Drosophila Activity Monitoring System

The ***Drosophila Activity Monitoring System*** enables a biologist to accurately characterize the locomotor and eclosion behavior rhythms in *drosophila* fruit flies and similarly-sized insects. The system has been used to screen for mutants, measure environmental and chemical sensitivities, and characterize social interaction, all based on the patterns of physical movement which the system observes and quantifies over time.

The individual flies are placed into glass chambers, where their confined motion may be detected and counted by infrared light beams in one or more activity monitoring units. At periodic intervals, these accumulated activity counts are uploaded from the monitors to a host Macintosh or Windows computer for storage and analysis.

■ The ***Locomotor Monitor*** uses 32 tubes of 5, 7, or 10 mm diameter, and measures the activity rhythms of 32 individual flies. An infrared beam bisects each tube, and detects motion as the flies walk back and forth from end to end.

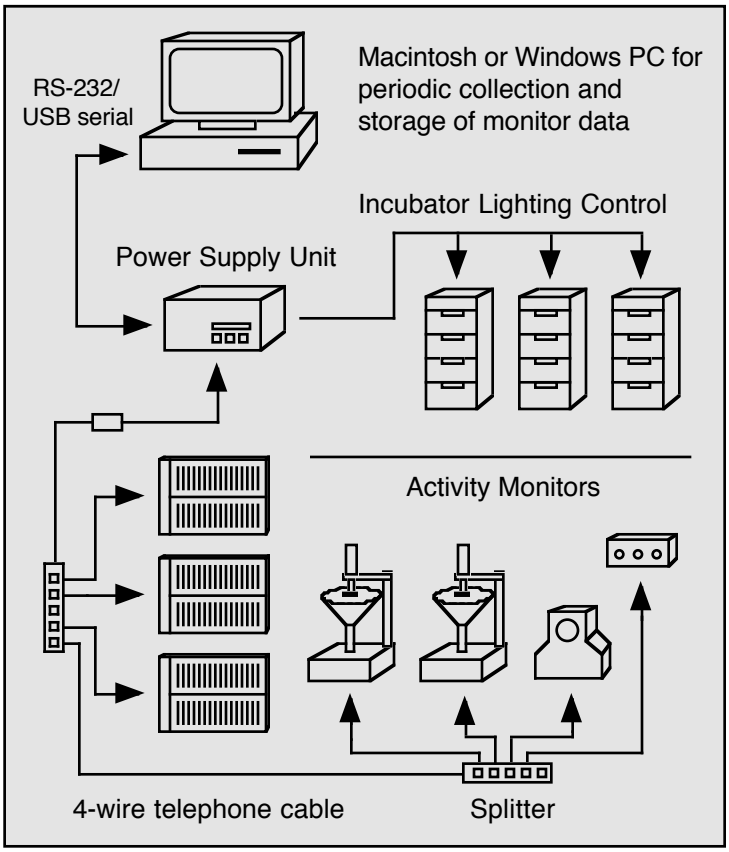
■ The ***Eclosion Monitor*** uses a 100 mm dia. glass funnel to collect emerging flies as they fall from their pupae cases on the underside of a plastic disk. An infrared ring detector at the funnel neck counts each as it passes by, and a mechanical tapper dislodges periodically those which remain adhered to the disk or funnel walls.

■ The ***Population Monitor*** uses a 25 mm dia. glass or plastic vial to contain a multiplicity of flies, and measures their aggregate movement with ring detectors spaced along the vial length.

■ The ***Environment Monitor*** measures the light intensity, temperature, and relative humidity within an incubator chamber, and provides a continuous archival record of these conditions over the duration of an experiment.

■ The ***Power Supply Unit*** supplies DC power to an entire system of up to 120 monitors using a parallel network of residence-type telephone cables. An optional Light Controller allows up to 6 incubator lights to be independently cycled on and off under computer control.

■ The ***DAMSystem Collection Software*** provides archival storage of the collected activity data from a number of monitors simultaneously, and allows for continuous operation over the hours, days, or weeks of an experimental run.



Features

- Robust and time-proven hardware designs provide years of continuous, trouble-free operation.
- Telephone cable network allows easy plug/unplug of activity monitors, and straightforward system expansion with standard wiring accessories.
- Light Controller provides programmable lighting sequences which are exactly synchronized to the computer data collection intervals.
- Up to 120 monitors may be used per system, and additional units may be added at any time.
- Data collection intervals ranging from 1 second to 60 minutes are available, up to a maximum of 100000 readings per monitor.
- DAMSystem data collection software is available for both the Apple Macintosh and Windows PC.

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Drosophila Activity Monitor

DAM2

The ***DAM2 Drosophila Activity Monitor*** measures the locomotor activity of 32 individual flies, each in a separate tube. As a fly walks back and forth within its tube, it interrupts an infrared beam that crosses the tube at its midpoint, and this interruption, detected by the onboard electronics, is added to the tube's activity count as a measure of fly activity.

In a typical experiment, an agar/sucrose food mixture is placed into one end of each tube, followed by the fly, and followed by a cotton plug in the open end. The 32 tubes are inserted into holes in the monitor case, and centered.

Over the course of the experiment, which may last for days or weeks, the counting circuits continuously monitor the activity in all 32 tubes, and at periodic intervals, upload their count totals to the host computer for storage and later analysis. This daily record provides a good measure of both the intensity of locomotor activity, and the relative periods of rest.

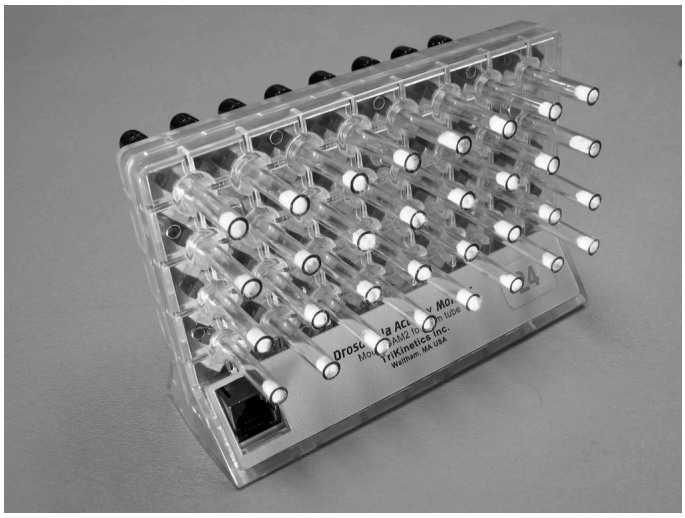
The DAM2 is fabricated from a transparent polycarbonate plastic, allowing light penetration to all points along the tube. It is compact, light in weight, and when used within an incubator, allows plentiful air circulation around the tubes. The through-hole design accommodates tubes of arbitrary length.

An on/off visible light sensor is built into each unit to provide a simple record of the ambient light state over time. This record accompanies the activity count data as it is acquired and stored, and is useful in analyzing circadian rhythms and adaptations of the flies to external light stimuli.

An optional gas distribution manifold is available to facilitate the controlled exchange of air within the tubes, as would be needed for hypoxia studies.

Specifications

- Dimensions: 127 x 48 x 87 mm LWH (5.0 x 1.9 x 3.4")
- Mass: 170g
- Tube diameter: DAM 2 = 5 mm
  DAM 2-7 = 7 mm
- Ambient Light Sensor threshold: 10 lux nominal, photopic response curve
- Interconnect: 4 wire, 6 position, RJ-11 modular telephone line jack to DAMSystem network for DC power input and data transmission
- Case material: Clear polycarbonate plastic



Features

- 32 independent activity channels per monitor.
- Up to 120 monitors per system provide over 3000 simultaneous monitoring channels.
- Compact design allows efficient use of incubator shelf space.
- Standard 5mm tube size (model DAM2) for studies of *drosophila melanogaster*.
- 7mm tube size (model DAM2-7) accommodates *d. virilis* and larger species.
- Ambient light sensor provides on/off record of entrainment cycles and stimulation pulses, as well as inadvertent light exposure.
- Consistent operation in ambient light levels from bright laboratory to total darkness.
- Optional gas distribution manifold allows controlled air exchange within the tubes.
- Available tubes (diameter x length):
  PGT5x65 = 5 x 65 mm Pyrex Glass
  PGT7x65 = 7 x 65 mm Pyrex Glass
  PPT5x65 = 5 x 65 mm Polycarbonate Plastic

  Plastic caps are available to seal the food in place of the traditional hot wax dip.

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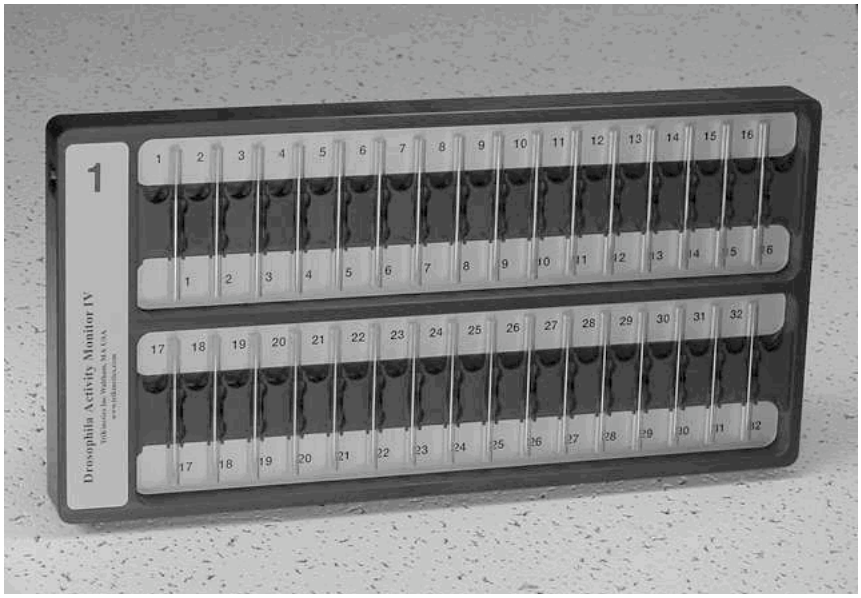
Drosophila Activity Monitor

DAM 5
DAM 10



The ***Drosophila Activity Monitor*** measures the activity rhythms of 32 individual flies, each in its own glass tube. In a typical experiment, a food mixture is placed into one end of the empty tube, and sealed on the outside with a wax coating. The fly is then inserted into the tube, followed by a cotton plug or ventilated plastic cap on the other end.

The tube is snapped into the plastic clips of the monitor case, and if the tube is horizontal, an active fly will walk back and forth from one end to the other. Each time that it does so, it breaks an infrared light beam which bisects the tube, perpendicular to its axis. This event is detected by the on-board electronics, and added to the count which is maintained for each channel.

At periodic intervals, ranging from 1 second to 1 hour, the DAMSystem software in the host computer acquires from the monitor its set of 32 count totals, and saves them. This archival record of the activity of each fly over the duration of the experiment may be plotted or analyzed, and used, for example, to measure the period and phase of the internal circadian clock of each of the 32 flies.

Such measurements have been instrumental to the scientific study of fly behavior, and its genetic basis - the circadian clock being the cornerstone. (See: THE TICK-TOCK OF THE BIOLOGICAL CLOCK. Michael W. Young in *Scientific American,* Vol. 282 No. 3, March 2000.)

Specifications

- Dimensions: 13.50 x 6.82 x 1.03” (343 x 173 x 26 mm)
- Mass: 1.2 kg
- Glass Tubes: Corning Pyrex standard wall tubing, according to model:
  DAM 5 = 5 mm diameter
  DAM10 = 10 mm diameter
- Maximum Tube Length: 3.00” (76 mm)
- Interconnect: 4 wire, 6 position, RJ-11 modular telephone line jack to DAMSystem network for DC power input and data transmission
- Case material: PVC/ABS plastic

Features

- 32 independent activity channels per monitor.
- Up to 120 monitors per system provide over 3000 simultaneous monitoring channels.
- Models available for various tube diameters:
  DAM 5 5 mm tube (for *D. melanogaster*)
  DAM10 10 mm tube
- Built-in clips hold tubes in place during handling.
- Recessed tube mounts allow monitors to be safely stacked with tubes installed.
- Telephone-type wiring jack allows easy connection to DAMSystem wiring network.
- Consistent operation in ambient light levels from bright laboratory to total darkness.
- Field-proven design over years of continuous use.
- Optional accessories: Pyrex Glass Tubes
  5 mm dia x 65 mm length
  10 mm dia x 70 mm length

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Drosophila Eclosion Monitor

DEM

The ***Drosophila Eclosion Monitor*** uses a glass funnel and infrared counting electronics to collect and measure the eclosion time history of a population of hatching flies.

Mature pupae cases are glued to a plastic disk, which is then inverted over the mouth of the glass funnel (see photo), and held in place by the tapping solenoid. Emerging flies fall down by gravity, and out through the funnel neck, where their passage is detected and counted by a set of infrared light beams.

At periodic, user-programmable intervals, the solenoid tapping mechanism briefly pushes down the disk/funnel stack, using enough force to dislodge any recalcitrant flies which may remain adhered to the disk or funnel surfaces. This insures that all eclosed flies are counted within a short time of their emergence, and that none will remain in the funnel cavity to reach flying maturity.

The onboard electronics maintains a count of the flies which fall through the funnel neck, and periodically on command uplinks this total to the DAMSystem computer for archival storage and analysis.

The funnel neck protrudes through the bottom of the monitor case, allowing for closed capture of the emerging flies by a vial morgue or collection apparatus. Tapped mounting holes are provided in the sides and bottom of the case to secure the unit to an incubator shelf, lest it walk during periods of extended tapping operation.

Specifications

- Dimensions: 4.375” sq. x 9.75 high” (111 mm sq. x 248 mm high)
- Mass: 1.8 kg (includes funnel and disk)
- Funnel stem extension below unit housing: 1.5” (38 mm)
- Tap excursion: 0.175” (4 mm)
- Tap frequency/duration: programmable
- Detection size threshold: 0.5 mm or smaller.
- Interconnect: 4 wire, 6 position, RJ-11 modular telephone line jack to DAMSystem network for DC power input and data transmission
- Glass funnel: Kimble #28950-100 (diameters: 100 mm mouth, 9 mm neck)
- Case material: Anodized aluminum, nylon

Features

- Wide funnel mouth captures emerging flies over large area.
- Built-in tapping solenoid shakes new imagoes loose from disk and funnel surfaces.
- Tapping mechanism swings aside for funnel/disk removal. Height adjustment controls tap strength.
- Telephone-type wiring jack allows easy connection to DAMSystem wiring network.
- Consistent operation in ambient light levels from bright laboratory to total darkness.
- Accessories included: Glass funnel, plastic pupae disk

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Drosophila Population Monitor

DPM

The ***Drosophila Population Monitor*** is built around a standard 25 mm diameter plastic or glass *drosophila* vial. A fly-food mixture is cast into the closed end, and a population of flies is then inserted, followed by a cotton plug.

The vial is placed into the monitor, with the closed end protruding through the rear housing, and resting against the end stop, As the flies walk back and forth along the walls of the tube, they interrupt the infrared beam rings which cross in 3 places along its length. These beam interruptions are detected and counted by the onboard electronics, and the totals are reported periodically to the host computer over the DAMSystem wiring network.

The infrared beam rings form narrow planes of invisible light which cross the tube, perpendicular to its long axis. A fly which moves anywhere within the plane of such a beam, either on the wall or in the middle, will be detected and counted as an activity event. Multiple flies which penetrate the beam simultaneously may well be counted only singly, though the likelihood of such an exact coincidence will remain small as long as the number of captive flies is reasonable (<100).

The archival record of the aggregate activity within the vial over an extended period of time may be used to characterize the circadian rhythm of a population of flies, or study the impact of social interaction on such naturally occurring rhythms. The multiple beam rings provide such measurements at 3 different positions relative to the food and tube ends, either for redundancy, or more detailed activity analysis.

Specifications

- Dimensions: 3.90 x 3.38 x 4.38” LWH (99 x 86 x 111 mm)
- Mass: 0.25 kg
- Beam ring separation: 0.94” (24 mm)
- First beam ring registration to end stop: 1.0” (25 mm) adjustable.
- Interconnect: 4 wire, 6 position, RJ-11 modular telephone line jack to DAMSystem network for DC power input and data transmission.
- Vial size: 25 mm diameter, plastic or glass
- Case material: ABS plastic

Features

- Uses standard 25 x 95 mm *drosophila* vials.
- Ring detectors at 3 axial positions allow redundant measurement for comparison purposes.
- Open construction allows light penetration to the vial contents.
- Adjustable end stop provides repeatable positioning of the vial with respect to the detector rings.
- Horizontal or vertical vial orientation.
- Telephone-type wiring jack allows easy connection to DAMSystem wiring network.
- Consistent operation in ambient light levels from bright laboratory to total darkness.
- Accessories included: Glass vial

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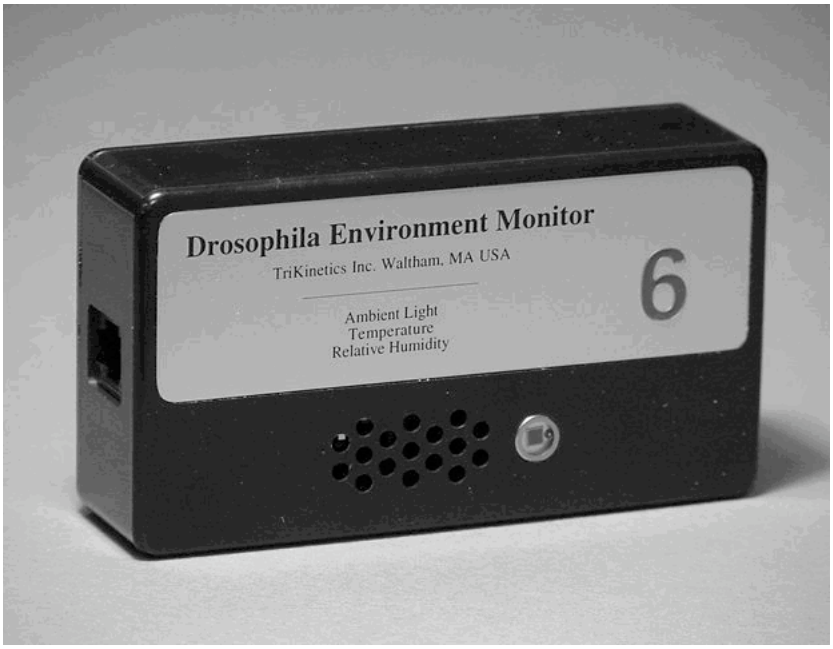
Drosophila Environment Monitor

DEnM



The ***Drosophila Environment Monitor*** continuously measures the temperature and relative humidity of its surrounding air, and the visible-band illumination of its top surface. These parameters are reported periodically to the DAMSystem host computer, providing an archival record of the environmental conditions within an incubator chamber over the course of an experimental run.

Temperature and relative humidity are measured by precision sensors located just beneath the perforation holes in the top surface of the unit (see photo). An identical pattern in the bottom surface allows ambient air to circulate in and around the sensors.

Incident light intensity is measured by the round photodiode sensor on the top surface. A visible-wavelength filter rejects IR and UV light, providing a sensitivity curve which approximates the photopic response.

In each case, the instantaneous values are reported, along with their minimum, average, and maximum values over the measurement period, allowing for detection of short-term upsets and characterization of environmental performance and stability.

Specifications

- Dimensions: 4.4 x 2.5 x 1.2” LWH (112 x 64 x 30 mm)
- Mass: 115 g
- Temperature:
  Accuracy: +/- 0.1 deg C
  Range: 0-70 deg C
- Relative Humidity:
  Accuracy: +/- 2%
  Range: 0-100% (non-condensing)
- Incident Light Intensity:
  Accuracy: +/- 5% (calibrated to CW fluorescent)
  Range: 0-2500 lux
  Peak wavelength: 550 nm
  Filter cutoff: 10% of peak at 350 and 820 nm
  Angular sensitivity: 50% at 55 degrees off axis
- Interconnect: 4 wire, 6 position, RJ-11 modular telephone line jack to DAMSystem network for DC power input and data transmission
- Case material: Black plastic

Features

- Accurately measures temperature, relative humidity, and incident ambient light.
- Precision temperature measurement verifies incubator setpoint accuracy and stability.
- Ambient light sensor verifies proper on/off light cycling, and detects inadvertent door openings, confirming true-dark conditions.
- Accurate lux measurement checks lighting intensity and uniformity.
- Min/Max readings detect short-term upsets to average conditions.
- Small unit size allows parameter measurement at various points within a chamber interior.
- Telephone-type wiring jack allows easy connection to DAMSystem wiring network.
- Data acquisition via standard DAMSystem software provides seamless archival record of environmental conditions.

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Power Supply Interface Unit

PSIU9

Successor to the venerable 'blue box,' the compact ***Power Supply Interface Unit*** provides a convenient connection between the host PC or Macintosh data collection computer and the network of activity monitors.

Enclosed in a small (gray) plastic housing, the PSIU uses a USB connection to transmit and receive data from the host computer, and an array of RJ-11 phone-type jacks to connect to the activity monitors.

DC power to the PSIU, and in turn the activity monitors, is supplied by an external 9V power supply through one of two power input jacks. If both jacks are used, and connected to independent 9V power sources, the system will be protected by redundancy against failure of a single power supply. The PSIU will automatically switch to the good input, and power to the activity monitors will be uninterrupted.

Green and yellow status lights on the top of the unit indicate the presence of input power and the transmission of data to and from the collection computer.

Specifications

- Dimensions: 80 x 80 x 27 mm LWH (3.15 x 3.15 x 1.05")
- Mass: 125g
- Computer interconnect: A-B male USB cable (supplied)
- Monitor interconnect: 4 6-position RJ-11 modular telephone line jacks to DAM-System monitor network for DC power and data transmission
- Power input: 9VDC, 3A maximum on each of 2 input jacks
- Power input jacks: 5.5mm OD x 2.5mm ID round, center pin positive
- Compatible power supplies: PS9-1 or PS9-3, universal input (supplied)
- Case material: ABS plastic

Features

- Compact size allows easy desktop placement adjacent to collection computer.
- USB connection to host facilitates use with any current desktop or laptop Macintosh or Windows PC for data collection and storage.
- 4 telephone-type jacks provide direct connection to 4 activity monitors or monitor networks. Additional monitors are connected in 'daisy-chain' fashion using 5-way splitters (supplied as necessary.)
- Universal-input external power supplies allow straight-forward worldwide operation (100-240 VAC, 50/60hz.)
- Dual DC power inputs offer protection against power supply failure. Redundant switchover is automatic, with no output power interruption or data loss.
- Status leds indicate power inputs and data transmission.
- Accessories included: USB cable, PS9-1 Power Supply, AC Line Cord.

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Notes

Basic System	A basic system will include the PSIU9 with PS9-1 Power Supply, one or more activity monitors, and a customer-supplied Macintosh or Windows PC with USB port. Optional accessories will include a 2nd Power Supply for redundancy, a Light Controller for incubator light timing, and monitor tubes.
Wiring Accessories	All systems are shipped with appropriate DAMSystem network wiring accessories, including cables, couplers, and 5-way splitters. Monitor cables are 90cm (3') long, and extension cables are 3m (10') long, unless otherwise specified.
Monitor Numbers	All units are identified by a unique numeric address in the range 1:120, which must be specified at the time of order. Addresses should not be duplicated within a system, and will be assigned consecutively from #1 unless otherwise specified.
Software	The DAMSystem data acquisition software package for both Macintosh and Windows PC is available for download from the TriKinetics web site, www.trikinetics.com.
Modifications	Custom variants of any and all of the above-listed products and accessories are available on request.
Foreign Orders	Overseas shipment is available for any item. Foreign customers should be advised that VAT or other import duty will likely be assessed on arrival, and may slow delivery if preparations are not made in advance.
Suggestions	Comments on product performance, and suggestions for product improvement, are particularly important to us, and always welcome.
Warranty and Repair	Defective units will be repaired at no charge.
Specifications	All specifications are nominal, and subject to change without notice to improve product reliability or performance. No liability is assumed for loss of data or consequential damages, and all trademarks are the property of their respective owners.
Acknowledgments	These units were developed with the continuing assistance and support of scientists in many laboratories around the world, and this support is gratefully acknowledged. We are especially indebted to Drs. Michael Rosbash and Jeffrey Hall at Brandeis University for their cooperation and assistance in the early days.

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