostatic check valve in the discharge channel to control this discharge automatically -a drain to remove condensation -an exhaust pipe, with a vacuum system which may be used to assist drying of the load -an air intake with a self-sterilizing filter for introducing warm sterile air into the chamber after sterilization.
37.	TC (slide #2 - autoclaves) KEYED IN Graphic #1 (Stop Review Section 2) FADE OUT	MUSIC
38.	TC (slide #1 autoclave) KEYED IN (Section Heading #3: operation)	
39.	VTR (Technician loading autoclave, closing door and turning the operating valve)	With the load in place and 15 pounds pressure in the jacket, the safety door is closed. As the operating valve is turned
40.	VPX (Super-8mm film, penetration of steam within autoclave chamber)	steam leaves the jacket and enters the chamber at the rear. It flows over a deflector, the baffle plate and towards the front pushing air ahead of it. Because its density is only half that of air, the steam tends to remain at the top,

	Video.	Audio.
		while air sinks and begins to escape to the outlet. This is known as gravity displacement. Because of this, the top of the chamber is the hottest. Gradually as the air escapes, steam fills the chamber completely and the temperature throughout rises to the required 121 degrees centigrade.
41.	TC (Amsco-film. Effect of steam on thermostatic valve)	An expansion element in the thermostatic valve automatically closes, as pure steam comes in contact with it.
42.	TC (Amsco-film. Animation-effect of steam on door locking clutch)	The steam in the system cannot escape and begin to exert pressure. This automatically and positively engages a locking clutch in the safety door, preventing rotation of a hand wheel which is necessary for opening it. The full 15 lbs. pressure above atmospheric is the same within the chamber in a few minutes.
43.	VTR CU (cyclomatic control system - operating valve closes)	When this temperature has been maintained for the selected time, the operating valve closes so that no more steam enters the chamber.
44.	VPX (Super-8mm film-steam escaping through the exhaust pipe-penetration of air)	There is a correct period of exposure for each type of material and load at the sterilizing temperature. At the same time that the operating valve closes the chamber pressure is reduced by allowing the existing steam to escape through the exhaust pipe. When the pressure returns to that of the atmosphere, filtered air is passed in to the chamber through a vacuum dryer and replaces the residual steam, circulating air serves as a vehicle to conduct vapour as it forms and remove it to the exhaust outlet.

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	Video.	Audio.
45.	TC (Amsco-film. Effect of release of pressure on door locking clutch)	With the release of pressure, the clutch of the door disengages and the hand wheel may then be rotated and the door opens. The load has been sterilized and dried and the materials are ready for use.
46.	TC (slide #2-autoclaves) KEYED IN Graphic #1 (Stop Review Section #3) FADE OUT	MUSIC
47.	TC (slide #1-autoclave) KEYED IN Section Heading #4 (efficiency of autoclave sterilization)	
48.	Graphic #8 (Comparative chart - saturated steam vs dry heat)	Saturated steam at the boiling point of water is a more efficient sterilizing agent than dry air at that temperature since protein is not coagulated by dry air at that point.
49.	Graphic #9 (Effect of heat - saturated steam vs superheated steam - Overlay: % of moisture)	However if heat is applied to saturated or flowing steam, so that its temperature is raised, its percentage of moisture falls. Superheated steam may be formed if the jacket temperature is greater than the chamber temperature.
50.	TC (Insert of motile microorganisms) KEYED IN (right section of graphic #9)	Microorganisms of the type which are destroyed by saturated steam dry out in this superheated steam. Their protein does not coagulate as readily and they remain viable longer.
51.	CU (Effect of supersaturated steam - "Heavy" condensation on flasks)	Also, steam should not be supersaturated, that is wet due to droplets of condensation forming. Its efficiency as a

	Video.	Audio.
		sterilizing agent is reduced because the droplets carried will saturate fabrics and prevent the further penetration of steam.
52.	Sub-heading #1 (efficiency of auto-clave sterilization: 1 saturated steam)	Thus, saturated steam is ideal for sterilization, and saturation with water vapour is the first requirement for the efficiency of autoclave sterilization.
53.	TC (6" film-insert bacteria - Graphic #10 (1 minute) (KEYED IN)	Of the two general types of microbial life: vegetative cells are killed within 1 minute on exposure to boiling water or saturated steam.
54.	TC Print (spores) KEYED IN Graphic #11 (10 minutes)	However, spore forms, the normal resting stage of certain bacterial cells, contain less water than their parent vegetative forms, and therefore require a longer exposure to saturated steam for their destruction. Ten to twelve minutes at 121 degrees centigrade will destroy the most resistant spores.
55.	Graphic #12 (Comparative effect of pure steam and air steam mixture on temperature)	However, if any air has remained within the chamber, for instance, because of a clogged discharge line, the temperature will rise slowly and may never attain the necessary state even though the steam may be saturated and admitted under 15 lbs. pressure.
56.	Sub-heading #2 (complete removal of air) KEYED IN	Complete removal of air from autoclave chamber is therefore the second requirement.
57.	TC (Amsco-film insert) (penetration of steam through layers of material)	Moreover, these conditions assume direct contact of the steam with the microorganisms, where pene-tration of many layers of material is a factor as in the sterilization of surgical packs, this time must be lengthened so that spores buried very deep in the center will be destroyed.

	Video.	Audio.
58.	Sub-heading #3 (time and temperature) KEYED IN	And these factors of time and temperature along
59.	Sub-heading #4 (careful loading) KEYED IN	with complete removal of air from autoclave and careful loading thus become the next requirements for steam sterilization
60.	TC (slide #2-autoclaves) KEYED IN Graphic #1 (Stop Review Section #4) FADE OUT	
61.	TC (slide #1-autoclave) KEYED IN Section heading #5 (Load arrangement and preparation)	
62.	VTR CU (2 racks of tubes containing media) SLOW ZOOM OUT to LS (Technician placing racks on shelves)	Although the methods of preparing supplies for sterilization will naturally vary in different hospitals and laboratories, the principles to be discussed here are fundamental.
63.	TC (Amsco-film insert) (gravitation of steam through packs)	Since the air in an autoclave gravitates downward as steam is introduced, it is important to remember this basic rule: Prepare all packs or other materials, and load the sterilizer, so that, there is the least possible resistance to the passage of steam through the load, from the top of the chamber toward the bottom.
64.	VTR MLS (Technician preparing packs for sterilization)	This is a typical large pack. It should be wrapped loosely in a double thickness of muslin.
65.	MCU (Technician placing sterilization indicators)	Sterilization indicators are placed in the center of the largest and most densely packed items of the load. They should be used regularly as a standard control procedure. The size of a pack for surgical dressings and other cloth articles should be limited to 1[illegible]2x20 inches because the la[illegible] the pack the longer will be the time required for sterilization. Also

[POOR COPY]

	Video.	Audio.
		constant lengthy exposures are injurious to fabrics.
66.	SLOW PAN (Technician loading autoclave tray)	Packs should be placed on the edge so that the layers of cloth are vertical, and arranged loosely so the air can drain out toward the bottom between the vertical layer.
67.	Graphic #13 (exposure time: 30 minutes)	30 minutes exposure at the sterilizing temperature will be sufficient for such packs correctly made up and arranged.
68.	VTR MCU (preparation of glass containers for sterilization) SLOW ZOOM OUT and PAN	If empty and dry containers are to be autoclaved, they must not be tightly stoppered, because steam would be excluded and sterilization by moist heat impossible.
69.	MLS (Technician loading autoclave tray)	They should be placed on their sides in the autoclave to allow a horizontal path to the entry of steam and escape of air. If unstoppered, they will be sterilized quickly. If stoppered even loosely as with cotton wool or a loosened screw cap, the displacement of air is slow and
70.	Graphic #14 (exposure time: 30 minutes)	the holding period at 121^{o}C (degrees centigrade) should be extended to 30 minutes.
71.	VTR MCU (Technician putting stoppers on tubes)	Because of the uncertainty of air displacement from stoppered empty containers, unless there are rubber liners inside the screw cap, it is better to sterilize empty dry glassware and containers in the hot air oven.
72.	VTR MS (Technician loading hot air oven)	Also dry materials in sealed containers,
73.	VTR CU (labelled jar) SLOW PAN	powders, fats, oils and grease such as petroleum jelly, that

Video.	Audio.
	are impermeable to moisture should be sterilized in the hot air oven
74. VTR MLS (Technician loading hot air oven)	and in small lots as they are penetrated very slowly by heat.
75. VTR CU (hands preparing filter) SLOW ZOOM OUT to MLS PAN	Seitz filter, with the filter loosely assembled and the asbestos disk in position, the delivery tube passed through a rubber band when a filtering flask is used, are wrapped in Kraft paper and sterilized in the autoclave.
76. Graphic #15 (exposure time: 35-40 minutes)	Like membrane filters they withstand sterilization for 35 to 40 minutes at 121°C.
77. VTR CU (flasks filled to 75% of their capacity) ZOOM OUT to MLS (Technician loading autoclave tray)	Note that in the sterilization of aqueous solutions, bottles, tubes should not be filled to more than 75% of their capacity, to avoid the contents overflowing on expansion during heating. To avoid drenching of cotton wool stoppers in the autoclave, stoppers should be covered with Kraft paper. Sterilization indicators are placed in the coolest part of the chamber, that is, the bottom where air tends to collect.
78. VTR LS (Technician pushing load toward autoclave)	Sterilization requires variation of the periods of exposure from 15 minutes to 30 minutes depending on the size, shape and thickness of the containers used.
79. VTR LS (Technician loading autoclave)	Remember that recommended exposure periods for sterilization may vary according to articles and therefore articles requiring different treatment such as aqueous media in unsealed containers and wrapped goods requiring drying should not be sterilized together.

[POOR COPY]

	Video.	Audio.
80.	VTR LS (Technician locking autoclave door - turning operating valve)	Since the liquid inside contains the essential sterilizing factor of moisture heat alone must be supplied.
81.	TC (Amsco-film insert - effect of saturated steam on flask containing media)	When the steam in the autoclave comes in contact with a cold container, it condenses and readily supplies this heat. Although the temperature of the solution is raised for above its boiling point, no ebullition will occur during the actual sterilizing period because of the steam pressure maintained in the chamber. To prevent ebullition from occuring during the period of cooling the chamber pressure must be reduced slowly.
82.	Graphic #16 (chart - total exposure period)	Also note that the total holding period which is timed to begin when the chamber reaches 121^{o}C is calculated to include the minimum safety standard of 15 minutes, plus the additional heat-up time required for the bottles and their content to reach this temperature.
83.	TC (slide #2-autoclaves) KEYED IN Graphic #} (Stop review section 5)	MUSIC
	FADE OUT	
84.	TC (slide #1-autoclave) KEYED IN Section heading #6 (Sterilization cycles)	
85.	VTR CU (cyclomatic control system)	The modern autoclave is equipped with a cyclomatic control system for carrying through exactly the correct sequence of operation in each sterilization cycle, including: heating up, holding, cooling and drying stage, without requiring attention from the operator.

[POOR COPY]

	Video.	Audio.
86.	VTR CU (selector - hand turning selector to the different positions)	Also note the various controls and indicators on this panel: the selector which has 4 positions. -dry for packs, dry goods and so forth -fast exhaust for instruments, glassware and utensils where drying is not required slow exhaust for solutions -and manual if for some reason an operator desires to manage the process by hand.
87.	Sub-heading #5 (Heating up the jacket)	
88.	VTR CU (steam - supply valve turned on)	Open the steam supply valve. The steam is introduced in the jacket, which should be kept filled with steam at 121°C throughout the whole day, both during and between the successive steamings in the chamber.
89.	VTR CU (jacket guage)	Watch the jacket gauge until it shows 15 lbs. pressure per sq. inch.
90.	VTR MS (Technician closing autoclave door)	With the load in the sterilizer and the door locked
91.	VTR CU (hand setting timer)	set the timer to the desired period
92.	VTR CU (hand switching selector)	switch the selector to the appropriate position
93.	VTR CU (hand turning operating valve)	and turn the operating valve.
94.	Sub-heading #6 (Heating up the chamber)	
95.	VPX (Super-8mm film-insert-penetration of steam in autoclave chamber)	Steam is allowed to enter the chamber through a baffle high up at the back. Remember that air is heavier than steam and as more steam is introduced, air is displayed down by gravity through

	Video.	Audio.
		the load and out through the discharge channel. The length of the warm up period depends on the nature of the container, the volume of its contents and the mode of operation of the autoclave.
96.	Sub-heading #7 (holding period)	
97.	VTR CU (Thermometer's graphic temperature recorder)	The holding period at 121^{o}C begins when the thermometer in the discharge channel first shows that this temperature is reached.
98.	VTR CU (timer)	The timer will begin to operate and count back to zero. If the temperature falls below this height during this phase, the timer automatically resets itself to the starting position of the selected exposure period.
99.	Sub-heading #8 (cooling and drying period)	
100.	VTR CU (cyclomatic control system - operating valve handle)	At the completion of the timed sterilizing period the valve automatically moves to the selected exhaust position and the yellow signal light comes on. If the selector has been set for "Fast exhaust and dry" the valve will automatically move to dry after the chamber pressure has been reduced to zero.
101.	VTR MS (Technician turning valve handle)	When the load is completely processed, the green signal light will come on, and an alarm will sound until the valve handle is turned to off.
102.	VTR MLS (Technician turning off capstan head and opening door)	The operator may now remove the load with the assurance that all steps in the process of sterilization have been correctly carried off.

	Video.	Audio.
103.	TC (slide #2 - autoclave) KEYED IN Graphic #1 (Stop Review Section 6) FADE OUT	MUSIC
104.	TC (slide #1 - autoclave) KEYED IN Section heading #7 (autoclave controls and sterilization indicators)	
105.	VTR MLS (Technician removing load from autoclave) ZOOM IN (Sterilization indicators)	The success or failure of the sterilization procedure in any one hospital or laboratory is dependent in large measure on the personnel responsible for its supervision, on careful preparation of all supplies and loading of the sterilizer; on exact time and temperature for sterilization,
106.	VTR MCU (hand writing in records book)	and on accurate recording of all these data.
107.	VTR CU (thermometer's graphic time recorder)	Autoclave controls such as the thermocouple measurement, or the thermometer's graphic time recording help the operator to avoid errors in timing the holding period.
108.	VTR CU (Bowie Dick indicator)	The use of chemical indicators such as Bowie Dick adhesive tape (turning from colorless to black).
109.	C_2 MCU (Browne's tube)	Browne's tube (turning from red to green) afford a certain factor of safety in routine sterilization although they are occasionally unreliable.
110.	MCU (spore strips indicator) ZOOM OUT (Technician inoculating spore strips) KEYED IN Graphic #17 (Bacillus steorothermophilus)	Biological indicators are probably the best means at our disposal to confirm the sterility of an article or to determine the efficiency of sterilization process. Paper strips impregnated with dried spores of Bacillus steorothermophilus are after autoclaving tested for viability by being

Video.	Audio.
	cultivated at 55°C as this organism is a thermophile.
111. TC (slide #2 - autoclave) KEYED IN Graphic #1 (Stop Review Section 7)	MUSIC
112. MS (capstan head turned off).	Remember that all of these should be understood by those responsible for the operation of the autoclave and the standardization of the sterilization procedure, that is: principle of moist heat, requirement for effective process, cycles and proper use of sterilization indicators.
113. TC (slide #8 - ECU capstan head door SLOW OUT OF FOCUS	
	MUSIC

APPENDIX C

Evaluation Instrument

a) Pretest-Posttest

b) Posttest

c) Evaluation Questionnaire

d) Questionnaire related to manipulation of the autoclave

NOTE: For tabulation purposes of pre-and-posttest

-Section B =
Subparts of questions 1 and 2 were renumbered 6 to 11

-Section C =
Subparts of questions I were renumbered 12 to 21
Subparts of questions II were renumbered 22 to 30
Subparts of questions III were renumbered 31 to 62

PRETEST-POSTTEST NAME: ____________________

AUTOCLAVE STERILIZATION

Part A:

Circle the letter opposite the phrase, sentence or symbol which best answers the question. Only one answer is acceptable for each question.

1. In operation of an autoclave set for 121°C, failure to allow displacement of all air from the chamber will result in:
   a. decrease in chamber pressure
   b. temperature below 121°C
   c. formation of excess condensate
   d. temperature above 121°C
   e. bubbling liquids

2. Timing of the sterilization period in an autoclave is started when the:
   a. chamber pressure reaches 15 lb. psi
   b. jacket pressure reaches 15 lb. psi
   c. steam enters the chamber
   d. discharge line temperature reaches 121°C
   e. chamber temperature reaches 121°C

3. The effect of steam sterilization on the bacterial cell is:
   a. charring of cell contents
   b. lysis of cell
   c. coagulation of proteins
   d. breakdown of cell wall
   e. dehydration of cell

4. When sterilizing by means of an autoclave:
   a. materials should be packed in as tightly as possible in order to shorten the sterilization time.
   b. superheated steam is used because it is a very effective sterilizing agent
   c. liquids should be sterilized in containers with tight fitting lids
   d. timing should begin when the chamber pressure gauge registers the desired temperature
   e. none of the above

5. Autoclave door:
   a. rotation of the hand wheel may occur during the sterilization process
   b. is locked by a security system before allowing steam to enter the chamber
   c. pressure exerted by the steam engages a locking clutch in the door, preventing rotation of the handwheel
   d. setting the timer automatically locks the door preventing rotation of the handwheel
   e. none of the above

[POOR COPY]

Part B:

Each question consists of 4 lettered headings followed by a list of 5 numbered words or phrases. In the space provided, opposite each numbered word or phrase place the letter corresponding to the appropriate lettered heading.

That is: A if the numbered phrase is associated with A only
B if the numbered phrase is associated with B only
C if the numbered phrase is associated with both A and B
D if the numbered phrase is associated with neither A nor B

1. A - pressure steam sterilization
B - hot air oven sterilization
C - both
D - neither

_____ 1. destruction of all microbial forms of life vegetative and spore forms

_____ 2. liberation of latent heat

_____ 3. requires temperature above 121°C to be effective

_____ 4. effectiveness limited to vegetative cells as it/they do(es) not destroy bacterial and fungal spores

_____ 5. highly penetrating

2. A - operating valve
B - thermostatic valve
C - both
D - neither

_____ 1. prevent(s) escape of air from chamber

_____ 2. allow(s) steam to leave the jacket and to enter the chamber

_____ 3. control(s) the chamber discharge system

_____ 4. when surrounded by pure steam, an expansion element extends and closes the orifice

_____ 5. helps to build up pressure within chamber

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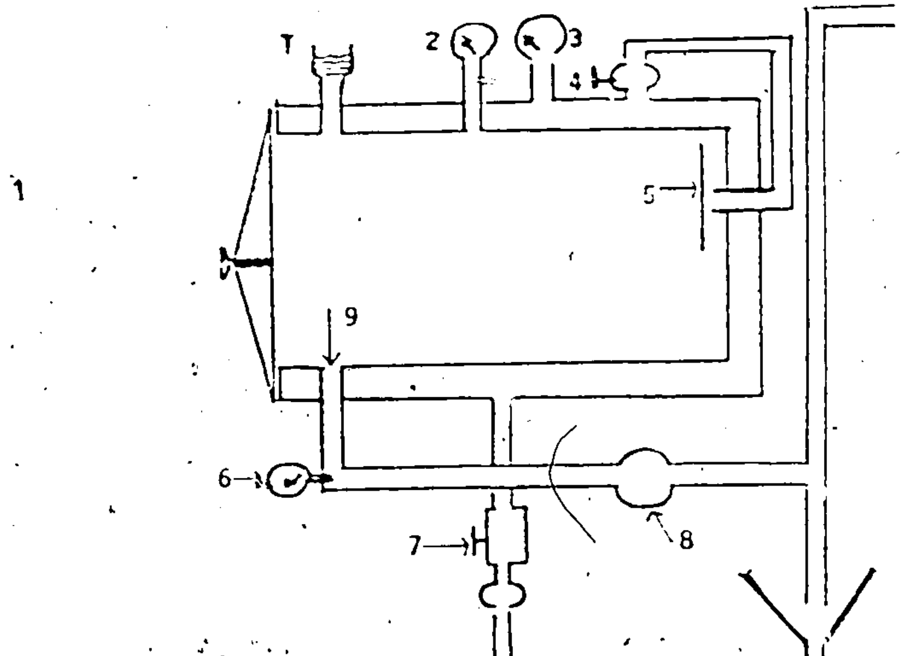
PART C:

Section I:

In this diagram of an autoclave:

a) indicate the direction of flow of steam through the system by placing arrows directly on the diagram.

b) there are 9 numbered parts. From the list of parts given, select the letter corresponding to the appropriate part and place it in the space provided.



1. ____________ 4. ____________ 7. ____________

2. ____________ 5. ____________ 8. ____________

3. ____________ 6. ____________ 9. ____________

A. door
B. pressure regulator
C. drain
D. chamber pressure gauge
E. discharge channel
F. vent
G. baffle plate deflector
H. operating valve
I. chamber
J. thermostatic valve
K. temperature gauge
L. air filter
M. jacket pressure gauge
N. chamber rear wall

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II.

A list of articles each identified by a number is given below; followed by a list of methods used for sterilization (each identified by a letter). Place the letter corresponding to the appropriate method in the space provided.

1. Rubber tubing ______
2. Inoculating loop ______
3. Nutrient broth ______
4. Petroleum jelly ______
5. Glass petri plates ______
6. Membrane filter ______
7. Test tubes with rubber-lined caps ______
8. surgical dressings ______
9. Talc powder ______

A – Hot air oven

B – Autoclave

C – Red heat

III.

1. List 4 factors upon which the efficiency of autoclave sterilization is dependent.

   1. ______________________
   2. ______________________
   3. ______________________
   4. ______________________

2. Indicate whether the following statements are true or false. If false, indicate what the true statement should be and why?

   ______ 1. Packs for surgical dressings should be placed flat as to allow a horizontal path to the entry of air.

   True or false

   If false, the true statement would be:

   ____

   ____

   ______ 2. Empty cotton stoppered tubes should be placed vertically in the autoclave to facilitate the displacement of air and penetration of steam.

   True or false

   If false, the true statement would be:

   ____

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3. i) State the name of two chemical indicators and the change of color observed following effective sterilization.

   a) ______________________________

   b) ______________________________

   ii) State which type of indicator - chemical or biological - is more reliable, and mention one disadvantage of the biological indicator.

   ____

   ____

   ____

   iii) State two areas where sterilization indicators should be placed in the autoclave or load and why.

   a) ______________________________

   ____

   b) ______________________________

   ____

iv) Complete the following statements with the correct words or phrase:

1. The most suitable organism for use in testing autoclave efficiency is ______________. Paper strips impregnated with the ______________ of this organism are inoculated in culture medium following sterilization and incubated at ______________.

2. Dry heat destroys microorganisms by ______________.

3. During the sterilization process, air is removed from the chamber by: ______________.

4. Pressure of the normal atmosphere is ______________ at sea level.

5. For the sterilization of aqueous solutions, bottles should not be filled to more than ______________% of their capacity.

6. Total sterilization time is composed of:

____

____

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EVALUATION QUESTIONNAIRE
of the
VIDEOTAPE PACKAGE
"AUTOCLAVE STERILIZATION"

1. Name one or more characteristics that you would consider as the strongest points of this package.

____

____

____

2. Name one or more characteristics that you would consider as the weakest aspects of this package.

____

____

____

A. VIDEOTAPE EVALUATION:

Circle the number that best corresponds to your appreciation of this programme.

1. Is the material explained in the right order?

1	2	3	4	5
Highly disorganized		Organized		Extremely well organized

Comments: ____

____

____

2. Are informations clear and well explained?

1	2	3	4	5
Unclear and confusing		Clear and understandable		Extremely clear and understandable

Comments: ____

____

____

[POOR COPY]

3. Pacing.

1	2	3	4	5
Too fast		Adequate		Too slow

Comments: ______________________

4. Clarity of voice (narrator).

1	2	3	4	5
Unclear		Clear		Extremely clear

Comments: ______________________

5. Selection of visual representation.

1	2	3	4	5
Poor		Good		Excellent

Comments: ______________________

6. Schematic representation of autoclave and labelling.

1	2	3	4	5
Poor		Good		Excellent

Comments: ______________________

[POOR COPY]

7. Selection of technologist and identification.

1	2	3	4	5
Inappropriate prefer a man as demonstrator		Good could associate with her		Excellent felt highly motivated

Comments: ____________________

Additional information needed:

Are you a male? [ ]

Are you a female? [ ]

8. Quantity of music during presentation.

1	2	3	4	5
Would like more music		Adequate		Perfect

Comments: ____________________

9. Selection of music as indicative of Review Section.

1	2	3	4	5
Poor		Good		Excellent

Comments: ____________________

10. Amount of interest generated.

1	2	3	4	5
Uninteresting		Moderately interesting		Extremely interesting

Comments: ____________________

11. Student understanding.

1	2	3	4	5
Did not understand the material		Good understanding of the material		Excellent understanding of the material

Comments: ______________________

12. Selection of color as opposed to black and white.

1	2	3	4	5
Distracting rather like black and white		Useless for the type of material presented but more pleasant than black and white		Needed for this programme and highly pleasant

Comments: ______________________

B. VIEWING GUIDE EVALUATION

1. Clarity of presentation.

1	2	3	4	5
Unclear		Clear		Extremely clear

Comments: ______________________________

2. Part 1 of each section = Content and objective.

1	2	3	4	5
Useless and tedious to read		Moderately useful		Very useful help in approaching material

Comments: ______________________________

3. Questions clarity and usefulness.

1	2	3	4	5
Unclear and useless		Clear and useful		Extremely clear and useful

Comments: ______________________________

4. Need for answer sheet within the viewing guide.

1	2	3	4	5
Useless could have been omitted		Moderately useful		Highly useful help to review material

Comments: ______________________________

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C. GENERAL INFORMATION

1. General rating of the videotape package.

1	2	3	4	5
Poor		Good		Excellent

Comments: ____________________

2. Would you like to continue learning in this fashion?

1	2	3	4	5
Never again		Sometimes		All the time

Comments: ____________________

3. Would you feel confident to load and operate the autoclave after completing this package?

Yes ☐

No ☐

Comments: ____________________

4. What are the positive aspects that this videotape package offers in comparison to the traditional lecture session?

____

5. What are the positive aspects that the traditional lecture session offers in comparison to this method?

____

6. Please add any other comments that might aid in improving this programme.

___

___

___

7. Do you think that this material:

i) can replace the traditional lecture on the topic? ___

ii) should be used only for review sessions? ___

iii) others? ___

8. Have you any question about autoclave sterilization? Please list ...

___

___

___

___

___

___

___

___

___

___

___

___

9. Glossary:

1	2	3	4	5
Useless, unclear could be omitted		Useful, clear facilitate understanding		Very useful, extremely clear

Comments: ___

___

___

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Questionnaire Related to Manipulation of the Autoclave:

Load ______________________ Name ______________________

1. State:

   a) the temperature to be selected for the yellow pointer on the Indicator-Recorder: ______________________

   b) the Exposure period selected: ______________________

   c) the kind of sterilization indicator used: ______________________

   d) the button pressed for the required cycle: ______________________

2. List the 4 sterilization cycles.

____

____

____

____

3. State what is happening within the chamber when the operating valve turns automatically and the "Heat" light comes on:

____

4. State the exhaust system that will be automatically selected at the end of this sterilization period.

____

5. When the "sterilize" light comes on:

   a) state which sterilization cycle (period) is in process:

____

   b) state the required condition for the sterilization cycle to start, and briefly describe what is happening within the autoclave at that time.

____

____

____

____

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APPENDIX D

Adjunct material used by lecture group

a. Workbook

b. Laboratory Exercises

Sections of workbook

MOIST HEAT (STEAM) UNDER PRESSURE

Steam confined under pressure in an enclosed area provides a more effective sterilizing agent than flowing steam.

a) it attains a ____________ temperature.

b) it penetrates __________ material better.

c) it rapidly denatures protein by ________________

The laboratory apparatus designed to use steam under pressure is called an ______________.

A common household example is the __________ ____________.

At normal atmospheric pressure, (__________ p.s.i.) steam and water are at 100°C

However a temperature of __________° Celsius (moist heat) is needed to kill the most resistant spores and is the ____________ standard considered safe for sterilization.

For example: at 10 p.s.i. steam temperature is ____________.
at 15 p.s.i. steam temperature is ____________
at 20 p.s.i. steam temperature is ____________

In order for sterilization to occur two situations must exist:

a) ____

b) ____

Why is steam used?

Steam has ______________ as much available heat as boiling water.

This heat is known as ____________ heat.

Why must dry saturated steam be used?

To obtain the dry saturated steam, the temperature must be just above that corresponding to the phase boundary between the ______ and ______ states.

Therefore a slight ______ in temperature (when the steam hits the article to be sterilized) results in the ______ of steam to water.

When steam condenses to water, its ______ is greatly reduced (> 1000 X). As a result a ______ pressure is created which in turn draws more ______ into the item.

Example: a linen pack. This process is repeated as the steam is drawn further into the pack until the whole load is the same temperature as the steam.

When Sterilizing Fluids

As saturated steam hits the side of the cool flask, condensation occurs and the process reoccurs until the temperature of the fluid in the flask is the same as that of the steam. Heat is transferred by conduction.

Caps and lids on flask or tubes of fluid need not be loose since moisture is provided by the fluids.

________ trap until pure steam is detected. The trap is then shut allowing the chamber pressure to build up to 15 p.s.i. The thermometer in the drain should read ________ From this point the ________ period is timed, for example 15 minutes at 15 pounds pressure, 121°C. At the end of the holding time, the steam supply to the chamber is shut off and the chamber ________ valve is opened. The jacket steam pressure is kept at 15 pounds pressure resulting in hot chamber walls which can evaporate moisture in the load. This evaporation results in a lower chamber temperature and a drop in chamber pressure to ________ ________. When this occurs the door may be opened.

The door: capstan head - radial locking bars
- pressure: ________ at 15 p.s.i.
- pressure lock prevents opening when pressure in chamber.

Jacket:
- hot walls - facilitates drying of load.
- prevents excess wetting.
- eliminates delay caused by heating metal mass.

Steam Supply - usually main building supply but may have own boiler.

Baffle:
- removes water deposit, condensate.
- prevents direct wetting of load.

Pressure gauges: can give rough indication of pressure - often
- inaccurate - necessary to regulate pressure via ________. gauge pressure: ________

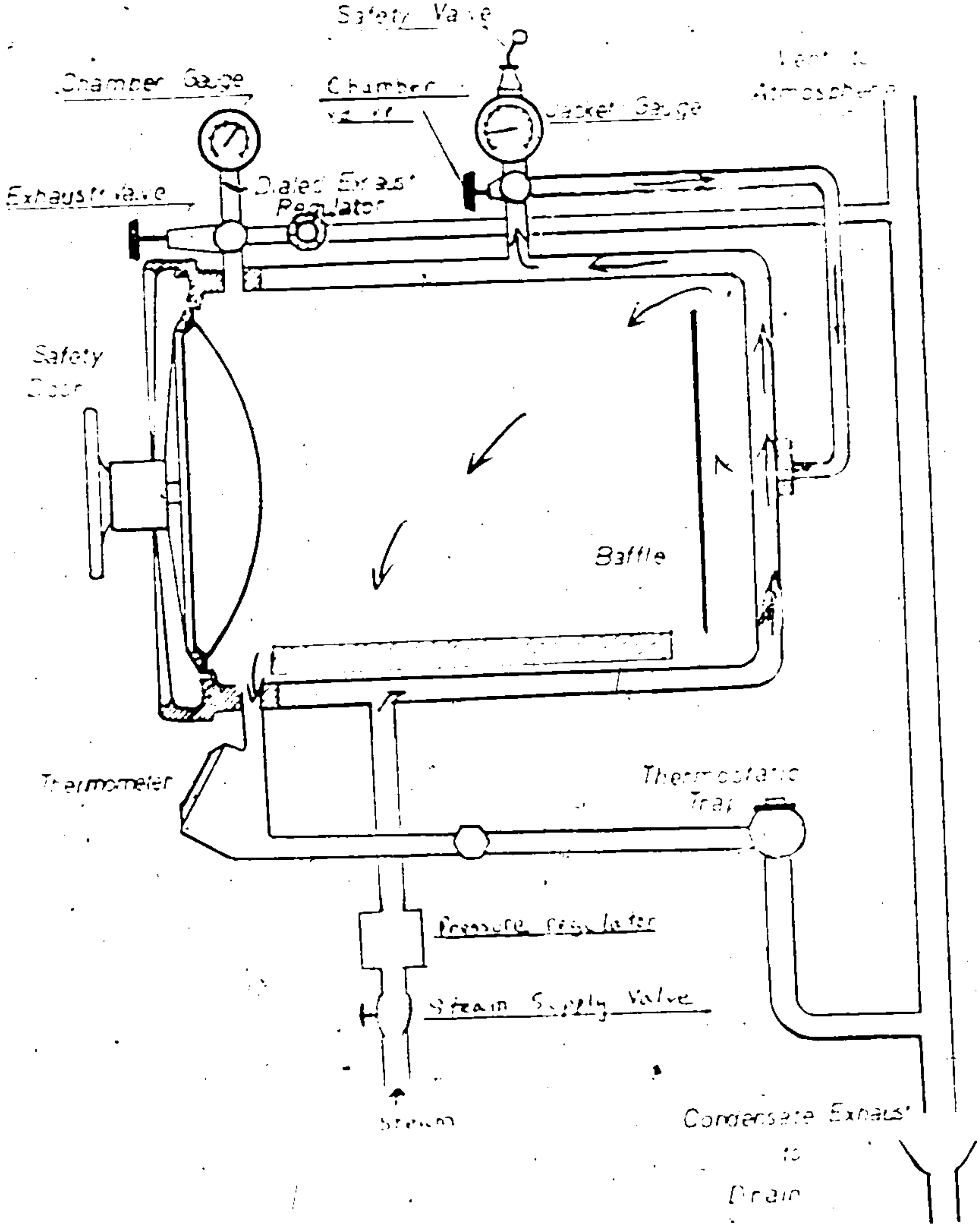
____

____

Thermometer: ________

____

____


Safety Valve
Chamber Gauge
Chamber Valve
Jacket Gauge
Exhaust Valve
Dialed Exhaust Regulator
Safety
Baffle
Thermometer
Thermostatic Trap
Pressure Regulator
Steam Supply Valve
Steam
Condensate Exhaust
to
Drain

AUTOCLAVE

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Thermostatic Trap: "Steam trap" - controls flow of air and condensate from chamber automatically.

Elimination of Air at Beginning of Cycle

_ methods depending on type of autoclave.

a) Gravity displacement

Cool air __________ as heavy as steam

air pushed down and out discharge line

- takes about ______________ minutes for displacement of air.

b) High vacuum

98% removal of air before steam admitted ∴ Steam penetration is ______________.

Exhaustion of Steam at end of cycle

Chamber pressure reduced to zero by allowing steam to escape through exhaust valve.

Slow exhaust: __________ - (will boil over, ______________ if fast exhaust used)

Fast exhaust: ______________________________

Drying at end of cycle

- important for packs and dressings

- after sterilization - damp with steam condensation

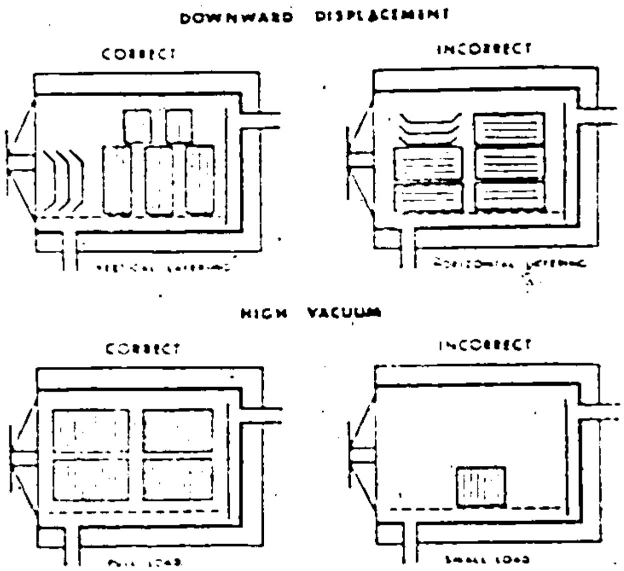
- ∴ must dry to prevent ______________.

2 main methods:

a) low vacuum - filtered air

b) high vacuum

Dressings, Packs

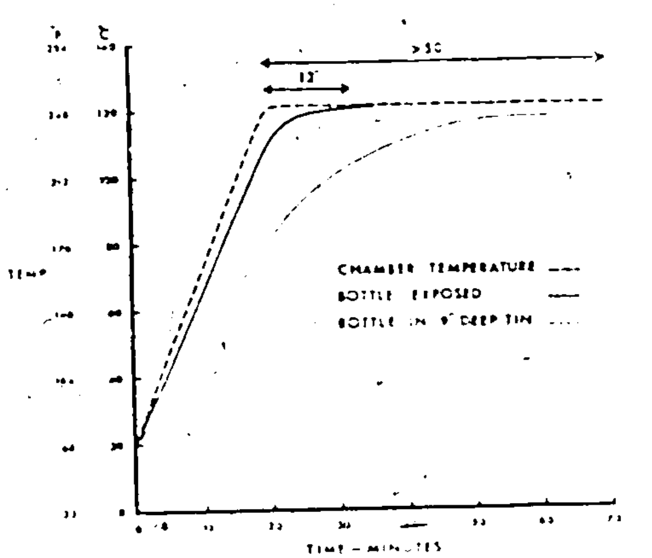


– Correct and incorrect loading of dressing sterilizers

Media Sterilization

a) Chamber pressure falls too quickly.

b) Tubed media or flasks autoclaved in bins.



Effect of air trapped in a metal container on the heat penetration time of bottled fluids.

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DRY HEAT

A) Hot air oven

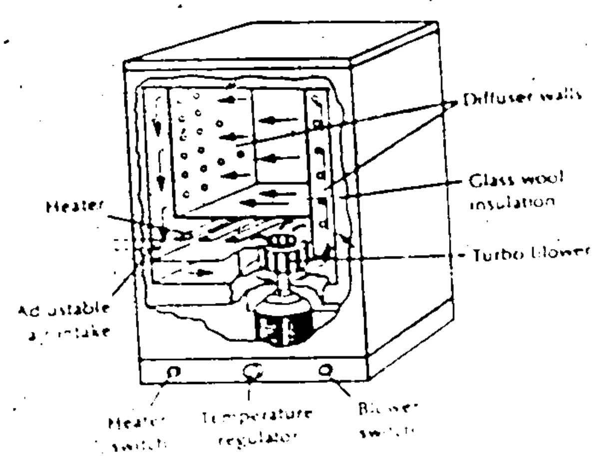
Dry heat effects sterilization by ______________________ of intracellular components.

Dry heat is recommended when it is undesirable or unlikely that steam under pressure will be able to make direct contact with the material to be sterilized.

For example: ______________________

____

____



Cutaway view of typical dry air oven

Holding time: ______________________

(Clostridium botulinum - 160°C - 25 min.)

Caution: a) oven must attain at least ______________________ dry heat below ______________ will not destroy spores in a reasonable length of time.

b) Greater than ______________: cotton and paper used for plugging and wrapping glassware will be ______________________

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DAY 1

MI.112.110.001(2)

TIMT: LABORATORY EXERCISES

STERILIZATION AND DISINFECTION

Reference: Cruickshank Medical Microbiology, Volume 1, 12th Edition,
Chapter 5, pg. 59-76.

Exercise A: Preparation of Equipment for Sterilization

1. 5 - 12 X 75 test tubes with cotton plugs

Use non-absorbant cotton. The plug should be about 1 1/2"
long with approximately 1/2 inch in the tube. Place the
plugged tubes in the labelled tote for sterilization.

2. 10- 13 X 100 test tubes with clear plastic caps

Make sure the cap is secure, but not on so tight that the
steam can't penetrate inside the tube. Place the capped
tubes in the labelled tote for sterilization.

3. 1 - Glass petri dish

Fill with cotton balls. Wrap in brown paper using "drug
store" wrap. Secure with string. The petri dishes will be
sterilized in the hot air oven.

4. 10 - Pasteur pipettes

Plug the mouth end loosely with non-absorbant cotton. Do
not allow cotton to extend beyond the glass. Burn off
extending cotton fibres in Bunsen burner. Place the pipettes
tip down in the large glass tubes provided. Leave the caps
loose. Place in baskets provided.

5. Graduated Pipettes

2 - 10 ml serological pipette

2 - Serological pipettes - any size

Plug the mouth end as in (4). Wrap the 10 ml pipettes in
brown paper as demonstrated. Label the brown paper with
the pipette size. Place the other pipettes into the
appropriately labelled totes at the front of the lab.
Serological pipettes are sterilized in the hot air oven.

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6. Preparation of cotton plugs for media boiling flasks (500 ml size)

Using a piece of non-absorbant cotton approximately 2" x 2" and a double layered piece of gauze 6" x 6", wrap the gauze around the cotton and fold in the manner demonstrated.

The plug should fit snugly in the flask neck to inhibit entrance of micro-organisms but not be so tight that free movement of air and steam is inhibited.

7. Glass syringe and rubber gloves

Observe the wrapping of a glass syringe and rubber gloves for sterilization.

8. Proceed with an instructor to the sixth floor (641) for the following demonstrations.

a) Autoclave and Hot Air Oven Operation

Observe the procedure for loading and operation of the autoclave and hot air oven.

b) Observation of various types of filter assemblies and filters

Observe: (i) Millipore assembly and filter

(ii) Seitz filter assembly and asbestos filter

(iii) Swinnex filter assembly for dispensing small aliquots of sterile broth.

APPENDIX E

Item by item analysis using t-test

TABLE 22

t-test of Differences of the Mean Scores for Each Item on the Posttest of the Lecture Group Versus those of the Videotape Groups

(df = 43)

Item	Group	Mean	Standard deviation	t-value	2-tail probability
1.	Lecture V.T.	0.909 0.824	0.302 0.387	0.67	.507
2	Lecture V.T.	0.273 0.588	0.467 0.500	-1.85	.071
3	Lecture V.T.	1.00 0.912	0.000 0.288	1.01	.319
4.	Lecture V.T.	0.454 0.559	0.522 0.504	-0.59	.557
5	Lecture V.T.	0.818 0.882	0.405 0.327	-0.53	.596
6	Lecture V.T.	1.000 0.255	0.000 0.448	5.40	.001
7	Lecture V.T.	0.363 0.794	0.505 0.410	-2.86	.007
8	Lecture V.T.	0.727 0.471	0.467 0.507	1.49	.144
9	Lecture V.T.	1.000 0.294	0.000 0.462	5.02	.001
10	Lecture V.T.	0.545 0.853	0.522 0.359	-2.20	.030
11	Lecture V.T.	0.454 0.558	0.522 0.504	-0.59	.557
12	Lecture V.T.	0.727 0.941	0.467 0.239	-2.01	.051
13	Lecture V.T.	0.909 0.706	0.302 0.462	1.36	.181
14	Lecture V.T.	0.636 0.706	0.505 0.462	-0.42	.674
15	Lecture V.T.	0.091 0.118	0.302 0.327	-0.24	.812
16	Lecture V.T.	0.363 0.794	0.505 0.410	-2.86	.007
17	Lecture V.T.	0.636 0.765	0.505 0.431	-0.82	.414
18.	Lecture V.T.	0.909 0.941	0.302 0.239	-0.36	.718
19.	Lecture V.T.	0.909 0.912	0.302 0.288	-0.03	.979
20.	Lecture V.T.	0.636 0.823	0.505 0.387	-1.29	.203
21.	Lecture V.T.	0.818 0.882	0.405 0.327	-0.53	.596

TABLE 22 (continued)

Item	Group	Mean	Standard deviation	t-value	2-tail probability
22	Lecture V.T.	0.727 0.970	0.467 0.171	-2.59	.013
23	Lecture V.T.	0.272 0.676	0.467 0.475	-2.46	.018
24	Lecture V.T.	0.273 0.853	0.467 0.359	-4.32	.001
25	Lecture V.T.	1.00 0.912	0.000 0.288	1.01	.319
26	Lecture V.T.	0.636 0.853	0.505 0.359	-1.59	.124
27	Lecture V.T.	1.000 1.000	0.000 0.000	0.0	1.000
28	Lecture V.T.	0.909 0.882	0.302 0.327	0.24	.812
29	Lecture V.T.	0.818 0.765	0.405 0.431	0.36	.718
30	Lecture V.T.	0.636 0.647	0.505 0.485	-0.06	.950
31	Lecture V.T.	0.545 0.794	0.522 0.410	-1.63	.110
32	Lecture V.T.	0.727 0.794	0.467 0.410	-0.45	.652
33	Lecture V.T.	0.909 0.882	0.302 0.327	0.24	.812
34	Lecture V.T.	0.909 0.853	0.302 0.359	0.4[illegible]	.643
35	Lecture V.T.	0.000 0.265	0.000 0.448	-1.95	.058
36	Lecture V.T.	0.454 0.706	0.522 0.462	-1.56	.136
37	Lecture V.T.	0.363 0.470	0.505 0.507	-0.61	.546
38	Lecture V.T.	0.818 0.529	0.405 0.507	1.72	.093
39	Lecture V.T.	1.000 0.882	0.000 0.327	1.18	.243
40	Lecture V.T.	0.727 0.853	0.467 0.358	-0.94	.355
41	Lecture V.T.	0.363 0.617	0.505 0.493	-1.48	.147

TABLE 22 (continued)

Item	Group	Mean	Standard deviation	t-value	2-tail probability
42	Lecture Y.T.	0.454 0.764	0.522 0.431	-1.97	.055
43	Lecture Y.T.	0.454 0.706	0.522 0.462	-1.52	.136
44	Lecture Y.T.	0.182 0.529	0.405 0.507	-2.07	.045
45	Lecture Y.T.	0.181 0.235	0.405 0.431	-0.36	.718
46	Lecture Y.T.	0.545 0.441	0.522 0.504	0.59	.557
47	Lecture Y.T.	0.181 0.500	0.405 0.508	-1.89	.066
48	Lecture Y.T.	0.363 0.411	0.505 0.500	-0.28	.783
49	Lecture Y.T.	0.727 0.558	0.467 0.504	0.98	.333
50	Lecture Y.T.	0.454 0.588	0.522 0.500	-0.76	.449
51	Lecture Y.T.	0.636 0.882	0.505 0.327	-1.89	.066
52	Lecture Y.T.	0.636 0.735	0.505 0.448	-0.52	.540
53	Lecture Y.T.	0.545 0.764	0.522 0.431	-1.39	.171
54	Lecture Y.T.	0.363 0.647	0.505 0.485	-1.57	.102
55	Lecture Y.T.	0.090 0.323	0.302 0.475	-1.52	.135
56	Lecture Y.T.	0.454 0.588	0.522 0.500	-0.76	.449
57	Lecture Y.T.	0.545 0.294	0.522 0.4[illegible]2	1.52	.136
58	Lecture Y.T.	0.545 0.500	0.522 0.508	0.25	.799
59	Lecture Y.T.	0.363 0.67[illegible]	0.505 0.475	-1.87	.068
60	Lecture Y.T.	0.545 0.823	0.522 0.387	-1.90	.064
61	Lecture Y.T.	0.636 0.341	0.505 0.239	-2.74	.009
62	Lecture Y.T.	0.090 0.235	0.302 0.431	-1.03	.309

APPENDIX F

Clearance for Animated Film Clips

Animated Sequences Extracted from "Pressure Steam Sterilization" Film:

1. Sequence illustrating the condensation of steam (15")
2. Sequence illustrating the penetration of steam through layers of material (13")
3. Sequence illustrating the rise of temperature in a closed container (54")
4. Sequence illustrating the thermostatic valve (29")
5. Sequence illustrating the influence of steam on door clutch (14")
6. Sequence illustrating the penetration of surgical packs by steam (17")
7. Sequence illustrating gravitation of steam within packs (24")