measurements of absorbed dose rates of fractions of a microrad per hour. The apparatus is quite rugged, it exhibits no geotropism, is easily portable, and is battery operated. The electrometer and the muscle-equivalent, atmospheric-pressure, ion chamber seem to provide the simplest system (requiring the fewest corrections) for studying the dose to man from external environmental radiation, both natural and man-made.

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Antimicrobial Substances from Aspen Tissue Grown in vitro

Abstract. *Isolated aspen tissue, when grown in vitro for 3 weeks on agar medium, yielded antimicrobial substances which produced inhibitory zones when the culture plates were inoculated with* Fusarium roseum, Saccharomyces cervisiae, Bacillus subtilis, Bacillus cereus, Penicillium roqueforti, Torula utilis, Sarcina lutea, Flavobacterium aquatile, Pullularia pullulans, *and* Staphylococcus aureus.

The medicinal properties of various plant materials and extracts have been recognized since the beginning of the 5th century B.C. This recorded information, the results of investigations performed in the late 19th and early 20th centuries, and the advent of penicillin and other antibiotics provided the impetus for the investigation of vast numbers of higher plants for antimicrobial substances. In 1943, 2300 species of plants were systematically tested for activity against *Staphylococcus aureus* and *Escherichia coli* (*1*). Numerous investigations dealing with the screening of plants for inhibitory substances have been conducted as a result of increased interest in the search for antimicrobial materials and they have been reviewed in detail (*2*).

The occurrence of antimicrobial materials in various members of the genus *Populus* have been reported by a number of workers. Boiling-water extracts of the bark have shown fungistatic and fungicidal activity against *Stereum purpureum* (*3*). *Populus candicans* and *P. trichocarpa* produced extracts with strong activity while *P. monilifera, P. eugenii, P. robusta, P. fremontii,* and *P. wislizenii* produced extracts with very little such activity. Extracts from *P. regenerata, P. serotina erecta,* and *P. marilandica* also showed some activity. A number of compounds with low fungistatic activity were extracted from the bark of *P. candicans* (*4*). These included pyrocatechol, salicin, saligenin, and salicylic acid derivatives as well as two highly active substances which inhibited the growth of *Botrytis cinerea, Penicillium italicum, Aspergillus niger,* and *Rhizopus nigricans*. Extracts from *P. balsamifera* and *P. gileadensis* were active against *Staphylococcus aureus* and in some cases *Escherichia coli* (*5*). Extracts from *P. alba* did not inhibit the growth of these organisms. Extracts of *P. fremontii* have also shown antimicrobial activity (*6*). The antibacterial properties of the sesquiterpenes in *P. tacamahaca* were investigated in 1957 (*7*). Antimicrobial activity has also been detected in extracts from *P. alba* (*8*), *P. tacamahaca* (*9*), and *P. trichocarpa* (*10*).

Pyrocatechol has recently been extracted and isolated (*11*) from the bark of aspen (*P. tremuloides*). It inhibited the growth of *Hypoxylon pruinatum*. Isolated tissues are a source of antifungal materials (*12*). Lilac phloem contains antimicrobial material which is inhibitory at naturally occurring concentrations, producing zones several millimeters in width when explants were grown for 3 to 15 days and then inoculated with *Cytospora* sp. Activity was also detected in extracts of phloem from *Fraxinus americana, Ligustrum vulgare, Ailanthus glandulosa,* and *Catalpa bignoniodes*.

Table 1. Inhibition of various microorganisms by isolated aspen tissue grown in vitro.

Organism	Fresh weight of tissue growth (mg)	Diameter of inhibitory zone (mm)
Fusarium roseum	204	27
*Saccharomyces cervisiae**	246	19
Aspergillus niger	91	0
Bacillus subtilis	77	23
Bacillus cereus	121	18
Proteus vulgaris	121	0
*Penicillium expansum**	178	17
Penicillium roqueforti	155	20
*Torula utilis**	107	15
Escherichia coli	257	0
Aerobacter aerogenes	91	0
Sarcina lutea	100	30
Serratia indica	98	0
Flavobacterium aquatile	110	18
Pseudomonas fluorescens	109	0
Pullularia pullulans	185	25
*Staphylococcus aureus**	208	23
Chaetomium globosum	181	0
Salmonella gallinarum	220	0
Hypoxylon pruinatum	171	0
Bacillus sp.	72	23

* Indicates variable results.

Much of the early work with antimicrobial substances from higher plants centered around the use of extracts and juices from intact plants. The growth of cultured isolated tissue from various plants may also be used in the detection of antimicrobial materials. This isolated tissue is of interest because it may be grown in large quantities (*13*) and may produce substances which differ from those in the intact parent plant (*14*).

The results of an investigation of the diversity of the antimicrobial activity from isolated aspen tissue grown in vitro are reported here.

Aspen tissue, originally isolated from the approximate cambial region of triploid stem sections on 26 December 1961, was grown on an agar medium containing major nutrients (*15*), trace elements (*16*), 3 ppm glycine, 0.1 ppm thiamine, 2 percent sucrose, 10 percent coconut milk, and 0.5 ppm naphthaleneacetic acid. Occasionally, cultures became contaminated with various organisms. One of these contaminants (*Bacillus* sp.) did not grow in the region surrounding tissue of either diploid or triploid origin which had been growing for 2 to 3 weeks. Measurements of the *p*H showed that a change in the acidity of the medium was not

responsible for the production of the zones of inhibition. Experiments were designed to determine the sensitivity of a number of organisms to the growth inhibitors produced by aspen tissue. In each experiment three pieces of tissue each weighing approximately 6 mg, were placed on the surface of the medium and allowed to grow for a period of 3 weeks in the dark at 27° to 29°C. After this growth period the tissue was removed and weighed; the surface of the agar was flooded with a suspension of the test organism in nutrient broth (Difco) or *Staphylococcus* broth (Difco). The excess inoculum was removed and the cultures were incubated until sufficient growth of the test organism was evident.

Data from cultures in which all three pieces of tissue gave consistent results are shown in Table 1. Occasionally, the degree of inhibition was difficult to determine because of poor growth of the test organism or the tissue and in some cases not all three pieces of tissue produced an inhibitory zone even though the test organism and the tissue grew well (footnote to Table 1). As a result of this variability, all experiments were performed at least three times. In most cases the inhibitory zones were quite extensive and clearly defined. The diameter of the inhibitory zones is an indication of the magnitude of inhibition. A quantitative relationship between the diameter of the inhibitory zones and the amount of tissue growth was not observed. This aspect, however, was not extensively investigated.

The best test organisms selected for possible use in further investigation are *Fusarium roseum, Bacillus subtilis, Sarcina lutea,* and *Pullularia pullulans* because of uniform results and the production of clearly defined inhibitory zones (*17*).

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Cancer: Relation of Prenatal Radiation to Development of the Disease in Childhood

Abstract. *Experimental evidence indicating a linear response and the absence of a threshold for the development of childhood cancer and leukemia at total doses below 1 roentgen is contained in recent studies of prenatal diagnostic x-ray exposure. Implications for the nature of the carcinogenic mechanism in the human organism are discussed, with emphasis on the possible effects of the ionizing radiation from iodine-131 and other short-lived isotopes.*

One of the most difficult problems in predicting the effects of low-level radiation on the development of cancer in man has been the lack of data on the dose-response relationships of the human organism at levels approaching those produced by natural background radiation (0.1 to 0.2 roentgen per year). Experimental evidence has recently become available on whole-body doses well below 1 r to the infant *in utero.*

This evidence is contained in the recent study by MacMahon (*1*) of the effect of prenatal x-ray exposure on the mortality of children from neoplastic diseases, when it is combined with the earlier results of Stewart and her coworkers in England which MacMahon's investigation was designed to test (*2*). MacMahon's study was planned to overcome the principal criticisms of the earlier work with objective evidence from hospital records of intra-uterine x-ray exposures and with accurately controlled estimates of mortality rates for malignant diseases in both exposed and unexposed children.

The population studied by MacMahon consisted of all children born in 37 large maternity hospitals in the New York–New England area during the years 1947–54, a total of 734,243 children. Among 584 children who had died of cancer by 1959, sufficiently complete records of 556 single births were located. After correction for birth order and other variables, the average cancer mortality was about 40 percent higher for children who had been x-rayed *in utero* than for those who had not, and the rate was also higher for those irradiated during the first 6 months than the last 3 months. This finding is in qualitative agreement with the earlier result of Stewart (*2*), who had found an increase of about 90 percent for children in England and Wales, as well as increased sensitivity during early pregnancy.

The evidence for the dose-response relationship is in Stewart's and MacMahon's data for cancer mortality as a function of the number of x-ray films taken during a given examination. MacMahon's data have been plotted in Fig. 1, where the length of the vertical bars is a measure of the probable error arising from the size of the sample in each category, and the length of the horizontal bars represents the grouping used. These data show that there is no evidence for a threshold greater than the dose corresponding to one x-ray picture. Furthermore, as the number of films increases by a factor of 4 to 5, the increase in cancer mortality is best fitted by a linear law, although a quadratic law cannot be definitely excluded on the basis of these data alone (dashed line) (*3*).

To distinguish between a linear and quadratic relationship, it is necessary to compare Stewart's earlier data with MacMahon's more recent results grouped in a comparable manner (Fig. 2). Stewart's data also are fitted best by a straight line through the point of zero exposure, but with a slope almost twice that indicated by MacMahon's results. Such a trend is in fact to be expected from the improvement in x-ray techniques starting during the postwar period, when the bulk of Stewart's cases received their irradiation (1944–51), and continuing more rapidly through the later period covered by MacMahon's sample (1947–54).

As shown by detailed comparisons